HDR Architecture, Inc.

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Construction Documents
Project Manual

VOLUME 02

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SECTION 21 05 11
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 21.

B. Definitions:
   1. Exposed: Piping and equipment exposed to view in finished rooms.
   2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Excavation and Backfill: Section 31 20 00, EARTH MOVING.

D. Concrete and Grout: Section 03 30 00, CAST-IN-PLACE CONCRETE.

E. Building Components for Attachment of Hangers: Section 05 31 00, STEEL DECKING. Section 05 36 00, COMPOSITE METAL DECKING.

F. Section 05 50 00, METAL FABRICATIONS.

G. Section 07 84 00, FIRESTOPPING.

H. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.

I. Section 07 92 00, JOINT SEALANTS.

J. Section 09 91 00, PAINTING.

K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.3 QUALITY ASSURANCE

A. Products Criteria:
   1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. See other specification sections for any exceptions.
   2. Equipment Service: Products shall be supported by a service organization which maintains a complete inventory of repair parts and is located reasonably close to the site.
   3. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
   4. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
   5. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
   6. Asbestos products or equipment or materials containing asbestos shall not be used.

B. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

C. Guaranty: In GENERAL CONDITIONS.

D. Supports for sprinkler piping shall be in conformance with NFPA 13.

E. Supports for standpipe shall be in conformance with NFPA 14.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
   1. Equipment and materials identification.
   2. Fire-stopping materials.
   3. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
   4. Wall, floor, and ceiling plates.

C. Coordination Drawings: Provide detailed layout drawings of all piping systems. Provide details of the following.
   1. Mechanical equipment rooms.
   2. Ceiling space.
   3. Hangers, inserts, supports, and bracing.
   4. Pipe sleeves.
   5. Equipment penetrations of floors, walls, ceilings, or roofs.

D. Maintenance Data and Operating Instructions:
   1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
   2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment.

1.5 APPLICABLE PUBLICATIONS

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

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

A36/A36M-2001	Carbon Structural Steel
A575-96	Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)
E84-2003	Standard Test Method for Burning Characteristics of Building Materials
E119-2000	Standard Test Method for Fire Tests of Building Construction and Materials

C. National Fire Protection Association (NFPA):

90A-96	Installation of Air Conditioning and Ventilating Systems
101-97	Life Safety Code

PART 2 - PRODUCTS

2.1 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.2 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.

B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.

D. Control Items: Label all sensors, controllers and control devices .

E. Valve Tags and Lists:
   1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm(1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
   2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
   3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.3 FIRESTOPPING

A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping.

2.4 GALVANIZED REPAIR COMPOUND

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

2.5 PIPE PENETRATIONS

A. Install sleeves during construction.

B. To prevent accidental liquid spills from passing to a lower level, provide the following:
   1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
   2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
   3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.

C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Resident Engineer.

D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.

F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms and animal rooms.

G. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.

H. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.6 TOOLS AND LUBRICANTS

A. Furnish, and turn over to the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each equipment.

C. Tool Containers: Hardwood or metal, permanently identified for in tended service and mounted, or located, where directed by the Resident Engineer.

D. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.7 WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

PART 3 - - EXECUTION

3.1 INSTALLATION

A. Coordinate location of piping, sleeves, inserts, hangers, and equipment. Locate piping, sleeves, inserts, hangers, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.

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

C. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

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

E. Work in Animal Research Areas: Seal all pipe penetrations with silicone sealant to prevent entrance of insects.

F. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

G. Inaccessible Equipment:
   1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
   2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 LUBRICATION

A. Field check and lubricate equipment requiring lubrication prior to initial operation.

3.3 STARTUP AND TEMPORARY OPERATION

A. Start up equipment as described in equipment specifications. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.4 OPERATING AND PERFORMANCE TESTS

A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.

C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.5 INSTRUCTIONS TO VA PERSONNEL

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

END OF SECTION

SECTION 21 08 00
COMMISSIONING OF FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 21.

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 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 Fire Suppression systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more 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 this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Fire Suppression systems will be commissioned:
   1. Fire Protection System (Wet-pipe fire suppression and stand pipes).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 21 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 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. 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 21 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 21 10 00
WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The design and installation of a hydraulically calculated automatic fire sprinkler system complete and ready for operation, for the entire building including the penthouse mechanical equipment room, elevator machine rooms, elevator pits, and accessible shafts.

B. The design and installation of a standpipe system combined with the sprinkler system.

C. Installation of new sectional valves in the sprinkler/standpipe system feed mains as indicated on the drawings.

D. Provide access doors or panels where control or drain valves are located behind plaster or gypsum walls or ceilings as necessary to install piping above suspended plaster or gypsum ceilings.

E. Painting of exposed piping and supports to follow Section 09 91 00, PAINTING.

1.2 RELATED WORK

A. Treatment of penetrations through rated enclosures: Section 07 84 00, FIRESTOPPING.

B. Access panels for plaster ceilings: Section 08 31 13, ACCESS DOORS AND FRAMES.

C. Painting of exposed pipe: Section 09 91 00, PAINTING.

D. Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION.

E. Alarm Supervision: Section 28 31 00, FIRE DETECTION AND ALARM.

F. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 DESIGN CRITERIA

A. The design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system and standpipe system shall be in accordance with the required advisory provisions of NFPA 13, 14, and 25. Exception to NFPA Fire Codes are as follows:
   1. Standpipe system shall be sized to meet volume requirements of NFPA 14 but not pressure requirements.

B. Base system design hydraulic calculations using the area/density method on the following criteria and in accordance with NFPA 13 latest edition.
   1. Sprinkler Protection:
      a. All areas of the building, including: Mechanical Equipment Rooms, Transformer Rooms, Electrical Rooms, Electric Closets, Elevator Shafts (if required), Elevator Machine Rooms, and storage rooms: Ordinary Hazard, Group 2, 8.1 L/minute/m² (0.20 gpm/sq. ft.) over the hydraulically most remote 140 m² (1500 sq. ft.).
      b. Provide sprinklers in accessible shafts per NFPA 13 latest edition.
   2. Add water allowance of 15 L/s (250 gpm) for inside and outside hose streams to the sprinkler requirements at the connection to the distribution main.
   3. Hydraulic Calculations: The calculated demand including hose stream requirements shall fall no less than 10 percent below the available supply curve.

4. Water Supply:
    a. Elevation of static and elevation of residual test gage: 600 mm (2 ft.) above site grade
    b. Static pressure: 40 psi
    c. Residual pressure: 35 psi
    d. Flow: 820 gpm
    e. Date: November 4, 2010 Time: Afternoon

D. For each sprinkler zone provide a control valve, flow switch, self-contained test, drain assembly and pressure gage.

E. Provide a separate sprinkler valve for each traction elevator shaft and other areas as required by NFPA 13 latest edition.

F. Provide a guard for each sprinkler in the janitors closets, the elevator machine room and sprinklers within 2100 mm (7 ft.) of the floor and other areas as required by NFPA 13.

G. Seismic Protection: Seismically brace all new piping systems in accordance with NFPA 13 latest edition.

1.4 QUALIFICATIONS:

A. Designer's Qualifications: Design work and shop drawings shall be prepared by a licensed engineer practicing in the field of Fire Protection Engineering or a NICET (National Institute for Certification in Engineering Technologies) Level III sprinkler technician.

B. Installer's Qualifications: The installer shall possess a valid State fire protection contractor's license. The installer shall provide documentation of having successfully completed three projects of similar size and scope.

C. On-site emergency service within four hours notification.

1.5 SUBMITTALS

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

B. Sprinkler design shall be preformed by professional's Registration or Certification. All plans shall be stamped by qualified P.E.

C. Emergency service point of contact name and 24 hour emergency telephone number.

D. Manufacturer's Literature and Data:
    1. Pipe and fittings.
    2. Valves
    3. Drips
    4. Fire Department Siamese Connection
    5. Sprinklers-each type, temperature and model
    6. Inspectors Test Alarm Modules
    7. Sprinkler Cabinets
    8. Sprinkler Plugs
    9. Pressure Gages
    10. Pressure Switches
    11. Pipe Hangers and Supports
    12. Water Flow Switches
    13. Valve Tamper Switches
    14. Water Motor Alarm
    15. Double Detector Check Valve Assembly
    16. Water Measuring Device

E. Detailed drawings in accordance with NFPA 13 and NFPA 14, the latest editions. Drawings shall be prepared using CADD software stamped by fire protection professional engineer and include all new and existing sprinklers and piping. Use format in use at the VA medical center. Drawings are subject to change during the bidding and construction periods. Any wall and ceiling changes occurring prior to the submittal of contractors shop drawings shall be incorporated into the contractors detailed design at no additional contract cost.

F. Hydraulic calculations for each sprinkler system in accordance with NFPA 13 latest edition.

G. Operation and Maintenance Data:
   1. Indicating Valves
   2. Water Flow and valve tamper switches
   3. Alarm Valves

H. Recommended preventive maintenance schedule.

1.6 AS-BUILT DOCUMENTATION

A. A mylar as-built drawing and two blueline copies shall be provided for each drawing. One copy of final CADD drawing files shall also be provided on 89 mm (3 1/2 in.), 1.44 mb diskette, for each drawing.

B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

C. Four sets of hydraulic calculations for each sprinkler system updated to include submittal review comments and any changes to the installation which affect the calculations including one electronic set in PDF format.

D. Four copies of the hydrostatic report and NFPA 13 material and test certificate for each sprinkler system.

E. Four sets of operation and maintenance data updated to include submittal review comments and any equipment substitutions including one copy of NFPA 25.

F. Manufacturers literature, hydraulic calculations, reports and operation and maintenance data shall be in a labeled 3-ring binder.

1.7 WARRANTY

A. All work performed and materials and equipment furnished under this contract shall be free from defects for a period of one year from date of acceptance by the government.

B. All new piping and equipment incorporated into the new system shall be hydrostatically tested and warranted as new.

1.8 APPLICABLE PUBLICATIONS

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

B. National Fire Protection Association (NFPA)

13-2010	Installation of Sprinkler Systems
14-2010	Installation of Standpipe and Hose Systems
24-2010	Installation of Private Fire Service Mains and Their Appurtenances
25-2011	Inspection, Testing and Maintenance of water Based Fire Protection Systems
70-2011	National Electrical Code
72-2010	National Fire Alarm Code

170-2009 Standards for Fire Safety Symbols
291-2010 Fire Flow Testing and Marking of Hydrants

C. Underwriters Laboratories Inc. (UL)
2006 Fire Protection Equipment Directory

D. Factory Mutual Engineering Corporation (FM)
2006 Approval Guide

E. American Society for Testing and Materials (ASTM)
F442-99(2005) Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe

F. American Society of Sanitary Engineering (ASSE)
1015-2005 Double Check Backflow Prevention Assembly

G. Complete maintenance and inspection service for the sprinkler systems shall be provided by a factory trained authorized representative of the manufacturer of the major equipment for a period of one year after acceptance of the entire installation by the government.

H. Contractor shall provide all necessary test equipment, parts and labor to perform required maintenance.

I. All inspections, testing and maintenance work required by NFPA 25, NFPA 14, NFPA 13 and recommended by the equipment manufacturer shall be provided. Work shall include operation of sprinkler system alarm and supervisory devices.

J. Maintenance and testing shall be performed on a quarterly basis. A computerized preventive maintenance schedule shall be provided and shall describe the protocol for preventive maintenance of equipment. The schedule shall include a systematic examination, adjustment, and cleaning of all equipment.

K. Non-included Work: Maintenance service shall not include the performance of any work due to improper use, accidents or negligence for what the contractor is not responsible.

L. Service and emergency personnel shall report to the Engineering Office or their authorized representative upon arrival at the hospital and again upon the completion of the required work. A copy of the work ticket containing a complete description of work performed and parts replaced shall be provided.

M. Emergency Service:
1. Normal and overtime emergency call-back service shall consist of an on-site response to calls within four hours of notification.
2. Overtime emergency call-back service shall be limited to minor adjustments and repairs to effect the integrity of the system.
3. The standpipe system and sprinkler system must be operational before the responding service person leaves the facility.

PART 2 - PRODUCTS

2.1 GENERAL

A. All devices and equipment shall be Underwriters Laboratories Inc. listed for their intended purpose. All sprinklers shall be Factory Mutual approved.

2.2 PIPING AND FITTINGS

A. Pipe and fittings from inside face of building 300 mm (12 in.) above finished floor to a distance of approximately 1500 mm (5 ft.) outside building: Ductile Iron, flanged fittings and 316 stainless steel bolting.

B. Fire Protection water supply within the building up to sprinkler system isolation valves shall be per NFPA 13 and of black steel, schedule 10 minimum.

C. Sprinkler piping downstream of the isolation valve on wet-pipe systems shall be per NFPA 13 and of black steel, schedule 10 minimum.

D. Threaded or flanged fittings shall be ANSIB1 6.3 cast iron, class 125 minimum. Threaded fittings are not permitted on pipe with wall thickness less than schedule 40.

E. Slip type or clamp-on type rubber gasketed fittings shall be listed for each piping application.

F. Piping Materials Standards:
   1. Ferrous piping – follow ASTM A 795 Standard
   2. Welded and seamless steel pipe – follow ANSI/ASTM A 53
   3. Wrought steel pipe – follow ANSI/ASME B36.10M
   4. Electric resistance welded steel pipe – follow ASTM A 135

G. Fitting Materials Standards:
   1. Cast iron threaded fitting, Class 125 and 250 - follow ASME B16.4
   2. Cast iron pipe flanges and flanged fittings - follow ASME B16.1
   3. Malleable iron threaded fittings, Class 150 and 300 steel - follow ASME B16.3
   4. Factory made wrought steel buttweld fittings - follow ASME B16.9
   5. Buttwelding ends for pipe, valves, flanges, and fitting - follow ASME B16.25

H. Pipe Identification – All pipe, including specially listed pipe allowed by NFPA 13, shall be marked continuously along its length by the manufacturer in such a way as to properly identify the type of pipe. Pipe identification shall include the manufacturer's name, model designation, or schedule.

2.3 VALVES

A. Listed Indicating Valves:
   1. Gate: OS&Y, 1200 kPa (175 lb.) WOG or equal.
   2. Butterfly: Gear operated, indicating type, 1200 kPa (175 lb.) WOG or equal. Butterfly valves are to be installed in a manner that does not interfere with the operation of any system component.
   3. Ball (inspectors test and drain only): iron body, stainless steel trim, for 2050 kPa (300 psi) service, indicating type.
   4. Ball and butterfly valves shall not be used on incoming water service.

B. Check Valves: Swing type, rubber faced or wafer type spring loaded butterfly check valve, 1200 kPa (175 lb.) WOG or equal.

C. Alarm Check: Iron body, bronze mounted, variable pressure type with retarding chamber. Provide basic trimmings for alarm test by pass, gages, drain connections, mounting supports for retarding chamber, and drip funnel. Provide pressure sensitive alarm switch to actuate the fire alarm system.

D. Drain Valves: Threaded bronze angle, globe, ball or butterfly, 1000 kPa (150 lb.) WOG or equal equipped with reducer and hose connection with cap or connected to a drain line.

E. Self-contained Test and Drain Valve:

1. Ductile iron body with bronze “Drain” and “Test” bonnets. Acrylic sight glass for viewing test flow. Various sized orifice inserts to simulate flow through 14 mm (17/32 in.), 13 mm (1/2 in.), 12 mm (7/16 in.), and 10 mm (3/8 in.) diameter sprinklers, 32 mm (1 1/4 in.) female threaded outlets or 32 mm (1 1/4 in.) one-quarter turn locking lug outlets for plain end pipe (end preparation to be in accordance with manufacturer’s recommendation).
2. Bronze body, with chrome plated bronze ball, brass stem, steel handle, teflon seat and sight glasses. Provide valve with three position indicator plate (off, test, and drain), 6 mm (1/4 in.) tapping for pressure gage and various other orifice inserts to simulate flow through 10 mm (3/8 in.), 12 mm (7/16 in.), 13 mm (1/2 in.), and 14 mm (17/32 in.) diameter sprinklers.

F. Standpipe Hose Valve: 65 mm (2 1/2 in.) screwed, brass hose angle valve, 2050 kPa (300 psi) WWP, male hose threads same as local fire department service, 65 mm x 40 mm (2 1/2 in. x 1 1/2 in.) reducer, and with permanently attached polished brass cap and chain: Provide for valves installed in a cabinet a 65 mm (2 1/2 in.) attached cap and chain and a 65 mm x 40 mm (2 1/2 in. x 1 1/2 in.) reducer placed in cabinet.

G. Standpipe hose valve cabinets: Cabinets shall be white glossy polyester coated 20 gage steel with continuous steel hinge with brass pin, recessed type 600 x 600 x 250 mm (24 x 24 x 10 in.).

H. Double Check Backflow Prevention Assembly: Provide two independent check valves with OS&Y shut off valves, ball type test cocks. Maximum friction loss through assembly shall not exceed 35 kPa (5 psi) at design flow. Unit shall be functional in vertical or horizontal position, rated for 1200 kPa (175 psi) working pressure. Check valve assembly shall be in accordance with AWWA Class D. Double check backflow prevention assembly shall be FM approved, ASSE approved and UL listed.

2.4 AUTOMATIC BALL DRIPS

A. Cast brass 20 mm (3/4 in.) in line automatic ball drip with both ends threaded with iron pipe threads.

2.5 FIRE DEPARTMENT SIAMESE CONNECTION

A. Brass, flush wall type, exterior fire department connection with brass escutcheon plate, without sill cock, and a minimum of two 65 mm (2 1/2 in.) connections threaded to match those on the local fire protection service, with polished brass caps and chains. Provide escutcheon with integral raised letters ”Standpipe and Automatic Sprinkler”. Provide connection with a swing check valve. Install an automatic ball drip between fire department connection and check valve to discharge over an indirect drain connection or to the outside. When additional alarm valve is installed, additional check valve is not required. Check valves must be installed in accordance with their vertical or horizontal listing.

2.6 SPRINKLERS

A. Quick response sprinklers shall be standard type except as noted below. The maximum distance from the deflector to finished ceiling shall be 50 mm (2 in.) for pendent sprinklers. Pendent sprinklers in finished areas shall be provided with semi-recessed adjustable screwed escutcheons and installed within the center one-third of their adjustment. The sprinkler shall be installed in the flush position with the element exposed below the ceiling line. At the specified locations, provide the following type of sprinklers. All sprinklers shall be FM approved. Provide quick response sprinklers in all areas, except where specifically prohibited by their listing or approval, and the following:

LOCATION	TYPE
Mechanical Equipment Rooms, Electrical & Electrical Switch Gear Rooms	Quick Response, Upright or Pendent Brass [93 °C (200 °F)]
Elevator Shafts, Elevator Machine Rooms, Elevator Pits	Standard Upright or Sidewall Brass [93 °C (200 °F)]
All Areas Not Listed Above	Quick Response, Recessed Pendent, Sidewall, Chrome Plated [66-74 °C (150-165 °F)]

B. Sprinklers to be installed as per NFPA 13.

2.7 TOOLS AND REPLACEMENT PARTS

A. Sprinkler Cabinet:
   1. Provide a minimum 5 percent spare sprinklers with escutcheons with a minimum of two of each type/or as required by NFPA-13, whichever is more demanding.
   2. Provide a minimum of two of each type sprinkler wrenches used.
   3. Install cabinets in each building where directed by the Resident Engineer.
   4. Spare sprinklers shall be kept in a cabinet where ambient temperatures do not exceed 100 Deg F.

B. Sprinkler system water flow switch: one of each size provided.

C. Sprinkler system valve tamper switch: one of each type provided.

D. Sprinkler system pressure switch: one of each type provided.

E. Provide two sprinkler plugs attached to multi-section extension poles 2400 mm (8 ft.) minimum.

2.8 IDENTIFICATION SIGNS

A. Provide for all new and existing sectional valves, riser control valves, system control valves, drain valves, test and drain connections and alarm devices with securely attached identification signs (enamel on metal) in accordance with NFPA 13.

2.9 STANDPIPE HOSE VALVE CABINETS

A. White glossy polyester coated 20 gage steel box, 20 gage tubular steel door and 18 gage frame with continuous steel hinge with brass pin, welded and ground smooth steel corner seams, recess type, 600 x 600 x 250 mm (24 x 24 x 10 in.). Finish door and frame with white prime polyester coating.

2.10 HANGERS AND EARTHQUAKE BRACING

A. In accordance with NFPA 13 and 14. Comply with seismic requirements as per 15050 for seismic zone locations.

2.11 WATERFLOW SWITCHES

A. Integral, mechanical, non-coded, non-accumulative retard type, with two sets of SPDT auxiliary contacts and adjustable from 0 to 90 seconds. Set flow switches at an initial setting between 20 and 30 seconds.

B. All conduit and wiring connected thereto, shall be provided in Section 28 31 00, FIRE DETECTION AND ALARM.

2.12 VALVE SUPERVISORY SWITCHES

A. Provide each indicating sprinkler and standpipe control valve with adequate means for mounting a valve supervisory switch.

B. Mount switch so as not to interfere with normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem is moved no more than one fifth of the distance from its normal position.

C. The mechanism shall be contained in a weatherproof die cast aluminum housing, which shall provide a 20 mm (3/4 in.) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.

D. Switch housing to be finished in red baked enamel.

E. Supervisory switches for ball and butterfly valves may be integral with the valve.

F. All conduit and wiring connected thereto shall be provided in Section 28 31 00, FIRE DETECTION AND ALARM.

2.13 PRESSURE SWITCHES

A. Provide with 15 mm (1/2 in.) NPT male pressure connection.

B. Alarm switch shall be activated by any flow of water equal to or in excess of the discharge from one sprinkler.

C. Supervisory switch shall be activated by either high or low air pressure condition.

D. Furnish switch in a red baked enamel, weatherproof, oil resistant housing with tamper resistant screws.

2.14 WATER MOTOR GONG

A. Provide water powered mechanical device providing an audible signal when there is a flow of water in the automatic sprinkler system.

2.15 WALL, FLOOR AND CEILING PLATES

A. Exposed piping passing through walls, floors or ceilings shall be provided with chrome colored escutcheon plates.

B. Comply with NFPA 101 Fire Barrier Penetration codes.

2.16 PRESSURE GAUGE

A. Provide a 690 kPa (100 psi) pressure gauge at each flow alarm switch location, at the top of each sprinkler or standpipe riser, at each main drain connection, and on the suction and discharge of the fire pump.

2.17 HANGERS

A. Hangers shall be designed to support five times the weight of the water filled pipe plus 250 Lb (114Kg) at each point of piping support.

B. These points of support shall be adequate to support the system.

C. The spacing between hangers shall not exceed the value given for the type of pipe as indicated in NFPA 13 tables.

D. Hanger components shall be ferrous.

E. Detailed calculations shall be submitted , showing stress developed in hangers, piping, fittings and safety factors allowed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Supervisory Switches: For each indicating sprinkler system riser, sprinkler zone, standpipe system zone , main service entrance, control valve, provide a supervisory switch that is connected to the fire alarm system. Standpipe hose valves and test and drain valves shall not be provided with supervisory switches.

B. Waterflow Switches: For each sprinkler zone and each standpipe zone (floor), provide a waterflow switch. Install waterflow switch and adjacent valves in easily accessible locations.

C. Sprinkler Zone: Provide a separate sprinkler zone for each floor.

D. Piping connections:
   1. Combined Standpipe and Sprinkler System: Provide standpipe system complete. Start the sprinkler system work for each zone at valve connection to standpipe location at each zone.

E. Drains, Test Pipes and Accessories:
   1. Provide a drain at base of risers, drain connection on valved sections, and drains at other locations for complete drainage of the system. Provide valve in drain lines and connect to the central drain riser. Discharge riser outside, or as indicated. The main drain shall be capable of full discharge test without allowing water to flow onto the floor.
   2. Provide test pipes in accordance with NFPA 13. Test pipes shall be valved and piped to discharge through proper orifice as specified above for drains.

F. Provide a 690 kPa (100 psi) pressure gage at each flow alarm switch location, at the top of each sprinkler or standpipe riser, and at each main drain connection.

G. Conceal all piping, except in stairwells and rooms without ceilings.

H. Install new piping and sprinklers aligned with natural building and other sprinklers lines.

I. Locate piping in stairways as near ceiling as possible to prevent tampering by unauthorized personnel. Provide a minimum headroom of 2250 mm (7 ft.-6 in.) for all piping.

J. Piping arrangement shall avoid contact with other piping and equipment and allow clear access to other equipment or devices requiring access or maintenance.

K. Cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections, shall be affixed near to the pipe where the originated. They shall be displayed until final inspection and then removed.

L. For each new fire department connection, locate the symbolic sign given in NFPA 170 a distance of 2400 to 3000 mm (8 to 10 ft.) above each connection location. The sign shall be 450 x 450 mm (18 x 18 in.) with symbol at least 350 x 350 mm (14 x 14 in.).

M. Firestopping shall comply with Section 07 84 00, FIRESTOPPING. All holes through stairways, and fire walls shall be sealed on a daily basis.

N. Provide hydraulic design information signage as required by NFPA 13 and 14.

O. Install access doors in ceilings of rooms where above ceiling access is required.

3.2 TEST

A. Automatic Sprinkler System: NFPA 13 and 25.

B. Standpipe and Hose System: NFPA 25.

3.3 INSTRUCTIONS

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the sprinkler system, on the dates requested by the COTR.

END OF SECTION

SECTION 22 05 11
COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section shall apply to all sections of Division 22.

B. Definitions:
   1. Exposed: Piping and equipment exposed to view in finished rooms.
   2. Option or optional: Contractor's choice of an alternate material or method.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 31 20 00, EARTH MOVING: Excavation and Backfill.

D. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.

E. Section 05 31 00, STEEL DECKING, Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.

F. Section 05 50 00, METAL FABRICATIONS.

G. Section 07 84 00, FIRESTOPPING.

H. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.

I. Section 07 92 00, JOINT SEALANTS.

J. Section 09 91 00, PAINTING.

K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS

L. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

M. Section 23 09 23, DIRECT DIGITAL CONTROLS FOR HVAC.

N. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

O. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT .

P. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.
2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
7. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
8. Asbestos products or equipment or materials containing asbestos shall not be used.

B. Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
4. All welds shall be stamped according to the provisions of the American Welding Society.

C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Resident Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract drawings and specifications shall be referred to the RE/COTR for resolution. Written hard copies or computer files of manufacturer’s installation instructions shall be provided to the RE/COTR at least two weeks prior to commencing installation of any item.

2. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved.

E. Guaranty: Warranty of Construction, FAR clause 52.246-21.

F. Plumbing Systems: IPC, International Plumbing Code.

1.4 SUBMITTALS

A. Submittals shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMNON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.

C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

F. Upon request by Government, lists of previous installations for selected items of equipment shall be provided. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.

G. Manufacturer's Literature and Data: Manufacturer’s literature shall be submitted under the pertinent section rather than under this section.
   1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
   2. Equipment and materials identification.
   3. Fire stopping materials.
   4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
   5. Wall, floor, and ceiling plates.

H. Coordination Drawings: In accordance with GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION. Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping until layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
   1. Mechanical equipment rooms.

2. Hangers, inserts, supports, and bracing.
3. Pipe sleeves.
4. Equipment penetrations of floors, walls, ceilings, or roofs.

I. Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
2. Listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be provided.
3. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:
1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Damaged equipment shall be replaced with an identical unit as determined and directed by the RE/COTR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.

B. Cleanliness of Piping and Equipment Systems:
1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC), latest edition. All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.6 APPLICABLE PUBLICATIONS

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

B. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):

SEC IX-2007 ..... Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications.

C. American Society for Testing and Materials (ASTM):
A36/A36M-2008 ..... Standard Specification for Carbon Structural Steel

A575-96 (R 2007) ..... Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)

E84-2005 .....Standard Test Method for Surface Burning Characteristics of Building Materials

E119-2008a .....Standard Test Methods for Fire Tests of Building Construction and Materials

D. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
SP-58-02.....Pipe Hangers and Supports-Materials, Design and Manufacture

SP 69-2003 (R 2004).....Pipe Hangers and Supports-Selection and Application

E. National Electrical Manufacturers Association (NEMA):
MG1-2003, Rev. 1-2007 .....Motors and Generators

F. International Code Council, (ICC):
IBC-06, (R 2007).....International Building Code

IPC-06, (R 2007) .....International Plumbing Code

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements.

B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
   1. All components of an assembled unit need not be products of same manufacturer.
   2. Constituent parts that are alike shall be products of a single manufacturer.
   3. Components shall be compatible with each other and with the total assembly for intended service.
   4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, shall be the same make and model

2.2 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.3 SAFETY GUARDS

A. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

B. All Equipment shall have moving parts protected from personal injury.

2.4 LIFTING ATTACHMENTS

A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.5 ELECTRIC MOTORS, MOTOR CONTROL, CONTROL WIRING

A. All material and equipment furnished and installation methods shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.

B. Special Requirements:
   1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
   2. Assemblies of motors, starters, and controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
   3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
      a. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
      b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
      c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
   4. Motor sizes shall be selected so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
   5. Motors utilized with variable frequency drives shall be rated “inverter-ready” per NEMA Standard, MG1, Part 31.4.4.2.

C. Motor Efficiency and Power Factor: All motors, when specified as “high efficiency or Premium Efficiency” by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as “NEMA premium efficient” and the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as “high efficiency or premium efficient” shall comply with EPACT.

D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.

F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.

G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

2.6 VARIABLE SPEED MOTOR CONTROLLERS

A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for specifications.

B. The combination of controller and motor shall be provided by the respective pump manufacturer, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps, shall be product of a single manufacturer.

C. Motors shall be premium efficient type, “invertor duty”, and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.

D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

2.7 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.

B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, fans, etc. shall be identified.

C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.

D. Control Items: All temperature, pressure, and controllers shall be labeled and the component’s function identified. Identify and label each item as they appear on the control diagrams.

E. Valve Tags and Lists:
   1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).
   2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm(1/4-inch) for service designation on 19 gage, 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.

3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. A copy of the valve list shall be mounted in picture frames for mounting to a wall.
4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling.

2.8 FIRE STOPPING

A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION, for pipe insulation.

2.9 GALVANIZED REPAIR COMPOUND

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

2.10 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC), latest edition, and SECTION 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Submittals based on the International Building Code (IBC), latest edition, SECTION 13 05 41 requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in a state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the Resident Engineer in all cases. See these specifications for lateral force design requirements.

B. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.

C. For Attachment to Concrete Construction:
   1. Concrete insert: Type 18, MSS SP-58.
   2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (4 inches) thick when approved by the Resident Engineer for each job condition.

D. For Attachment to Steel Construction: MSS SP-58.
   1. Welded attachment: Type 22.
   2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8-inch) outside diameter.

E. For Attachment to Wood Construction: Wood screws or lag bolts.

F. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

G. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.

1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2-inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.

H. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
   1. General Types (MSS SP-58):
      a. Standard clevis hanger: Type 1; provide locknut.
      b. Riser clamps: Type 8.
      c. Wall brackets: Types 31, 32 or 33.
      d. Roller supports: Type 41, 43, 44 and 46.
      e. Saddle support: Type 36, 37 or 38.
      f. Turnbuckle: Types 13 or 15.
      g. U-bolt clamp: Type 24.
      h. Copper Tube:
         1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with isolation tape to prevent electrolysis.
         2) For vertical runs use epoxy painted or plastic coated riser clamps.
         3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
         4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
      i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp. //Spring Supports (Expansion and contraction of vertical piping):
         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. //
      j. Spring hangers are required on all plumbing system pumps one horsepower and greater.
   2. Plumbing Piping (Other Than General Types):
      a. Horizontal piping: Type 1, 5, 7, 9, and 10.
      b. Chrome plated piping: Chrome plated supports.
      c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
      d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.

I. Pre-insulated Calcium Silicate Shields:
   1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
   2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
   3. Shield thickness shall match the pipe insulation.
   4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.

a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.

5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

J. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.11 PIPE PENETRATIONS

A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for all risers, except those contained in walls.

B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.

C. To prevent accidental liquid spills from passing to a lower level, provide the following:
1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.

D. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.

E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.

G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel Sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.

H. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.

I. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.12 TOOLS AND LUBRICANTS

A. Furnish, and turn over to the Resident Engineer, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

C. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the Resident Engineer.

D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.13 WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3 inch) pipe, 0.89 mm (0.035-inch) for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Wall plates shall be used where insulation ends on exposed water supply pipe drop from overhead. A watertight joint shall be provided in spaces where brass or steel pipe sleeves are specified.

2.14 ASBESTOS

1. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.

B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.

C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.

D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.

E. Location of pipe sleeves and chases shall be accurately coordinated with equipment and piping locations.

F. Cutting Holes:
   1. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by RE/COTR where working area space is limited.
   2. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
   3. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.

G. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.

H. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

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

J. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. shall be used for all pad or floor mounted equipment. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

K. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

L. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and section 23 09 23 DIRECT DIGITAL CONTROLS FOR HVAC

N. Work in Animal Research Areas: Seal all pipe penetrations with silicone sealant to prevent entrance of insects.

O. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.

P. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

Q. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as electrical conduit, motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

A. Continuity of operation of existing facilities may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.

B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 shall apply.

C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

3.3 RIGGING

A. Openings in building structures shall be planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.

C. All openings in the building shall be closed when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.

E. Contractor shall check all clearances, weight limitations and shall provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.

3.4 PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the Resident Engineer.

B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.

C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. A minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work shall be provided.

D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC), latest edition, and these specifications.

E. Overhead Supports:
   1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
   2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
   3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:
   1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
   2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
   3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a grout material to permit alignment and realignment.
   4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 LUBRICATION

A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.

B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be delivered to RE/COTR in unopened containers that are properly identified as to application.

C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.

D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

E. All lubrication points shall be extended to one side of the equipment.

3.7 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

B. In addition, the following special conditions apply:
   1. Cleaning shall be thorough. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.

2. The following Material And Equipment shall NOT be painted::
   a. Motors, controllers, control switches, and safety switches.
   b. Control and interlock devices.
   c. Regulators.
   d. Pressure reducing valves.
   e. Control valves and thermostatic elements.
   f. Lubrication devices and grease fittings.
   g. Copper, brass, aluminum, stainless steel and bronze surfaces.
   h. Valve stems and rotating shafts.
   i. Pressure gages and thermometers.
   j. Glass.
   k. Name plates.
3. Control and instrument panels shall be cleaned and damaged surfaces repaired. Touch-up painting shall be made with matching paint obtained from manufacturer or computer matched.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this.

3.8 IDENTIFICATION SIGNS

A. Laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance shall be placed on factory built equipment.

C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.9 STARTUP AND TEMPORARY OPERATION

A. Start up of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.10 OPERATING AND PERFORMANCE TESTS

A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the Resident Engineer.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.

C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests such systems respectively during first actual seasonal use of respective systems following completion of work.

3.11 OPERATION AND MAINTENANCE MANUALS

A. Provide four bound copies. The Operations and maintenance manuals shall be delivered to RE/COTR not less than 30 days prior to completion of a phase or final inspection.

B. All new and temporary equipment and all elements of each assembly shall be included.

C. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.

D. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.

E. Lubrication instructions, type and quantity of lubricant shall be included.

F. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.

G. Set points of all interlock devices shall be listed.

H. Trouble-shooting guide for the control system troubleshooting guide shall be inserted into the Operations and Maintenance Manual.

I. The combustion control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.

J. Emergency procedures.

3.12 INSTRUCTIONS TO VA PERSONNEL

A. Instructions shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 22 05 12
GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section describes the general motor requirements for plumbing equipment.

1.2 RELATED WORK:

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one section of Division 26.

B. 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection of motors: Section

C. Section 26 24 19, MOTOR-CONTROL CENTERS: Motor Control Centers.

1.3 SUBMITTALS:

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Motor nameplate information shall be submitted including electrical ratings, dimensions, mounting details, materials, horsepower, power factor, current as a function of speed, current efficiency, speed as a function of load, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
   3. Motor parameters required for the determination of the Reed Critical Frequency of vertical hollow shaft motors shall be submitted.

C. Manuals:
   1. Companion copies of complete maintenance and operating manuals, including technical data sheets and application data shall be submitted simultaneously with the shop drawings.

D. Certification: Two weeks prior to final inspection, unless otherwise noted, four copies of the following certification shall be submitted to the Resident Engineer:
   1. Certification shall be submitted stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.

1.4 APPLICABLE PUBLICATIONS:

A. The publications listed below (including amendments, addenda, revisions, supplements and errata) shall form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):
   MG 1-07 .....Motors and Generators

MG 2-01 .....Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators

C. National Fire Protection Association (NFPA):
70-08 .....National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 MOTORS:

A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.

B. Voltage ratings shall be as follows:
1. Single phase:
   a. Motors connected to 120-volt systems: 115 volts.
   b. Motors connected to 208-volt systems: 200 volts.
   c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
2. Three phase:
   a. Motors connected to 208-volt systems: 200 volts.
   b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
   c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
   d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
   e. Motors connected to high voltage systems: Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.

C. Number of phases shall be as follows:
1. Motors, less than 373 W (1/2 HP): Single phase.
2. Motors, 373 W (1/2 HP) and larger: 3 phase.
3. Exceptions:
   a. Hermetically sealed motors.
   b. Motors for equipment assemblies, less than 746 W (1 HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.

D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.

E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

F. Motor Enclosures:
1. Shall be the NEMA types shown on the drawings for the motors.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
4. All motors in hazardous locations shall be approved for the application and meet the Class and Group as required by the area classification.

G. Electrical Design Requirements
   1. Motors shall be continuous duty.
   2. The insulation system shall be rated minimum of class B, 130° C (266° F).
   3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80° C (176° F).
   4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
   5. Motors shall be suitable for full voltage starting, unless otherwise noted.
   6. Motors for variable frequency drive applications shall adhere to NEMA standards publication MG 1, Part 30, Application considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable voltage or Adjustable frequency controls, or both, or Part 31, Definite Purpose Inverter Fed Polyphase Motors.

H. Mechanical Design Requirements
   1. Bearings shall be rated for a minimum of 26,280 hours L-10 life at full load direct coupled, except vertical high thrust motors.
   2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30% of normal down thrust.
   3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
   4. Grease fittings, if provided, shall be Alemite type or equivalent.
   5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
   6. Vibration shall not exceed 0.15 inch per second, unfiltered peak.
   7. Noise level shall meet the requirements of the application.
   8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
   9. All external fasteners shall be corrosion resistant.
   10. Condensation heaters, when specified, shall keep motor windings at least 5° C (41° F) above ambient temperature.
   11. Winding thermostats, when specified shall be normally closed, connected in series.
   12. Grounding provisions shall be in the main terminal box.

I. Additional requirements for specific motors, as indicated in other sections, shall also apply.

J. NEMA Premium Efficiency Electric Motors, Motor Efficiencies: All permanently wired polyphase motors of 746 Watts (1 Horsepower) or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 Watts (one horsepower) or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Efficiencies Open Drip-Proof				Minimum Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

K. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM. Power factor correction capacitors shall be installed unless the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

3.2 FIELD TESTS

A. Megger all motors after installation, before start-up. All shall test free from grounds.

END OF SECTION

SECTION 22 05 19
METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the requirements for water meters and pressure gages.

1.2 RELATED WORK

A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Pressure Gages.
   2. Product certificates for each type of gauge

C. Operations and Maintenance manual shall include:
   1. System Description
   2. Major assembly block diagrams
   3. Troubleshooting and preventive maintenance guidelines
   4. Spare parts information.

D. Shop Drawings shall include the following:
   1. One line, wiring and terminal diagrams including terminals identified, protocol or communication modules, and Ethernet connections.

1.4 APPLICABLE PUBLICATIONS

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

B. American National Standards Institute (ANSI):
   American Society of Mechanical Engineers (ASME): (Copyrighted Society)
   B40.1-05 Gauges-Pressure Indicating Dial Type-Elastic

C. American Water Works Association (AWWA):
   C700-07 (R 2003) Standard for Cold Water Meters, Displacement Type, Bronze Main Case
   C701-07 Cold Water Meters-Turbine Type, for Customer Service AWWA/ ANSI
   C702-01 Cold water meters – Compound Type

D. International Code Council (ICC):
   IPC-06 (2007 Supplement) International Plumbing Code

1.5 AS-BUILT DOCUMENTATION

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

B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

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

PART 2 - PRODUCTS

2.1 PRESSURE GAGES FOR WATER USAGE

A. ANSI B40.1 all metal case 114 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 1375 kPa (0 to 200 psi) gauge.

B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.

C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psi.

D. The pointer shall be dark colored metal.

E. The window shall be glass.

F. The ring shall be brass or stainless steel.

G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Direct mounted pressure gages shall be installed in piping tees with pressure gage located on pipe at the most readable position.

B. Valves and snubbers shall be installed in piping for each pressure gage.

C. Test plugs shall be installed on the inlet and outlet pipes all heat exchangers or water heaters serving more than one plumbing fixture.

D. Pressure gages shall be installed where indicated on the drawings and at the following locations:
   1. Building water service entrance into building
   2. Inlet and outlet of each pressure reducing valve
   3. Suction and discharge of each re-circulating hot water return pump.

END OF SECTION

SECTION 22 05 23
GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the requirements for general-duty valves for domestic water systems.

1.2 RELATED WORK

A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Valves.
   2. Backflow Preventers.
   3. Pressure Reducing Valves.
   4. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

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

B. American Society for Testing and Materials (ASTM):A536-84(R 2004) Standard Specification for Ductile Iron Castings

C. American Society of Sanitary Engineering (ASSE)
   ASSE 1003-01 (R 2003).....Performance Requirements for Water Pressure Reducing Valves

   ASSE 1012-02.....Backflow Preventer with Intermediate Atmospheric Vent

   ASSE 1013-05.....Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers

D. International Code Council (ICC)
   IPC-06 (R 2007).....International Plumbing Code

E. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   SP-25-98.....Standard Marking System for Valves, Fittings, Flanges and UnionsSP-67-02a (R 2004) Butterfly Valve of the Single flange Type (Lug Wafer)

   SP-70-06.....Cast Iron Gate Valves, Flanged and Threaded Ends.

SP-72-99.....Ball Valves With Flanged or Butt Welding For General Purpose

SP-80-03.....Bronze Gate, Globe, Angle and Check Valves.

SP-110-96.....Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

1.5 DELIVERY, STORAGE, AND HANDLING

A. Valves shall be prepared for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Valves shall be prepared for storage as follows:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew point temperature.

PART 2 - PRODUCTS

2.1 VALVES

A. Asbestos packing and gaskets are prohibited.

B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.

C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.

D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 meters (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.

E. Ball valves, pressure regulating valves, gate valves, globe valves, and plug valves used to supply potable water shall meet the requirements of NSF 61.

F. Shut-off:
   1. Cold, Hot and Re-circulating Hot Water:
      a. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-72, SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4140 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be solder,

b. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A 536, ductile iron.

G. Balancing:
1. Hot Water Re-circulating, 80 mm or DN80 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (¼" NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.

H. Check:
1. Check valves less than 80 mm or DN80 (3 inches) and smaller) shall be class 125, bronze swing check valves with non metallic Buna-N disc. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B 62, solder joints, and PTFE or TFE disc.

I. Globe:
1. 80 mm or DN80 (3 inches) or smaller: Class 150, bronze globe valve with non metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B 62 with solder ends, copper-silicon bronze stem, TPFE or TFE disc, malleable iron hand wheel.

2.2 WATER PRESSURE REDUCING VALVE AND CONNECTIONS

A. 80 mm or DN80 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.

B. The regulator shall have a tap for pressure gauge.

C. The regulator shall have a temperature rating of 100° C (210° F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9-kPa (+/- 1 psig).

D. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.

E. Connections Valves and Strainers: shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gage shall be installed on the low pressure side of the line.

2.3 BACKFLOW PREVENTERS

A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be ASSE 1013 listed and certified.

B. Reduced pressure backflow preventers shall be installed in the following applications.
   1. Non-potable (industrial) water system connection.
   2. Water make up to heating systems, chilled water system, and similar equipment consuming water.
   3. Water service entrance from loop system.

C. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated duct iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be Noryl (NSF listed). The stem shall be stainless steel conforming to ASTM A276. The seat disc elastomer shall be EPDM. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.

B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.

C. Threads on valve and mating pipe shall be examined for form and cleanliness.

D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Valves shall be located for easy access and shall be provided with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.

C. Valves shall be installed in horizontal piping with stem at or above center of pipe

D. Valves shall be installed in a position to allow full stem movement.

E. Check valves shall be installed for proper direction of flow and as follows:
   1. 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.

END OF SECTION

SECTION 22 08 00
COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 22.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning plumbing systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.
   1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
   2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.

D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Plumbing systems will be commissioned:
   1. Domestic Hot Water Systems (steam-to-hot water converters, hot water circulating pumps and motors, controls).
   2. Laboratory Gas Systems (compressed air, carbon dioxide, Gas Alarm System).
   3. Emergency Plumbing Fixtures (Showers, eye wash stations, instruments and gages)

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 22 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 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. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 22 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.

1.2 RELATED WORK

A. Penetrations in rated enclosures: Section 07 84 00, FIRESTOPPING.

B. Preparation and finish painting and identification of piping systems: Section 09 91 00, PAINTING.

C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Pipe Insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Piping.
   2. Strainers.
   3. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

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

B. Federal Specifications (Fed. Spec.):
   A-A-1427C Sodium Hypochlorite Solution
   A-A-59617 Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections

C. American National Standards Institute (ANSI):

D. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
   A13.1-96 Scheme for Identification of Piping Systems
   B16.3-98 Malleable Iron Threaded Fittings ANSI/ASME
   B16.4-98 Cast Iron Threaded Fittings Classes 125 and 250 ANSI/ASME
   B16.9-01 Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME
   B16.11-01 Forged Steel Fittings, Socket-Welding and Threaded ANSI/ASME
   B16.12-98 Cast Iron Threaded Drainage Fittings ANSI/ASME
   B16.15-85(R 1994) Cast Bronze Threaded Fittings ANSI/ASME
   B16.18-01 Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME
   B16.22-01 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME

Element ANSI/ASME

E. American Society for Testing and Materials (ASTM):
A47-99 Ferritic Malleable Iron Castings Revision 1989
A53-02 Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless
A74-03 Cast Iron Soil Pipe and Fittings
A183-83(R1998) Carbon Steel Track Bolts and Nuts
A312-03 Seamless and Welded Austenitic Stainless Steel Pipe
A536-84(R1999) E1 Ductile Iron Castings
A733-03 Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
B32-03 Solder Metal
B61-02 Steam or Bronze Castings
B62-02 Composition Bronze or Ounce Metal Castings
B75-99(Rev A) Seamless Copper Tube
B88-03 Seamless Copper Water Tube
B584-00 Copper Alloy Sand Castings for General Applications Revision A
B687-99 Brass, Copper, and Chromium-Plated Pipe Nipples
C564-03 Rubber Gaskets for Cast Iron Soil Pipe and Fittings
D2000-01 Rubber Products in Automotive Applications
D4101-03b Propylene Plastic Injection and Extrusion Materials
D2447-93 Polyethylene (PE) Plastic Pipe, Schedule 40 and 80, Based on Outside Diameter
D2564-94 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
D2665-94 Revision A Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
D4101-03b Propylene Plastic Injection and Extrusion Materials
E1120 Standard Specification For Liquid Chlorine
E1229 Standard Specification For Calcium Hypochlorite

F. American Water Works Association (AWWA):
C110-03/ A21.10-03 Ductile Iron and Gray Iron Fittings - 75 mm thru 1200 mm (3 inch thru 48 inches) for Water and other liquids AWWA/ ANSI
C151-00/ A21.51-02 Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids AWWA/ ANSI
C203-02 Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied AWWA/ ANSI
C651-99 Disinfecting Water Mains

G. American Welding Society (AWS):
A5.8-92 Filler Metals for Brazing

H. National Association of Plumbing - Heating - Cooling Contractors (PHCC):
National Standard Plumbing Code - 1996

I. International Association of Plumbing and Mechanical Officials (IAPMO):
Uniform Plumbing Code - 2000
IS6-93 Installation Standard

J. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
SP-72-99 Ball Valves With Flanged or Butt Welding For General Purpose
SP-110-96 Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

K. American Society of Sanitary Engineers (ASSE):

1001-02 Pipe Applied Atmospheric Type Vacuum Breakers
1018-01 Performance for trap seal primer valve-water supply fed
1020-04 Vacuum Breakers, Anti-Siphon, Pressure Type

L. Plumbing and Drainage Institute (PDI):
PDI WH-201 Water Hammer Arrestor

PART 2 - PRODUCTS

2.1 WATER SERVICE CONNECTIONS TO BUILDINGS

A. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material selected shall be the same for the size specified.

B. Seventy five millimeters (3 inch) Diameter and Over: Ductile iron, AWWA C151, 850 kPa (125 pounds) water steam pressure (WSP), exterior bituminous coating, cement lined. Provide flanged and anchored connection to interior piping.

C. Under 75 mm (3 inch) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings as specified under Article, INTERIOR DOMESTIC WATER PIPING. Use brazing alloys, AWS A5.8, Classification BCuP.

D. Flexible Expansion Joint: Ductile iron with ball joints rated for 1725 kPa (250 psi) working pressure conforming to ANSI/AWWA A21.53/C153, capable of deflecting a minimum of 30 degrees and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene.

2.2 INTERIOR DOMESTIC WATER PIPING

A. Pipe: Copper tube, ASTM B88, Type K or L, drawn.

B. Fittings for Copper Tube:
1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, MSS SP72 & SP 110, Solder or braze joints.
2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
3. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.

D. Adapters: Provide adapters for joining screwed pipe to copper tubing.

E. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.

F. Brazing alloy: AWS A5.8, Classification BCuP.

2.3 EXPOSED WATER PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets and equipment when not concealed by apron including those furnished by the Government or specified in other sections.
   1. Pipe: Fed. Spec. WW-P-351, standard weight.
   2. Fittings: ANSI B16.15 cast bronze threaded fittings with chrome finish, (125 and 250).
   3. Nipples: ASTM B 687, Chromium-plated.
   4. Unions: Mss SP-72, SP-110, Brass or Bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

B. Unfinished Rooms and Mechanical Rooms : Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

2.5 TRAP PRIMER WATER PIPING:

A. Pipe: Copper tube, ASTM B88, type K, hard drawn.

B. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.

C. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

2.6 WATERPROOFING

A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.

B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.

C. Walls: See detail shown on drawings.

2.7 STRAINERS

A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.

B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.

C. Body: Smaller than 80 mm (3 inches), brass or bronze.

2.8 DIELECTRIC FITTINGS

A. Provide dielectric couplings or unions between ferrous and non-ferrous pipe.

2.9 STERILIZATION CHEMICALS

A. Liquid Chlorine: ASTM E1120.

B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

2.10 WATER HAMMER ARRESTER:

A. Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N 0-rings pressure packed and lubricated with FDA approved Dow Corning No. 11 silicone compound. All units shall be designed in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and install in accordance with Plumbing and Drainage Institute requirements (PDI WH 201). Unit shall be as manufactured by Precision Plumbing Products Inc., Watts or Sioux Chief. Provide water hammer arrestors at all solenoid valves, at all groups of two or more flush valves, at all quick opening or closing valves, and at all medical washing equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with the PHCC National Standard Plumbing Code and the following:
   1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
   2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
   3. All pipe runs shall be laid out to avoid interference with other work.
   4. Install union and shut-off valve on pressure piping at connections to equipment.
   5. Pipe Hangers, Supports and Accessories:
      a. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8.
      b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with red lead or zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
      c. Floor, Wall and Ceiling Plates, Supports, Hangers:
         1) Solid or split unplated cast iron.
         2) All plates shall be provided with set screws.
         3) Pipe Hangers: Height adjustable clevis type.
         4) Adjustable Floor Rests and Base Flanges: Steel.
         5) Concrete Inserts: "Universal" or continuous slotted type.
         6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
         7) Riser Clamps: Malleable iron or steel.
         8) Rollers: Cast iron.
         9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
         10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gauge steel. The shield shall be sized for the insulation.
         11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.

6. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
7. Penetrations:
   a. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the fire stopping materials.
   b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

B. Piping shall conform to the following:
   1. Domestic Water:
      a. Where possible, grade all lines to facilitate drainage. Provide drain valves at bottom of risers. All unnecessary traps in circulating lines shall be avoided.
      b. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

3.2 TESTS

A. General: Test system either in its entirety or in sections.

B. Potable and non-potable (Industrial) Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested.

C. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

3.3 STERILIZATION

A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water and non – potable water distribution system in accordance with AWWA C651.

B. Use either liquid chlorine or hypochlorite for sterilization.

END OF SECTION

SECTION 22 11 23
DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Hot water circulating pump and .

1.2 RELATED WORK

A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

B. Section 26 29 11, LOWVOLTAGE MOTOR STARTERS.

C. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Pump:
      a. Manufacturer and model.
      b. Operating speed.
      c. Capacity.
      d. Characteristic performance curves.
   2. Motor:
      a. Manufacturer .
      b. Speed.
      c. Current Characteristics and W (HP).
      d. Efficiency.

D. Certified copies of all the factory and construction site test data sheets and reports.

E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
   1. Include complete connection which indicates all components of the system.
   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.

1.4 APPLICABLE PUBLICATIONS

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

B. National Electrical Manufacturers Association (NEMA):
   ICS693 (R2001) Industrial Control and Systems Enclosures
   25003 Enclosures for Electrical Equipment (1000 Volts Maximum)

C. American Society of Mechanical Engineers (ASME):
   Boiler and Pressure Vessel Code: 2002
   Section VIII Pressure Vessels, Division I and II.

D. Underwriters' Laboratories, Inc. (UL):
50899 (R2002) Safety Industrial Control Equipment

PART 2 - PRODUCTS

2.1 CIRCULATING PUMP

A. Use for hot water systems. Pump for hot water system shall be designed for 65 degrees C (150 degrees F) water service. Centrifugal, single stage, constructed to prevent contact of water with metal other than nonferrous. Driver shall be electric motor, close coupled .

B. Mounting shall be the following:
1. Inline mounted.

C. Casings: Epoxy coated cast iron, bronze, stainless steel, vertically or horizontally split.

D. Impeller: High grade, cast brass or bronze, accurately machined and properly balanced.

E. Motors: Maximum 40 degrees C ambient temperature rise, dripproof, for operation with current of voltage, phase and cycle shown in schedule on Electrical drawings, conforming to NEMA 250Type 4. Capacity to be such to operate pump without overloading. Inline pump motors shall not exceed 1800 rpm and shall be provided with spring mountings or other devices to assure quiet operation. Motors shall be equipped with thermal overload protection. When motor has cooled down it shall restart automatically if the control has been left on.

F. Pump shall operate continuously with "on-off" switch for shut down. In the inlet and outlet piping of the pump shutoff valves shall be installed to permit service to the pump without draining the system.

G. A check valve shall be installed nearby in the piping upstream of the circulating pump.

PART 3 - EXECUTION

3.1 TEST

A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

B. When any defects are detected, correct defects and repeat test.

END OF SECTION

SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.

B. Section 07 92 00 Joint Sealants: Sealant products.

C. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.

D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.

E. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Pipe Insulation.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Piping.
   2. Floor Drains.
   3. Trap Primers.
   5. Cleanouts.
   6. All items listed in Part 2 - Products.

1.4 APPLICABLE PUBLICATIONS

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

B. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
   A112.6.3-01 (R 2007) .....Standard for Floor and Trench Drains

   A13.1-07.....Scheme for Identification of Piping Systems

   B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300.

   B16.4-06.....Standard for Grey Iron Threaded Fittings Classes 125 and 250

   B16.12-98 (R 2006).....Cast Iron Threaded Drainage Fittings

   B16.15-06.....Cast Bronze Threaded Fittings, Classes 125 and 250

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

A47/A47M-99 (R 2004).....Standard Specification for Steel Sheet, Aluminum Coated, by the Hot Dip Process

A53/A53M-07 .....Standard Specification for Pipe, Steel, Black And Hot-Dipped, Zinc-coated, Welded and Seamless

A74-06.....Standard Specification for Cast Iron Soil Pipe and Fittings

A183-03.....Standard Specification for Carbon Steel Track Bolts and Nuts

A536-84(R 2004) .....Standard Specification for Ductile Iron Castings

B32-08.....Standard Specification for Solder Metal

B75-02.....Standard Specification for Seamless Copper Tube

B306-02.....*Standard Specification for* Copper Drainage Tube (DWV)

B584-06a .....Standard Specification for Copper Alloy Sand Castings for General Applications

C564-03a .....Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

D2000-08.....Standard Classification System for Rubber Products in Automotive Applications

D2564-04E1 .....Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D2665-08.....*Standard Specification for* Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

D. International Code Council:
IPC-06 .....International Plumbing Code

E. Cast Iron Soil Pipe Institute (CISPI):
301-05 .....Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

310-04 .....Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

F. American Society of Sanitary Engineers (ASSE):
1018-01 .....Trap Seal Primer Valves – Potable, Water Supplied

G. Plumbing and Drainage Institute (PDI):
PDI WH-201 .....Water Hammer Arrestor

PART 2 - PRODUCTS

2.1 SANITARY WASTE, DRAIN, AND VENT PIPING

A. Cast iron waste, drain, and vent pipe and fittings:
   1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
      a. Pipe buried in or in contact with earth
      b. Sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
      c. Interior waste and vent piping above grade.
   2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
   3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.
   4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with lead and oakum.

B. Copper Tube, (DWV):
   1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
   2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
   3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
   4. 4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

2.2 EXPOSED WASTE PIPING

A. Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, and equipment when not concealed by apron including those furnished by the Government or specified in other sections.
   1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
   2. The Fittings shall conform to ANSI B16.15, cast bronze threaded fittings with chrome finish, (125 and 250).
   3. Nipples shall conform to ASTM B 687, Chromium-plated.
   4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.

B. In unfinished Rooms such as mechanical Rooms , Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

2.3 SPECIALTY PIPE FITTINGS

A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
   1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.

2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.

B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.

C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.

D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

2.4 CLEANOUTS

A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.

B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on drawings and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.

C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.

D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in above ceiling may use plain end (hubless) blind plug and clamp.

2.5 FLOOR DRAINS

A. Type C (FD-C) floor drain shall comply with ANSI A112.6.3. The type C floor drain shall have a cast iron body, double drainage pattern, clamping device, light duty square or round nickel bronze adjustable strainer and grate with vandal proof screws. The grate shall be square, 150 mm (6 inches) minimum.

B. Type E (FD-E) floor drain shall comply with ANSI A112.6.3. The type E floor drain shall have a heavy, deep cast iron body, double drainage pattern, heavy hinged ductile iron grate not less than 300 mm (12 inches) square with locking device, removable sediment bucket with removable, stainless steel 200 mesh screen lining. Clearance between body and bucket shall be ample for free flow of waste water. In cage wash areas , an extra heavy duty load classification ductile iron grate shall be provided.

C. Type G (FD-G) floor drain shall comply with ANSI A112.6.3. The type G floor drain shall have a cast iron body, shallow type with double drainage flange and removable, perforated aluminum sediment bucket. The floor drain shall have a clamping device. The frame and grate shall be nickel bronze. The grate shall be approximately 200 mm (8 inches) in diameter. The space between body of drain and basket shall be sufficient for free flow of waste water.

D. Type H (FD-H) floor drain shall comply with ANSI A112.6.3. The type H drain shall have a cast iron body, double drainage pattern, without sediment bucket but with loose set nickel bronze grate, secondary strainer, and integral clamping collar. The grate shall be 300 mm (12 inches) in diameter or 300 mm (12 inches) square. The drain body shall be 150 mm (6 inches) deep.

E. Type S (FD-S) floor sink shall comply with ANSI A112.6.3. The type S floor sink shall be constructed from type 304 stainless steel and shall be 300 mm (12 inches) square, and 200 mm (8 inches deep). The interior surface shall be polished. The double drainage flange shall be provided with weep holes, internal dome strainer, and heavy duty non-tilting loose set grate. A clamping device shall be provided.

2.6 TRAPS

A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as pipe connected to. Slip joints are not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

2.7 TRAP SEAL PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS

A. Trap Primer (TP-2): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 5.98 kPa (125 psig) and conforming to standard ASSE 1018**.**

1. The inlet and outlet connections shall be 15 mm or DN15 (NPS ½ inch)
2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
5. The manifold shall be omitted when serving only one trap.

2.8 WATERPROOFING

A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.

B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
   1. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.

C. All pipe runs shall be laid out to avoid interference with other work.

D. The piping shall be installed above accessible ceilings where possible.

E. The piping shall be installed to permit valve servicing or operation.

F. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.

G. The piping shall be installed free of sags and bends.

H. Seismic restraint shall be installed where required by code.

I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.

K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"

L. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".

3.2 JOINT CONSTRUCTION

A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
   2. Pipe sections with damaged threads shall be replaced with new sections of pipe.

E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

3.3 SPECIALTY PIPE FITTINGS

A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.

B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:

A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.

B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.

D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
   1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
   2. 80 mm or DN 80 (NPS 3 inch): 1500 mm (60 inches) with 13 mm (½ inch) rod.
   3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 to NPS 5): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.

E. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 19 mm (¾ inch) rod.

F. 0 mm or DN250 to 300 mm or DN 300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 22 mm (7/8 inch) rod.

G. The maximum spacing for plastic pipe shall be 1.22 m (4 feet).

H. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).

I. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
   1. Solid or split unplated cast iron.
   2. All plates shall be provided with set screws.

3. Height adjustable clevis type pipe hangers.
4. Adjustable floor rests and base flanges shall be steel.
5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
6. Riser clamps shall be malleable iron or steel.
7. Rollers shall be cast iron.
8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.

J. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.

K. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

L. Penetrations:

M. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
   1. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

N. Piping shall conform to the following:
   1. Waste and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm or DN 80 (3 inches) and smaller	2%
100 mm or DN 100 (4 inches) and larger	1%

   2. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

3.5 TESTS

A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.

B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.

1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 35 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
4. Final Tests: Either one of the following tests may be used.
   a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
   b. Peppermint Test: Introduce (2 ounces) of peppermint into each line or stack.

END OF SECTION

SECTION 22 14 00
FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.

B. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.

C. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.

D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Pipe Insulation.

1.3 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Piping.
   2. Roof Drains.
   3. Cleanouts.
   4. All items listed in Part 2 - Products.

C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.

1.4 APPLICABLE PUBLICATIONS

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

B. American National Standards Institute (ANSI).

C. American Society of Mechanical Engineers (ASME): (Copyrighted Society)
   A112.21.2m-83.....Roof Drains

   A13.1-07.....Scheme for Identification of Piping Systems

   B16.3-06.....Malleable Iron Threaded Fittings, Classes 150 and 300.

   B16.9-07 Factory-Made Wrought Steel Butt welding Fittings

B16.11-05.....Forged Steel Fittings, Socket-Welding and Threaded

B16.12-98 (R 2006) Cast Iron Threaded Drainage Fittings

B16.15-06) .....Cast Bronze Threaded Fittings, Class 125 and 250

B16.18-01 (R 2005).....Cast Copper Alloy Solder-Joint Pressure Fittings

B16.22-01 (R 2005).....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

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

A47-99 (R 2004) .....Standard Specification for Steel Sheet, Aluminum Coated, by the Hot-Dip Process

A53-07.....Standard Specification for Pipe, Steel, Black And Hot-Dipped, Zinc-coated Welded and Seamless

A74-06.....Standard Specification for Cast Iron Soil Pipe and Fittings

A183-03) .....Standard Specification for Carbon Steel Track Bolts and Nuts

A312-03.....Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe

A536-84(R 2004) .....Standard Specification for Ductile Iron Castings

A733-03.....Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples

B32-04.....Standard Specification for Solder Metal

B61-08.....Standard Specification for Steam or Bronze Castings

B62-02.....Standard Specification for Composition Bronze or Ounce Metal Castings

B75-02.....Standard Specification for Seamless Copper Tube

B88-03.....Standard Specification for Seamless Copper Water Tube

B306-02.....Standard Specification for Copper Drainage Tube (DWV)

B584-08.....Standard Specification for Copper Alloy Sand Castings for General Applications

B687-99.....Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples

C564-06a .....Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings

D2000-08.....Standard Classification System for Rubber Products in Automotive Applications

D4101-07.....Standard Specification for Propylene Plastic Injection and Extrusion Materials

D2447-03.....Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40 and 80, Based on Outside Diameter

D2564-04e1.....Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D2665-07.....Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings

E. American Welding Society (AWS):
A5.8-04.....Specification for Filler Metals for Brazing and Braze Welding

F. International Code Council (ICC):
IPC-06 .....International Plumbing Code

G. Cast Iron Soil Pipe Institute (CISPI):
301-05 .....Hubless Cast Iron Soil and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

310-04 .....Couplings for Use in Connection with Hubless Cast Iron Soil and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

H. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
SP-72-99.....Standard for Ball Valves with Flanged or Butt Welding For General Purpose

SP-110-96.....Ball Valve Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends

PART 2 - PRODUCTS

2.1 STORM WATER DRAIN PIPING

A. Cast Iron Storm Pipe and Fittings:
1. Cast iron storm pipe and fittings shall be used for the following applications:
   a. Pipe buried in or in contact with earth.
   b. Extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls.
   c. Interior storm piping above grade.
   d. All mechanical equipment rooms or other areas containing mechanical air handling equipment.
2. The cast iron storm Pipe shall be bell and spigot, or hubless (plain end or no-hub) as required by selected jointing method.
3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI Standard 301, ASTM A-888, or ASTM A-74.

4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM Standard C-564 or be installed with leak and oakum.

B. Copper Tube, (DWV): May be used for piping above ground.
   1. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
   2. The Copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
   3. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

C. Roof drain piping in locations where the outdoor conditions are subject to freezing shall be insulated.

2.2 SPECIALTY PIPE FITTINGS

A. Transition pipe couplings shall join piping with small differences in outside diameters or be of different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear erring and corrosion resistant metal tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
   1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
   2. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.

B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 860 kPa (125 psig) at a minimum temperature of 82°C (180°F). The end connection shall be solder joint copper alloy and threaded ferrous.

C. Dielectric flange insulating kits shall be of non conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.

D. The dielectric nipples shall be electroplated steel nipple comply with ASTM F 1545 with a pressure ratings of 2070 kPa (300 psig) at 107°C (225°F). The end connection shall be male threaded. The lining shall be inert and noncorrosive propylene.

2.3 CLEANOUTS

A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.

B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts where shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.

C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.

D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in mechanical space or above ceiling may use plain end (no-hub) blind plug and clamp.

2.4 ROOF DRAINS AND CONNECTIONS

A. Roof Drains: Roof Drains (RD) shall be cast iron with clamping device for making watertight connection. Free openings through strainer shall be twice area of drain outlet. For roof drains not installed in connection with a waterproof membrane, a soft copper membrane shall be provided 300 mm (12 inches) in diameter greater than outside diameter of drain collar. An integral gravel stop shall be provided for drains installed on roofs having built up roofing covered with gravel or slag. Integral no-hub, soil pipe gasket or threaded outlet connection shall be provided.

1. Flat Roofs: The roof drain shall have a beehive or dome shaped strainer with integral flange not less than 300 mm (12 inches) in diameter. For an insulated roof, a roof drain with an adjustable drainage collar shall be provided, which can be raised or lowered to meet required insulation heights, sump receiver and deck clamp. The Bottom section shall serve as roof drain during construction before insulation is installed.
2. Roof Drains, Overflow: Roof Drains identified as overflow drains shall have a 50 mm (2 inch) water dam integral to the drain body.

B. Downspout Nozzle: The downspout nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. The pipe installation shall comply with the requirements of the International code and these specifications.

B. Branch piping shall be installed from the piping system and connect to all drains and outlets.

C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.

D. All pipe runs shall be laid out to avoid interference with other work.

E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.

F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every1.22 m (4 feet) of pipe length.

G. The piping shall be installed free of sags and bends.

H. Seismic restraint shall be installed where required by code.

I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep ¼ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and 1/8 bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.

K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"

L. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".

3.2 JOINT CONSTRUCTION

A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
   2. Pipe sections with damaged threads shall be replaced with new sections of pipe.

E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.

3.3 SPECIALTY PIPE FITTINGS

A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.

B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES:

A. All piping shall be supported according to the International plumbing code, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications.

B. Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.

C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.

D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
   1. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
   2. NPS 3 (DN 80): 1500 mm (60 inches) with 13 mm (1/2 inch) rod.
   3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 16 mm (5/8 inch) rod.
   4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 19 mm (3/4 inch) rod.
   5. NPS 10 to NPS 12 (DN 250 to DN 300): 1500 mm (60 inches) with 22 mm (7/8 inch) rod.

E. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).

F. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, Wall and Ceiling Plates shall have the following characteristics:
   1. Solid or split unplated cast iron.
   2. All plates shall be provided with set screws.
   3. Height adjustable clevis type pipe hangers.
   4. Adjustable Floor Rests and Base Flanges shall be steel.
   5. Hanger Rods shall be low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
   6. Riser Clamps shall be malleable iron or steel.
   7. Roller shall be cast iron.
   8. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (min.) metal protection shield Centered on and welded to the hanger and support. The shield shall be 4 inches in length and be 16 gage steel. The shield shall be sized for the insulation.

G. Miscellaneous Materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.

H. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

I. Penetrations:
   1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
   2. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

J. Piping shall conform to the following:

1. Storm Water Drain and Vent Drain to main stacks:

Pipe Size	Minimum Pitch
80 mm (3 inches) and smaller	2%
100 mm (4 inches) (4 inches) and larger	1%

3.5 TESTS

A. Storm sewer system shall be tested either in its entirety or in sections.

B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
   1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
   2. For an air test, an air pressure of 35 kPa (5 psi) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
   3. Final Tests: Either one of the following tests may be used.
      a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 1.3 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
      b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.

END OF SECTION

SECTION 22 35 00
DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes the requirements for domestic hot water heat exchangers including thermometers and all necessary accessories, connections and equipment.

1.2 RELATED WORK

A. Section 09 91 00, PAINTING: Preparation and finish painting.

B. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

C. Section 22 11 23, DOMESTIC WATER PUMPS: Circulating Pump.

D. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Heater Insulation.

E. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING, 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING, and 22 11 00, FACILITY WATER DISTRIBUTION: Piping, Fittings, Valves and Gages.

1.3 SUBMITTALS

A. Submit manufacturer's literature and data pertaining to the water heater in properly bound package, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Include the following as a minimum:
   1. Heat Exchangers.
   2. Pressure and Temperature Relief Valves.
   3. Steam Control Valves.
   4. Thermometers.
   5. Pressure Gages.
   6. Vacuum Breakers.

B. Equipment components in contact with potable water and non potable (industrial) water shall meet NSF compliance requirements in document NSF 61, "Drinking Water System Components – Health Effects.

C. A form U-1 or other documentation stating compliance with the ASME Boiler and Pressure Vessel code.

1.4 APPLICABLE PUBLICATIONS:

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

B. American National Standard Institute (ANSI):
   Z21.22-00/4.4A-00 Relief Valves for Hot Water Supply systems

C. American Society of Mechanical Engineers (ASME):
   B1.20.1-01 Pipe Threads, General Purpose

B16.5-03	Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24
B16.24-06	Cast Copper Alloy Pipe Flanges, Class 150, 300,600, 900, 1500, 2500
PTC 25.3-02	Pressure Relief Devices
Section IV-07	Heating Boilers
Section VIII-07	Pressure Vessels Division 1

1.5 AS-BUILT DOCUMENTATION

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

B. Four sets of manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.

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

PART 2 - PRODUCTS

2.1 SHELL AND TUBE, DOMESTIC WATER HEAT EXCHANGERS:

A. General: The parallel instantaneous water heater assembly with two heat exchangers and integral programmable digital recirculation valve (DRV) shall be mounted on an angle iron frame. The assembly shall be pre-piped with performance matched components and pressure tested before delivery. Substitute assemblies which require field assembly other than basic water, and steam service shall be unacceptable. The instantaneous water heater shall be of the horizontal shell and tube design providing easy access to the individual tubes without moving the heater from its installed position. No overhead clearance shall be required for servicing. The tubes shall be double wall with a U-bend. Helical tubes shall be unacceptable. Only the necessary steam, water and condensate connections to the instantaneous water heater shall be pre-plumbed. Copper lined storage tanks shall not be used. Temperature controller (DRV) shall be controlled digitally via integrated circuit board technology designed to deliver blended water economically at a safe, accurate temperature for sanitary use in re-circulated hot water systems. No minimum system draw-off required. The DRV shall have a 2 line, 16 character display of delivered temperature with the option of °F or °C. Display also shows the error codes and alarm conditions. The temperature controller shall be compliant with ASSE Standard 1017, CSA B125 & CE and so certified and identified. Model shall be D535 DW-P by Armstrong International, or equal. Materials of construction and items included shall be:

1. Shells of carbon steel with 2-1/2" NPT steam inlet and 1" NPT condensate exit ports.
2. Tubes of 5/8" copper inner, ¾" ID grooved copper outer expanded into steel (steam side) and brass (water side) tube sheets.
3. 1-1/2" NPT water connections.
4. Stand of 2" Carbon Steel Angle.
5. Water pipe of Type L copper.
6. Armstrong Steam Trap model 813.
7. Armstrong Thermostatic Air Vent.
8. One 12V Digital Recirculating Valve (DRV).
9. One UL Listed Power supply's rated at 100-240V (12V AC output).
10. All required valve fittings and isolation valves, pressure gauges, inlet combination ball valve strainers, inlet/return check valves, inlet, system blend and return line thermometers.
11. All Stainless Steel Construction (DRV only).
12. Circulating pump in the re-circulation pipe line as scheduled.
13. Compression tank as scheduled.

B. Performance: The instantaneous water heater assembly with DRV shall include all of the following capabilities:

1. Maximum water pressure drop not exceeding 10 psi in the instantaneous heater.
2. Operational steam pressure of 2-15 psig.
3. Maximum allowable steam pressure of 150 psig.
4. Operational water pressure of 20-150 psig
5. Maximum allowable water pressure of 150 psig
6. Accurate control of blended water drawn from the system at a point of use typically within +/-2°F at draw off points a minimum of 5m downstream of mixing valve during consistent system demand periods.

7. Minimum valve inlet to outlet temperature requirement (system recirculation temperature loss) of 2°F.
8. Automatic shutoff of hot water flow upon cold water inlet supply failure.
9. Automatic shutoff of hot water flow in the event of a power failure.
10. Maintain a consistent system "idling" temperature and control "temperature creep" without the use of a manual throttling device or balance valve.
11. System shall not require a temperature activated pump shut-off device (aquastat).
12. Programmable set point range of 100-158°F (37-70°C) plus full hot/full cold.
13. Ability to thermally disinfect at recommended temperatures.
14. Programmable 1st level hi/lo temp alarm display.
15. Programmable 2nd level hi/lo temp alarm display/full cold.
16. Provide two 4-20 mA current loop interfaces.
    a. Input: Setpoint Selection.
    b. Output: Measured Blend Temperature.
    c. Relay output: 24V DC/240V AC SPCO.
    d. Error Relay: Activated in alarm or error mode.
    e. Provide a BAS Module (Brainscan™, or equal) for complete connectivity to the building DDC control system. Provide connectivity that transmits/receives all field programmable and LED display features. In addition provide a serial data port on the water heater for connection of the BAS Module.
    f. Setpoint configuration, unit selection, and alarm conditions shall be available via the IrDA programming port used with the programming software or via the Building DDC control system.

2.2 THERMOMETERS

A. Thermometers shall be rigid stem or remote sensing, dial type with an aluminum, black metal, stainless steel, or chromium plated brass case. The thermometer shall be back connected, mercury, vapor, BI-metal or gas actuated, with circular dial 90 mm (3 1/2 inches) in diameter graduated from 4 to 100°C (40 to 210°F), with two-degree graduations guaranteed accurate within one scale division. The socket shall be separable, double-seat, micrometer-fittings, with extension neck not less than 65 mm (2 1/2 inches) to clear tank or pipe covering. The thermometer shall be suitable for 20 mm (3/4 inch) pipe threads. Thermometers may be consoles mounted with sensor installed in separate thermometer well.

2.3 SAFETY VALVES FOR SHELL AND STEAM HEATERS:

A. Separate temperature relief valve and pressure relief valve or combination pressure/temperature relief valves shall be provided on each water heater. The safety valve discharge shall be routed to nearest floor drain.

B. Temperature Relief Valves shall be constructed from all brass or bronze material. The temperature relief valves shall be automatic, self-closing reseating type valve, equipped with a noncorrosive metal thermostat with bulb extending into tank that can be manually displaced from its seat for test purposes. The temperature relief valve shall be tested and approved as to its BTU capacity by ASME or an independent laboratory satisfactory to the Contracting Officer. In no case shall total rated BTU relieving capacity of temperature relief valve, or valves, be less than BTU input into water heater. Temperature relief valve shall be completely open before temperature reaches 98°C (210°F) and shall close when temperature goes below 93°C (200°F).

C. Pressure relief valves shall conform to requirements of ASME, Section IV. BTU relieving capacity of pressure relief valve, or valves, shall be not less than BTU input of the water heater. The pressure relief shall be set at 690 kPa (100 psig) pressure.

D. A double solenoid safety system shall be provided for each shell and steam coil heater to function as a safety over temperature prevention system. System shall consist of aquastat, pilot light, solenoid steam safety valve and solenoid water safety valve located in the control circuit. The aquastat shall be set at 60°C (140°F).

2.4 DOMESTIC HOT WATER COMPRESSION TANKS

A. A steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as shown. The air pre-charge shall be set to minimum system operating pressure at tank.

B. The tappings shall be factory fabricated steel, welded to the tank and include ASME B1.20.1 pipe thread.

C. The interior finish shall comply with NSF 61 barrier materials for potable water tank linings and the liner shall extend into and through the tank fittings and outlets.

D. The air charging valve shall be factory installed.

2.5 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES

A. The combination temperature and pressure relief valves shall be ASME rated and stamped and include a relieving capacity at least as great as the heat input and include a pressure setting less than the water heater's working pressure rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The water heaters shall be installed on concrete bases. Refer to Specification Section 03 30 00, CAST-IN-PLACE CONCRETE and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING

B. The water heaters shall be installed level and plumb.

C. Water heaters shall be installed and connected in accordance with manufacturer's written instructions.

D. All pressure and temperature relief valves discharge shall be pipe to nearby floor drains.

E. Thermometers shall be installed on water heater inlet and outlet piping.

F. The control thermostats shall be set for a maximum setting of 54°C (130°F).

3.2 LEAKAGE TEST

A. Before piping connections are made, the water heaters shall be tested at a hydrostatic pressure of 1375 kPa (200 psi) for water heaters rated at less than 1103 kPa (160 psig) and 1654 kPa (240 psig) for units with an maximum working pressure of 1103 kPa (160 psig) or over. Any failed test shall be corrected and the water heater shall be retested at no additional cost to the VA.

3.3 PERFORMANCE TEST

A. Ensure that all of the remote water outlets will have a minimum of 49°C (120°F) and a maximum of 54°C (130°F) water flow at all times. If necessary, make all correction to balance the return water system or reset the thermostat to make the system comply with design requirements.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.

1.2 RELATED WORK

A. Sealing between fixtures and other finish surfaces: Section 07 92 00, JOINT SEALANTS.

B. Flush panel access doors: Section 08 31 13, ACCESS DOORS AND FRAMES.

C. Through bolts: Section 10 21 13, TOILET COMPARTMENTS.

D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 SUBMITTALS

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

B. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.

1.4 APPLICABLE PUBLICATIONS

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

B. American National Standard Institute (ANSI):

C. The American Society of Mechanical Engineers (ASME):

A112.6.1M-02(R2008)	Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
A112.19.1M-04	Enameled Cast Iron Plumbing fixtures
A112.19.2M-03(R2008)	Vitreous China Plumbing Fixtures
A112.19.3-2001(R2008)	Stainless Steel Plumbing fixtures (Designed for Residential Use)

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

A276-2003	Stainless and Heat-Resisting Steel Bars and Shapes

E. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM AMP 500-505

Metal Finishes Manual (1988)

F. American Society of Sanitary Engineers (ASSE):

1016-05 Performance Requirements for Individual Thermostatic, Pressure Balancing and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings

G. National Sanitation Foundation (NSF)/American National Standards Institute (ANSI):

61-03 Drinking Water System Components-Health Effects

H. American with Disabilities Act(A.D.A) Section 4-19.4 Exposed Pipes and Surfaces

PART 2 - PRODUCTS

2.1 STAINLESS STEEL

A. Corrosion-resistant Steel (CRS):
   1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
   2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.

B. Die-cast zinc alloy products are prohibited.

2.2 STOPS

A. Provide lock-shield loose key or screw driver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.

B. Furnish keys for lock shield stops to Resident Engineer.

C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.

D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple.

2.3 ESCUTCHEONS

A. Heavy type, chrome plated, with set screws. Provide for piping serving plumbing fixtures and at each wall, ceiling and floor penetrations in exposed finished locations and within cabinets and millwork.

2.4 LAMINAR FLOW CONTROL DEVICE

A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.

B. Flow Control Restrictor:
   1. Capable of restricting flow 5.7 Lpn /s (1.5 gpm) for lavatories and hand wash sinks; 5.7 to 7.6 Lpm/s (1.5 to 2.0 gpm) for sink P-528 and process sinks; Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 and 550 kPa (25 and 80 psi).
   2. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-clearing action, and is capable of easy manual cleaning.

C. Device manufactured by OMNI Products, Inc. or equal.

2.5 CARRIERS

A. ASME/ANSI A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down.

B. ASME/ANSI A112.6.1M, lavatory, chair carrier for thin wall construction. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.

C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

2.6 WATER CLOSETS

A. (P-103a) Water Closet (Wall Hung, ASME/ANSI A112.19.2M, Figure 9) office and industrial, elongated bowl, siphon jet, dual flush 6 L/4.2 L (1.1 or 1.6 gallons) per flush, wall outlet. Top of rim shall be between 410 and 435 mm (16 to 17 inches) above finished floor. Handicapped water closet shall have rim set 460 mm (18 inches) above finished floor.

1. Seat: Institutional/Industrial, extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
2. Fittings and Accessories: Gaskets - neoprene; bolts with chromium plated caps nuts and washers.
3. Flush valve: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, non-hold open ADA approved side oscillating handle for manual operation. Water saver, dual flush design. Pushing handle DOWN initiates “full” flush 6 L (1.6 gallons) per flush, lifting handle UP initiates “reduced” flush 4.2 L (1.1 gallons) per flush, with maximum 10 percent variance, 25mm (one-inch) screwdriver back check angle stop with vandal resistant cap, adjustable tailpiece, a high back pressure vacuum breaker, spud coupling for 40 mm (1-1/2 inch) top spud, wall and spud flanges, and sweat solder adapter with cover tube and set screw wall flange. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM alloy classification for semi-red brass. Seat bumpers shall be integral part of flush valve. Set centerline of inlet 292 mm (11-1/2 inches) above rim.

2.7 URINALS

A. (P-201a) Urinal (Wall Hung, ANSI A112.19.2M, Figure 30) bowl with integral flushing rim, wall to front of flare 356 mm (14 inches). Wall hung with integral trap, washdown flushing action 1 L (0.25 gallons) per flush with 50mm (2-inch) back outlet and 20 mm (3/4-inch) top inlet spud.

1. Support urinal with chair carrier and install with rim 432 mm (17 inches) above finished floor to meet ADA requirements. All mounting hardware shall be included.
2. Flushing Device: Large chloramines resistant diaphragm, semi-red brass body, exposed flush valve , electronic sensor activated, battery powered, active infrared sensor for automatic operation // non-hold-open, water saver design, 20 mm (3/4-inch) screwdriver angle stop valve. Set centerline of inlet 292 mm (11-1/2 inches) above urinal. Valve body, cover, tailpiece, and control stop shall be in conformance with ASTM alloy classification for semi-red brass.

2.8 LAVATORIES

A. Dimensions for lavatories are specified, Length by width (distance from wall) and depth.

B. Brass components in contact with water shall contain no more than 3 percent lead content by dry weight.

C. (P-418) Lavatory (Sensor Control, Gooseneck Spout, ASME/ANSI A112.19.2M, Figure 16) straight back, approximately 500 by 450 mm (20 by 18 inches) and a 102mm (4-inch) maximum apron, first quality vitreous china with punching for gooseneck spout. Set rim 864 mm (34 inches) above finished floor.
   1. Faucet: Solid cast brass construction, chrome plated, gooseneck spout with outlet 102 to 127 mm (4 to 5 inches) above rim. Electronic sensor activated, 102 mm (8 inch) center set mounting battery operated electronic module solid brass hot-cold water mixer adjusted from top deck with barrier free design control handle and inline filter. Provide laminar flow control device. Breaking the light beam shall activate the water flow. Flow shall stop when user moves away from light beam. All connecting wiring between transformer, solenoid valve and sensor shall be cut to length with no excess hanging or wrapped up wiring allowed.
   2. Drain: Cast or wrought brass with flat grid strainer with offset tailpiece, brass, chrome plated.
   3. Stops: Angle type. See paragraph 2.2.Stops
   4. Trap: Cast copper alloy, 40 by 32 mm (1-1/2 by 1-1/4 inch) P-trap. Adjustable with connected elbow and 17 gage tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall.
   5. Provide cover for drain, stops and trap per A.D.A 4-19.4.

2.9 SINKS

A. Dimensions for sinks are specified, length by width (distance from wall) and depth.

B. Sinks in procedure rooms including faucets, drains, P-traps and associated piping to connection to stop valves shall be provided by owner.
   1. Plumbing contractor is responsible for routing utilities to location shown on architectural dwgs and terminate with angle type stops. Provide a plug or cap at all waste stub-outs for future sinks.

C. (P-502a) Service Sink (rectangular, Floor Mounted) stain resistant terrazzo, 711 by 711 mm (36 by 24 by 12 inches) with 152 mm (six-inch) drop front. Terrazzo, composed of marble chips and white Portland cement, shall develop compressive strength of 20 684 kPa (3000 psi) seven days after casting. Provide extruded aluminum cap on front side.
   1. Faucet: Solid brass construction, combination faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, integral stops, mounted on wall above sink. Spout shall have a pail hook, 20 mm (3/4-inch) hose coupling threads, vacuum breaker, and top or bottom brace to wall. Four-arm handles on faucets shall be cast, formed, or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have a smooth bright finish. Provide 914 mm (three-foot) hose with wall hook. Centerline of rough in is 1220 mm (48 inches) above finished floor.
   2. Drain: Eighty millimeter (3-inch) cast brass drain with nickel bronze strainer.
   3. Trap: P-trap, drain through floor.

D. (P-517)Hand wash Sink (CRS, Single Compartment, Wall Hung) 20 gage type 304 CRS, approximately 406 by 381 mm (16 by 15 inches) by 152 mm (6-inches) deep with 152 mm (6 inch) splash back. Provide rolled rim on front and ends. Corners and edges shall be well rounded. Support sink with 10 gage CRS brackets on ASME/ANSI A112.6.1M, Type I, chair carrier and secure fixture with minimum 10 mm (3/8-inch) all-thread bracket studs and nuts. Set rim of sink 914 mm (36-inches) above finished floor.

1. Faucet: backsplash mounted, Solid cast brass construction, chrome plated, high gooseneck spout with outlet 102 to 228 mm (4 to 9 inches) above rim minimum. Electronic sensor activated, battery operated, barrier free . Adjustable automatic shut-off. Breaking the light beam shall activate the water flow. Flow shall stop when user moves away from light beam. All connecting wiring between transformer, solenoid valve and sensor shall be cut to length with no excess hanging or wrapped up wiring allowed.
2. Provide with thermostatic mixing valve.
3. Provide laminar flow control device . 5.7 Lpm/s (1.5 gpm).
4. Drain: Drain plug with strainer, stainless steel.
5. Trap: Cast copper alloy, 40 mm (1-1/2 inch) P-trap. Adjustable with connected elbow and nipple to wall and escutcheon.
6. Provide cover for drain, stops and trap per A.D.A 4-19.

E. (P-528) Sink (CRS, Single Compartment, Counter Top ASME/ANSI A112.19.2M, Kitchen Sinks, Figure 5) self rimming, back faucet ledge, approximately 533 by 558 mm (21 by 22 inches) with single compartment inside dimensions approximately 406 by 483 by 190 mm (16 by 19 by 7 ½ inches) deep. Shall be minimum of 1.3 mm thick (18 gauge) CRS. Corners and edges shall be well rounded:
1. Faucet: Solid brass construction, deck mounted combination faucet with monel or ceramic seats, removable replacement unit containing all parts subject to ware, swivel gooseneck spout with approximately 200 mm (8-inch) reach with spout outlet 150 mm (6-inches above deck and 102 mm (4 inch) wrist blades. Faucet shall be polished chrome plated.
2. Drain: Drain plug with cup strainer, stainless steel.
3. Trap: Cast copper alloy 40 mm (1-1/2 inch) P-trap with cleanout plug. Provide wall connection and escutcheon.
4. Provide cover for drain, stops and trap per A.D.A 4-19.4.
5. Provide with Food waste disposer. Continuous feed, with ¾" H.P. motor, galvanized grinding elements with 2 stainless steel 360 deg swivel lugs.
6. Provide tee on cold water for connection to ice maker in nearby refrigerator.

2.10 DISPENSER, DRINKING WATER

A. (P-607) Drinking Fountain, Wall Hung, Surface Mounted at elevation to meet ADA requirements, CRS, stainless steel receptor, 18 gage, type 304 with satin finish and complete with mounting plate and back panel. Unit dimensions, 300 mm (12 inches) wide by 487 mm (18 inches) front to back by 152 mm (6 inch) high Lead free, inline water filter , chrome-plated solid brass bubbler with antimicrobial head, and self-closing, gooseneck glass filler spout with push lever operation and polished chrome-plated brass finish. Set bubbler 914 mm (36 inches) above finished floor. Unit shall be push button activated.

2.11 SHOWER FIXTURE

A. (P-701) Shower Fixture (Detachable, Wall Mounted, Concealed Supplies, Type T/P Combination Valve):
1. Shower Installation: Wall mounted detachable spray assembly, 600 mm (24-inch) wall bar, elevated vacuum breaker, supply elbow and flange and valve. All external trim, chrome plated metal.
2. Shower Head Assembly: Plastic shower head with flow control to limit discharge to 9.5Lpm (2.5 gpm), 1500 mm (5-foot) length of rubber lined CRS, chrome plated metal flexible, or white vinyl reinforced hose and supply wall elbow. Design showerhead to fit in palm of hand. Provide CRS or chrome plated metal wall bar with an adjustable swivel hanger for showerhead. Fasten wall bar securely to wall for hand support.

3. Valves: Type T/P combination thermostatic and pressure balancing, with chrome plated metal lever type operating handle adjustable for rough-in variations and chrome plated metal or CRS face plate. Valve body shall be any suitable copper alloy. Internal parts shall be copper, nickel alloy, CRS or thermoplastic material. Valve inlet and outlet shall be 15 mm (1/2-inch) IPS. Provide external screwdriver check stops, vacuum breaker and temperature limit stops. Set stops for a maximum temperature of 40 degrees C (105 degrees F). All exposed fasteners shall be vandal resistant. Valve shall provide a minimum of 380 mL/s at 310 kPa (6 gpm at 45 psi) pressure drop.

2.12 EMERGENCY FIXTURES

1. Emergency shower and eye washes in Soiled cage wash area are furnished under specification 11 53 43, installed under this specification section.
2. Emergency eye washes in procedure rooms are to be provided by owner. Provide domestic water rough-in with stop valve for eye wash.

2.13 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES

A. (P-801a) Wall Hydrant: Anti-siphon, cast bronze interior hydrant with integral backflow preventer and detachable key. Set not less than 460 mm (1-1/2 feet) nor more than 920 mm (3-feet) above grade.

B. Hose bibbs, hose reels, mixing valves and wall boxes are furnished under specification 11 53 43, installed under this specification section.

C. Provide required hot and cold water connections.

PART 3 - EXECUTION

A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00, JOINT SEALANTS.

B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.

C. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4-inch) diameter bolts, and to extend at least 75 mm (3-inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.

D. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4-inch) threaded studs, and shall extend at least 35 mm (1-1/4 inches) into wall.

E. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.

F. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.

G. Do not use aerators on lavatories and sinks.

H. Install all equipment and fixtures in accordance with the manufacturer's written installation instructions.

3.2 CLEANING

A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

END OF SECTION

SECTION 22 63 00
GAS SYSTEMS FOR LABORATORY

PART 1 - GENERAL

1.1 DESCRIPTION

A. Laboratory Gas Systems: Consisting of carbon dioxide , and compressed air services; complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, gages, alarms including low voltage wiring, cylinder manifolds, pressure regulators, and all necessary parts, accessories, connections and equipment.

B. Laboratory gas system alarm wiring from equipment to alarm panels.

1.2 RELATED WORK

A. Sealing around pipe penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

B. Sealing around pipe penetrations through the floor to prevent moisture migration: Section 07 92 00, JOINT SEALANTS.

C. General requirements and items common to more than one section of Division 22. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Alarm interface with ECC. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

E. Conduit: Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

F. Control wiring: Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

G. Electrical wiring and accessories: Section 26 27 26, WIRING DEVICES.

1.3 QUALITY ASSURANCE

A. Equipment Installer: Show technical qualifications and previous experience in installing laboratory and healthcare equipment on three similar projects. Submit names and addresses of referenced projects.

B. Equipment Supplier: Show evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names and addresses where the product is installed.

C. Laboratory System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of laboratory pipeline testing. Such testing shall be performed by a party other than the installing contractor.

D. Provide names of three projects where testing of laboratory gases systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.

E. Submit the testing agency's detailed procedure which will be followed in the testing of this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.

F. Certification: Provide documentation prior to submitting request for final inspection to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits allowed by this specification.

G. 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, for certification by the Third Party Testing Company. As-built drawings are to be provided, and a copy of them on Auto-Cad version (R-14 or later) provided on compact disk. 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.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Piping.
   2. Valves.
   3. Inlet and outlet cocks.
   4. Valve cabinets.
   5. Gages.
   6. Laboratory service fitting rough-in assemblies (Coordinated with Section 11 53 43).
   7. Alarm controls and panels.
   8. Pressure Switches.
   10. Manifolds.

C. Certification: The completed systems have been installed, tested, purged and analyzed in accordance with the requirements of this specification.

1.5 TRAINING

A. Furnish the services of a competent instructor for not less than two four-hour periods for instructing personnel in the operation and maintenance of the laboratory and healthcare gas systems, on the dates requested by COTR.

B. Coordinate with other requirements specified in Section 01 00 00, GENERAL REQUIREMENTS.

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 test by the basic designation only.

B. American Society for Testing and Materials (ASTM):
   B819-(R2006) Seamless Copper Tube for Medical Gas Systems

C. American Society of Mechanical Engineers (ASME):
   A13.1-07 Scheme for Identification of Piping Systems

B16.22-01(R2005)	Wrought Copper and Bronze Solder-Joint Pressure Fittings
B40.100-98	Pressure Gauges and Gauge Attachments
	Boiler and Pressure Vessel Code -
Section VIII-07	Pressure Vessels, Division I
Section IX-07	Welding and Brazing Qualifications

D. American Welding Society (AWS):

AWS A5.8-04	Brazing Filler Metal
AWS B2.2-91	Standard for Brazing Procedure and Performance
Qualification	(Modified per NFPA 99)

E. Compressed Gas Association (CGA):

C-9-04	Standard Color Marking of Compressed Gas Cylinders
G-4.1-04	Cleaning Equipment for Oxygen Service
G-10.1-04	Nitrogen, Commodity
P-9-01	Inert Gases Argon, Nitrogen and Helium
V-1-05	Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections

F. National Electrical Manufacturers Association (NEMA):

ICS-6-93(R2006)	Industrial Controls and Systems Enclosures

G. United States Pharmacopoeia XXI/National Formulary XVI (USP/NF)

H. Manufacturing Standardization Society (MSS):

MSS-SP-72-99	Ball Valves With Flanged or Butt Welding For General Purpose
MSS-SP-110-96 and	Ball Valve Threaded, Socket Welding, Solder Joint, Grooved Flared Ends
MSS-SP-73-03	Brazing Joints for Copper and Copper Alloy Solder Pressure Fittings

PART 2 - PRODUCTS

2.1 PIPING

A. Copper Tubing: Type "K" or "L", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with MSS SP-73. Size designated reflecting nominal inside diameter. All tubing and fittings shall be cleaned fox oxygen service.

B. Brazing Alloy: AWS A5.8, Classification BCuP, greater than 537 °C (1000 °F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.

C. Screw Joints: Polytetrafluoroethylene (teflon) tape.

D. Apply piping identification labels shall be done at time of installation in accordance with current NFPA. Supplementary color identification shall be in accordance with CGA Pamphlet C-9.

E. Special Fittings:
   1. Dielectric fittings where required to connect laboratory service fittings .

2.2 VALVES

A. Ball: In-line:

1. Seventy five millimeter (2 1/2 inches) and smaller: Bronze/ brass body, Fed. Spec. MSS SP72 & SP 110 , Type II, Class 150, Style 1, with tubing extensions for brazed connections, full ported, three-piece or double union end connections, teflon seat seals, full flow, 4125 kPa (600 psi) WOG minimum working pressure, with locking type handle and cleaned for oxygen service. An acceptable manufacturer that meets the specification: Jomar model S-100.

B. Check:
   1. Eighty millimeter (3 inches) and smaller: brass and Bronze body, straight through design for minimum pressure drop, spring loaded, self aligning with teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, cleaned for oxygen use, 2750 kPa (400 psi) WOG minimum working pressure.

2.4 GAGES

A. Pressure Gages: Includes gages temporarily supplied for testing purposes.
   1. For line pressure use adjacent to source equipment: ASME B40.1, pressure gage, single, size 115 mm (4-1/2 inches), for compressed air, nitrogen and oxygen, accurate to within two percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Install with gage cock.
   2. For all services downstream of main shutoff valve: Manufactured expressly for oxygen use but labeled for appropriate service and marked "USE NO OIL", 40 mm (1-1/2 inch) diameter gage with dial range 1-690 kPa (1-100 psi) for air service , and 1-690 kPa (1-100 psi) carbon dioxide for service .

2.5 GAS OUTLETS: Refer to section 11 53 43; LABORATORY SERVICE FITTINGS AND FIXTURES

2.7 GAS OUTLET ROUGH-IN

A. Flush mounted, protected against corrosion. Anchor rough-in securely to unit or wall construction.

B. Modular Cover Plate: Die cast plate, two-piece .85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, secured to rough-in with stainless steel or chromium plated countersunk screws.

D. Provide permanent, metal or plastic, identification plates securely fastened at each outlet and , with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
CARBON DIOXIDE	White letters on gray background

2.8 ALARMS

A. Provide all low voltage control wiring, except for wiring from alarm relay interface control cabinet to ECC, required for complete, proper functioning system, in conformance with Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Run wiring in conduit, in conformance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

B. Master Alarm Functions: Provide the following individual alarms at the master alarm panel.
   1. Carbon Dioxide Alarms:
      a. Reserve Switchover Alarm: Functions when secondary or reserve carbon dioxide supply goes in operation.
      b. Pressure Alarms: Functions when system pressure downstream of main shutoff valve drops below 275 kPa (40 psi), plus/minus 14 kPa (two psi) or increases above 415 kPa (60 psi), plus/minus 14 kPa (two psi) set points; operated by pressure switches or transmitters.

C. Alarm Panels:
   1. General: Modular design, easily serviced and maintained; alarms operate on alternative current low voltage control circuit; provide required number of transformers for efficient functioning of complete system. Alarm panels shall be integral units, reporting carbon dioxide service .
   2. Box: Flush mounted, sectional or one piece, corrosion protected. Size to accommodate required number of service functions for each location, and for one audible signal in each box. Anchor box securely.
   3. Cover plate: Designed to accommodate required number of signals, visual and audible, for each location, and containing adequate operating instructions within the operator's view. Bezel shall be extruded aluminum, chromium plated metal, or plastic. Secure to the box with chromium plated or stainless steel countersunk screws.
   4. Service indicator lights: Red translucent plastic or LED with proper service identification inscribed thereon. Number of lights and service instruction shall be as required for each location. Provide each panel with a green test button of the same material, inscribed with "PUSH TO TEST" or similar message.
   5. Audible signal: Provide one in each alarm panel and connect electrically with all service indicator light functions.
   6. Controls:
      a. Visual signal: When the condition occurs which any individual service indicator light is to report, button for particular service shall give a lighted visual signal which cannot be canceled until such condition is corrected.
      b. Audible signal: Alarm shall give an audible signal upon circuit energization of any visual signal. Audible signal shall be continuous until silenced by pushing a button. This shall cancel and reset audible only, and not affect the visual signal. After silencing, subsequent alarms shall reactivate the audible alarm.
      c. Signal tester: Test button or separate normal light shall be continuously lighted to indicate electrical circuit serving each individual alarm is energized. Pushing test button shall temporarily activate all visual signals and sound audible signal, thereby providing desired indications of status of system.

D. Alarm Relay Interface Control Cabinet: Design cabinet to transfer the closed circuit alarm signals through relays to a set of terminals for monitoring signals at the ECC without interrupting the closed circuit system. Construct of 1.9 mm (14 gage) steel, conforming with NEMA ICS-6, Type 1, enclosures. Provide both normally open and normally closed contacts for output signals, with number of circuits required for full alarm capability at the ECC. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for compatibility.

2.9 PRESSURE SWITCHES

A. General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range set by inside or outside adjustment; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor or pressure switch.

2.10 CYLINDER GAS SUPPLY MANIFOLDS

A. Non-ferrous metal manifold and fittings, valves, parts and connections, suitable for a regular working pressure of 25 mPa (3000 psi). Gas cylinders at manifold shall be individually chained to wall or floor with adequate support.

B. Duplex arrangement, each bank having number of cylinder connections as required, high pressure copper cylinder connection pigtails with brazed fittings. Shutting of either bank shall not interrupt supply to system.

C. Provide manifold with two (one for each bank) two-stage pressure regulators with gages and built-in safety valves, manifold header valves and check valves, service line connection valves, relief valves, tank connecting coils and handles, and all required equipment for a complete assembly. Enclose manifold controls in sheet metal cabinet.

D. Supply pressure for carbon dioxide is 60 psig.

E. Switch-over to full reserve bank shall be automatic when one cylinder bank becomes exhausted, with no fluctuation in pressure, and not require resetting of regulators. After replacement of empty tank, resetting of controls shall be automatic or by single lever. Reserve switch-over shall be actuated by pressure switch; alarm shall be part of manifold control.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.

B. Keep open ends of tube capped or plugged at all times or otherwise sealed until final assembly.

C. Cut piping square and accurately with a tube cutter (sawing not permitted) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for gas service.

D. Spacing of hangers: Current NFPA.

E. Rigidly support valves and other equipment to prevent strain on tube or joints.

F. While being brazed, joints shall be continuously purged with oil free nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.

G. Do not bend tubing. Use fittings.

H. Install pressure switches, transmitter and gauges to be easily accessed. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.

I. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ANSI A13.1.

J. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.

K. Penetrations:
   1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked 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, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.
   2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.

3.2 TESTS

A. Initial Tests: Blow down, and high and low pressure leakage tests as required by current NFPA with documentation.

B. Laboratory testing agency shall perform the following:
   1. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with, current NFPA and the procedures set forth in pre-qualification documentation.
   2. Verify that the systems, as installed, meet or exceed the requirements of current NFPA, this specification, and that the systems operate as required.
   3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 35 cubic feet (1000 liters) of gas through a clean white 0.45 micron filter at a minimum velocity of 3.5 scfm (100 Lpm). Filter shall show no discoloration, and shall accrue no more than 0.1 mg of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.
   4. Piping purity test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane), and halogenated hydrocarbons, and compare with source gas. The two tests must in no case exceed variation as specified in Paragraph, Maximum Allowable Variation. Perform test with the use of an inert gas as described in CGA P-9.
   5. Outlet and inlet flow test:
      a. Test all outlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
      b. Needle valve air outlets must deliver 1.5 scfm with a pressure drop of no more than five psi, and static pressure of 50 psi.
   6. Analysis Test:

a. Analyze each pressure gas source and outlet for concentration of gas, by volume.
b. Make analysis with instruments designed to measure the specific gas dispensed.
c. Allowable concentrations are within the following:

1) Laboratory air 19.5 percent to 23.5 percent oxygen.

Laboratory air	19.5 percent to 23.5 percent oxygen
Carbon Dioxide	99 plus percent carbon dioxide

END OF SECTION

SECTION 22 67 00

RECIRCULATION TYPE ANIMAL DRINKING WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the system for distribution of animal drinking water (ADW) and requirements for installation, commissioning, documentation, training, and start-up.

B. The system is defined in the system drawings and this Specification.

C. System Description:

1. The installed distribution system will be connected to a future Government Furnished, Government Installed (GFGI) animal drinking water production system. Interface points shall be shown on the drawing. .
2. Distribution system will supply water to cage racks, bottle filler stations and return to the animal drinking water equipment room. The system will include piping and components required to meet operational requirements of these units.

1.2 DESIGN CRITERIA:

A. Distribution system shall be designed for bacterial control by Recirculation through Future UV treatment & back through racks. The overall distribution network shall be designed to permit supplemental treatments that may include acidification.

B. Animal watering will serve approximately 8 holding rooms of various sizes and layouts . Each typical room contains 7 cage racks. Vendors are to provide a piping system that feeds the racks from recoil-hose drop down.

C. Vendor shall provide the distribution system, including 2 recoil hoses for each rack.

D. Equipment and Material:

1. Materials in contact with ADW shall be CPVC-FSP and stainless steel.
2. ADW from the future storage tank will be pressurized using a pump and piped throughout the network.
3. ADW delivery system at holding rooms will include isolation valves and gauges, recoil hoses with quick disconnect couplings.

E. All distribution system work shall be coordinated with Systems Engineering Lab Group Inc. (Al Carlile) – 877-253-8852.

1.3 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.

1.4 SCOPE OF WORK

A. Contractor shall provide:

1. Final system installation drawings, including line sizes
2. Final specification and data sheets for instrumentation.

3. Fully functional system, including equipment and instrumentation.
4. System pressure testing, flushing and demonstration that system achieves operational requirements.
5. Complete system documentation as listed under Submittals below.
6. ½ day of Training of client's personnel on operation and maintenance of components provided.

1.5 **SUBMITTALS**

A. Submittals WILL BE PROVIDED for documentation and those required by specifications under Related Work above.
   1. Approval of Submittal must be obtained prior to proceeding with fabrication or purchase of item. Drawings indicating:
      a. Layout of distribution system at ¼" = 1'-0".
      b. Catalog data on valves, gauges, Re-coil hoses, quick disconnect coupling and any other required components.
      c. Connection sizes and locations.
      d. Utility loads, flows to drain.
      e. Testing and commissioning plan.
   2. The following documentation in printed and electronic form (CD/DVD) shall be delivered with system:
      a. Operating and Maintenance manuals; including PM schedule, normal system operating conditions, complete spare parts list, and recommended spare parts list.
      b. Completed instrument data sheets.

1.6 **WARRANTY**

A. The respective manufacturer and contractor shall warrant system components installationand workmanship, boilding acceptance, for a period of 1 year from date of Building acceptance.

PART 2 - PRODUCTS

2.1 **PIPING SYSTEMS**

A. General:
   1. Two piping specifications shall be used:
      a. Corridor feed and return lines shall be CPVC-FSP.
      b. In-room Piping / Tubing Shall be SST.

2.2 **CAGE RACK INTERCONNECT STATION**

A. Each cage rack interconnect Feed point shall be provided with the following:
   1. Interconnect (I/C) assembly on supply line:
      a. Standard 1/4" universal style socket quick disconnect (QD)/half coupling fitting. Stainless Steel.
      b. Extended Reach: 7 feet.

B. Hose assembly for connecting cage rack manifold to Return line.
   1. When cage rack is not present, quick disconnect return leg of manifold will connect to free end of recoil supply hose.
      a. Standard 1/4" universal style socket quick disconnect (QD)/half coupling fitting. Stainless Steel.

b. Extended Reach: 7 feet

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping, instrumentation, and accessories as directed in this specification, specifications under Related Work, and in accordance with equipment manufacturer's recommendations.

B. Protect piping from contamination during storage, handling and installation.

C. Piping installers shall be trained and certified by the piping manufacturer to install the piping product to be installed under this Section. Manufacturer's warranty protection shall cover all work associated with system installation.

3.2 PIPING

A. Install piping in accordance with manufacturer's recommended installation procedures.
   1. Work shall be performed by factory technicians.
   2. Piping shall be attached to ceilings and walls with stainless steel mounting bracket. Include standoff bracket to keep piping away from mounting surface.
   3. Attach tubing/pipe to wall, ceilings or other suitable support structure with stainless steel clamps.
   4. Install in-room feed piping system at consistent level as indicated on plans. Limit rises and drops.
   5. Install in-room return piping system at consistent level as indicated on plans. Limit rises and drops.
   6. Suitable backing for brackets and clamps to be coordinated with supplied by general construction trades.
   7. Corridor distribution shall be installed above ceiling as indicated on plans.

3.3 COMMISSIONING/STARTUP

A. AWS vendor shall verify installation and pipe distribution work performed by contractors is in conformance to Drawings and Specifications.

END OF SECTION

SECTION 23 05 11
COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23.

B. Definitions:
   1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
   2. Option or optional: Contractor's choice of an alternate material or method.
   3. RE: Resident Engineer
   4. COTR: Contracting Officer’s Technical Representative.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Excavation and Backfill: Section 31 20 00, EARTH MOVING.

D. Concrete and Grout: Section 03 30 00, CAST-IN-PLACE CONCRETE.

E. Building Components for Attachment of Hangers: Section 05 31 00, STEEL DECKING, // and Section 05 36 00, COMPOSITE METAL DECKING. //

F. Section 05 50 00, METAL FABRICATIONS.

G. Section 07 84 00, FIRESTOPPING.

H. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.

I. Section 07 92 00, JOINT SEALANTS.

J. Section 09 91 00, PAINTING.

K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

M. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC or steam boiler plant construction, as applicable.

B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

C. Equipment Vibration Tolerance:

1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

D. Products Criteria:
1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. 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.
2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities, if the local codes are more stringent then those specified. Refer any conflicts to the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR).
4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:
1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located reasonably close to the site.

F. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

G. Outside Steam Distribution Welding: Refer to 33 63 00, STEAM ENERGY DISTRIBUTION.

H. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the RE/COTR for resolution. Provide written hard copies or computer files of manufacturer’s installation instructions to the RE/COTR at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.

2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to: all types of valves, filters and strainers, transmitters, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the RE/COTR for resolution.
3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.

B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

C. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

D. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

E. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

F. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.

G. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made as provided in the GENERAL CONDITIONS.

H. Layout Drawings:
1. Submit complete consolidated and coordinated layout drawings for all new systems, and for existing systems that are in the same areas. Refer to the GENERAL CONDITIONS.
2. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems.
3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
4. In addition, for HVAC systems, provide details of the following:
   a. Mechanical equipment rooms.

b. Interstitial space.
c. Hangers, inserts, supports, and bracing.
d. Pipe sleeves.
e. Duct or equipment penetrations of floors, walls, ceilings, or roofs.

I. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the Resident Engineer.
2. Submit electric motor data and variable speed drive data with the driven equipment.
3. Equipment and materials identification.
4. Fire-stopping materials.
5. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
6. Wall, floor, and ceiling plates.

J. HVAC Maintenance Data and Operating Instructions:
1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

K. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning and Refrigeration Institute (ARI):
430-99 Central Station Air-Handling Units

C. American National Standard Institute (ANSI):
B31.1-2004 Power Piping

D. Rubber Manufacturers Association (ANSI/RMA):
IP-20-2007 Drives Using Classical V-Belts and Sheaves
IP-21-1991(1997) Drives Using Double-V (Hexagonal) Belts
IP-22-2007 Drives Using Narrow V-Belts and Sheaves

E. Air Movement and Control Association (AMCA):
410-96 Recommended Safety Practices for Air Moving Devices

F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007 Power Boilers
Section IX-2007 Welding and Brazing Qualifications

G. Code for Pressure Piping:
B31.1-2004 Power Piping, with Amendments

H. American Society for Testing and Materials (ASTM):
A36/A36M-05 Carbon Structural Steel
A575-96(2002) Steel Bars, Carbon, Merchant Quality, M-Grades R (2002)

E84-07	Standard Test Method for Burning Characteristics of Building Materials
E119-07	Standard Test Method for Fire Tests of Building Construction and Materials

I. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:

SP-58-2002	Pipe Hangers and Supports-Materials, Design and Manufacture
SP 69-2003	Pipe Hangers and Supports-Selection and Application
SP 127-2001	Bracing for Piping Systems, Seismic – Wind – Dynamic, Design, Selection, Application

J. National Electrical Manufacturers Association (NEMA):

MG-1-2006	Motors and Generators

K. National Fire Protection Association (NFPA):

31-06	Standard for Installation of Oil-Burning Equipment
54-06	National Fuel Gas Code
70-08	National Electrical Code
85-07	Boiler and Combustion Systems Hazard Code
90A-02	Installation of Air Conditioning and Ventilating Systems
101-06	Life Safety Code

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:
1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the RE/COTR. Such repair or replacement shall be at no additional cost to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:
1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

A. Provide maximum standardization of components to reduce spare part requirements.

B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
1. All components of an assembled unit need not be products of same manufacturer.

2. Constituent parts that are alike shall be products of a single manufacturer.
3. Components shall be compatible with each other and with the total assembly for intended service.
4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.

D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3 BELT DRIVES

A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.

B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.

C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.

D. Maximum Speed: 25 m/s (5000 feet per minute).

E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.

F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.

G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.

H. Sheaves and Pulleys:
1. Material: Pressed steel, or close grained cast iron.
2. Bore: Fixed or bushing type for securing to shaft with keys.
3. Balanced: Statically and dynamically.
4. Groove spacing for driving and driven pulleys shall be the same.
5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations)in millimeters and inches:

Fractional Horsepower		Standard		High Capacity	
Cross Section	Min. od mm (in)	Cross Section	Min. od mm (in)	Cross Section	Min. od mm (in)
2L	20 (0.8)	A	83 (3.25)	3V	67 (2.65)
3L	38 (1.5)	B	146 (5.75)	4V	180 (7.10)
4L	64 (2.5)	C	239 (9.40)	5V	318 (12.50)
5L	89 (3.5)	D	345 (13.60)		
		E	554 (21.80)		

I. Drive Types, Based on ARI 435:
   1. Provide adjustable-pitch or fixed-pitch drive as follows:
      a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
      b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
   2. Provide fixed-pitch drives for drives larger than those listed above.
   3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

2.4 DRIVE GUARDS

A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.

B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.

D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.

E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

2.5 LIFTING ATTACHMENTS

A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.6 ELECTRIC MOTORS

A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT; Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient motors as scheduled. Unless otherwise specified for a particular application use electric motors with the following requirements.

B. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC).

C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.

D. Rating: Continuous duty at 100 percent capacity in an ambient temperature of 40 degrees centigrade (104 degrees F); minimum horsepower as shown on drawings; maximum horsepower in normal operation not to exceed nameplate rating without service factor.

E. Special Requirements:
   1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
   2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
   3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
      a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
      b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
      c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
   4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.
   5. Motors utilized with variable frequency drives shall be rated “inverter-ready” per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

F. Motor Efficiency and Power Factor: All motors, when specified as “high efficiency” by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as “NEMA premium efficient” and the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as “high efficiency” shall comply with EPACT.

G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

2.7 VARIABLE SPEED MOTOR CONTROLLERS

A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS for specifications.

B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.

C. Motors shall be energy efficient type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.

D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

2.8 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.

B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.

D. Control Items: Label all temperature sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.

E. Valve Tags and Lists:
   1. HVAC : Provide for all valves other than for equipment in Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
   2. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm(1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
   3. Valve lists: Typed or printed plastic coated card(s), sized 216 mm(8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
   4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.9 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, PLUMBING, AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

2.10 GALVANIZED REPAIR COMPOUND

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

2.11 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

B. Supports for Roof Mounted Items:
   1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
   2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

C. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.

D. Attachment to Concrete Building Construction:
   1. Concrete insert: MSS SP-58, Type 18.
   2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.
   3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.

E. Attachment to Steel Building Construction:
   1. Welded attachment: MSS SP-58, Type 22.
   2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.

F. Attachment to Metal Pan or Deck: As required for materials specified in // Section 05 31 00, STEEL DECKING .// Section 05 36 00, COMPOSITE METAL DECKING .//

G. Attachment to Wood Construction: Wood screws or lag bolts.

H. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.

I. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
   1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
   2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.

J. Supports for Piping Systems:

1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all other types of supports and hangers including those for preinsulated piping.
2. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
   a. Standard clevis hanger: Type 1; provide locknut.
   b. Riser clamps: Type 8.
   c. Wall brackets: Types 31, 32 or 33.
   d. Roller supports: Type 41, 43, 44 and 46.
   e. Saddle support: Type 36, 37 or 38.
   f. Turnbuckle: Types 13 or 15. Preinsulate.
   g. U-bolt clamp: Type 24.
   h. Copper Tube:
      1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non adhesive isolation tape to prevent electrolysis.
      2) For vertical runs use epoxy painted or plastic coated riser clamps.
      3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
      4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
   i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.
3. High and Medium Pressure Steam (MSS SP-58):
   a. Provide eye rod or Type 17 eye nut near the upper attachment.
   b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
   c. Piping with Vertical Expansion and Contraction:
      1) Movement up to 20 mm (3/4-inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
      2) Movement more than 20 mm (3/4-inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator. //
4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

K. Pre-insulated Calcium Silicate Shields:
1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
3. Shield thickness shall match the pipe insulation.
4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
   a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 1 inch past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
   b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

L. Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.

2.12 PIPE PENETRATIONS

A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.

B. To prevent accidental liquid spills from passing to a lower level, provide the following:
   1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
   2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
   3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.

C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of Resident Engineer.

D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.

E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.

F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms.

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.

2.13 SPECIAL TOOLS AND LUBRICANTS

A. Furnish, and turn over to the RE/COTR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.

C. Tool Containers: Hardwood or metal, permanently identified for in tended service and mounted, or located, where directed by the Resident Engineer.

D. Lubricants: A minimum of 0.95 L (one quart) of oil, and 0.45 kg (one pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

2.14 WALL, FLOOR AND CEILING PLATES

A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.

B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.

C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. 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.

2.15 ASBESTOS

A. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.

B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.

C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.

D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.

E. Cutting Holes:
   1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by RE/COTR where working area space is limited.
   2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
   3. Do not penetrate membrane waterproofing.

F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.

G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.

H. Electrical and Pneumatic Interconnection of Controls and Instruments: This generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.

I. Protection and Cleaning:
   1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, shall be replaced.
   2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. 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.

J. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

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

L. Work in Animal Research Areas: Seal all pipe and duct penetrations with silicone sealant to prevent entrance of insects.

M. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

N. Inaccessible Equipment:
   1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
   2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.2 TEMPORARY PIPING AND EQUIPMENT

A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.

B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Para. 3.1 apply.

C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.3 RIGGING

A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.

B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.

C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.

D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.

E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.

G. Restore building to original condition upon completion of rigging work.

3.4 PIPE AND EQUIPMENT SUPPORTS

A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the RE/COTR.

B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.

C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.

D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.

E. HVAC Vertical Pipe Supports:
   1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
   2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.

F. Overhead Supports:
   1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
   2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
   3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:
   1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.

2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 MECHANICAL DEMOLITION

A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the RE/COTR. 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 plant, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.

C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to RE/COTR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

E. Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

3.6 CLEANING AND PAINTING

A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.

B. In addition, the following special conditions apply:

1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
2. Material And Equipment Not To Be Painted Includes:
   a. Motors, controllers, control switches, and safety switches.
   b. Control and interlock devices.
   c. Regulators.
   d. Pressure reducing valves.
   e. Control valves and thermostatic elements.
   f. Lubrication devices and grease fittings.
   g. Copper, brass, aluminum, stainless steel and bronze surfaces.
   h. Valve stems and rotating shafts.
   i. Pressure gauges and thermometers.
   j. Glass.
   k. Name plates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Boilers, Burners, Fuel Trains and Accessories: Retain manufacturer's factory finish. Touch up or recoat as necessary to provide smooth, even-colored and even-textured finish.
6. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
7. Paint shall withstand the following temperatures without peeling or discoloration:
   a. Condensate and feedwater -- 38 degrees C (100 degrees F) on insulation jacket surface and 120 degrees C (250 degrees F) on metal pipe surface.
   b. Steam -- 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (375 degrees F) on metal pipe surface.
8. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

3.7 IDENTIFICATION SIGNS

A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16-inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.

B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.

C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.8 MOTOR AND DRIVE ALIGNMENT

A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.

B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.9 LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.

B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to RE/COTR in unopened containers that are properly identified as to application.

C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.

D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.10 STARTUP AND TEMPORARY OPERATION

A. Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.11 OPERATING AND PERFORMANCE TESTS

A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS, and Section 23 08 11, DEMONSTRATIONS AND TESTS FOR BOILER PLANT, and submit the test reports and records to the RE/COTR.

B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.

C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.12 INSTRUCTIONS TO VA PERSONNEL

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

END OF SECTION

SECTION 23 05 12
GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.

1.2 RELATED WORK:

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements common to more than one Section of Division 26.

B. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERSS: Starters, control and protection for motors.

C. Section 26 24 19, MOTOR-CONTROL CENTERS: Multiple motor control assemblies, which include motor starters.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

E. Section 23 21 23, HYDRONIC PUMPS.

F. Section 23 22 23, STEAM CONDENSATE PUMPS.

G. Section 23 34 00, HVAC FANS.

H. Section 23 36 00, AIR TERMINAL UNITS.

I. Section 23 64 00, PACKAGED WATER CHILLERS.

J. Section 23 82 00, CONVECTION HEATING and COOLING UNITS.

K. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

1.3 SUBMITTALS:

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:
   1. Provide documentation to demonstrate compliance with drawings and specifications.
   2. Include electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.

C. Manuals:
   1. Submit simultaneously with the shop drawings, companion copies of complete installation, maintenance and operating manuals, including technical data sheets and application data.

D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
   1. Certification that the motors have been applied, installed, adjusted, lubricated, and tested according to manufacturer published recommendations.

E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.4 APPLICABLE PUBLICATIONS:

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

B. National Electrical Manufacturers Association (NEMA):

MG 1-2006 Rev. 1 2009……Motors and Generators

MG 2–2001 Rev. 1 2007……Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

C. National Fire Protection Association (NFPA):

70-2008…… ……..National Electrical Code (NEC)

D. Institute of Electrical and Electronics Engineers (IEEE):

112-04…….. ……..Standard Test Procedure for Polyphase Induction Motors and Generators

E. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

90.1-2007……. ……..Energy Standard for Buildings Except Low-Rise Residential Buildings

PART 2 - PRODUCTS

2.1 MOTORS:

A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.

B. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS; and Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.

C. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
   1. Contractor's Option - Electrically Commutated motor (EC Type): Motor shall be brushless DC type specifically designed for applications with heavy duty ball bearings and electronic commutation. The motor shall be speed controllable down to 20% of full speed and 85% efficient at all speeds.

D. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
   1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.

E. Voltage ratings shall be as follows:
   1. Single phase:
      a. Motors connected to 120-volt systems: 115 volts.
      b. Motors connected to 208-volt systems: 200 volts.
      c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
   2. Three phase:

a. Motors connected to 208-volt systems: 200 volts.
b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 208-230/460 volts, dual connection.
c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.

F. Number of phases shall be as follows:
1. Motors, less than 373 W (1/2 HP): Single phase.
2. Motors, 373 W (1/2 HP) and larger: 3 phase.
3. Exceptions:
a. Hermetically sealed motors.
b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.

G. Motors shall be designed for operating the connected loads continuously in a 40°C (104°F) environment, where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation. If the motors exceed 40°C (104°F), the motors shall be rated for the actual ambient temperatures.

H. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.

I. Motor Enclosures:
1. Shall be the NEMA types as specified and/or shown on the drawings.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

J. Special Requirements:
1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
2. Assemblies of motors, starters, controls and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
a. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
c. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
4. Select motor sizes so that the motors do not operate into the service factor at maximum required loads on the driven equipment. Motors on pumps shall be sized for non-overloading at all points on the pump performance curves.

5. Motors utilized with variable frequency drives shall be rated "inverter-duty" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.

K. Additional requirements for specific motors, as indicated in the other sections listed in Article 1.2, shall also apply.

L. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section. Motors not specified as "premium efficiency" shall comply with the Energy Policy Act of 2005 (EPACT).

Minimum Premium Efficiencies Open Drip-Proof				**Minimum Premium Efficiencies Totally Enclosed Fan-Cooled**			
Rating kW (HP)	**1200 RPM**	**1800 RPM**	**3600 RPM**	**Rating kW (HP)**	**1200 RPM**	**1800 RPM**	**3600 RPM**
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

M. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

PART 3 - EXECUTION

3.1 INSTALLATION:

Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

3.2 FIELD TESTS

A. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before start-up. All shall test free from grounds.

B. Perform Load test in accordance with ANSI/IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.

C. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

3.3 STARTUP AND TESTING

A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

3.4 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 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.

A. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.5 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 – COMMISSIONING OF HVAC SYSTEMS.

END OF SECTION

SECTION 23 05 41
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Noise criteria, seismic restraints for equipment , vibration tolerance and vibration isolation for HVAC and plumbing work.

1.2 RELATED WORK

A. Section 03 30 00, CAST-IN-PLACE CONCRETE: Requirements for concrete inertia bases.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment

C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

D. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.

E. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS: Requirements for optional Air Handling Unit internal vibration isolation.

F. Section 23 31 00, HVAC DUCTS AND CASINGS: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.

G. SECTION 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: requirements for sound and vibration tests.

1.3 QUALITY ASSURANCE

A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Noise Criteria:
   1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Corridors(Public)	40
Laboratories	45
Locker Rooms	50
Offices, large open (3 or more occupants)	40
Offices, small private (2 or fewer occupants)	35
Cage Wash	50
Storage	50

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the fore-going noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, Sound and Vibration.
3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

C. Seismic Restraint Requirements:
1. Equipment:
   a. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist a horizontal force as outlined in 13 05 41.
2. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force as outlined in 13 05 41: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.

D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
1. Vibration isolators:
   a. Floor mountings
   b. Hangers
   c. Snubbers
   d. Thrust restraints
2. Bases.
3. Seismic restraint provisions and bolting.
4. Acoustical enclosures.

C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements, as specified in 13 05 41.

1.5 APPLICABLE PUBLICATIONS

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

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
2005 Fundamentals Handbook, Chapter 7, Sound and Vibration

C. American Society for Testing and Materials (ASTM):
A123/A123M-02 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A307-04Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
D2240-05 Standard Test Method for Rubber Property - Durometer Hardness

D. Manufacturers Standardization (MSS):
SP-58-02 Pipe Hangers and Supports-Materials, Design and Manufacture

E. Occupational Safety and Health Administration (OSHA):
29 CFR 1910.95 Occupational Noise Exposure

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.

B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.

C. Exposure to weather: Isolators, including springs, exposed to weather shall be hot dip galvanized after fabrication. Hot-dip zinc coating shall not be less than 609 grams per square meter (two ounces per square foot) by weight complying with ASTM A123.In addition provide limit stops to resist wind velocity. Comply with the design wind pressure of 30 PSF.

D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.

E. Color code isolators by type and size for easy identification of capacity.

2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENTS

A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.

B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment Size and material required for the base shall be as recommended by the isolator manufacturer.

C. On all sided of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment. The slack cable restraint method, Mason Industries, or equal, is acceptable.

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. Captive Spring Mount for Seismic Restraint (Type SS):
   a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.
   b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting.
5. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, 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 pounds per square inch).
6. Seismic Pad (Type DS): Pads shall be felt, cork neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene, with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).

B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
   1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
   2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
   3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
   4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
   5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.

C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.

D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

2.4 BASES

A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.

B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than 100 mm (four inches).

C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).

D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

2.5 SOUND ATTENUATING UNITS

A. Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Vibration Isolation:
   1. No metal-to-metal contact will be permitted between fixed and floating parts.

2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (l00 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

3.2 ADJUSTING

A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch (6-mm) movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's recommendations.

F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

END OF SECTION

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
a. REFRIGERATION MACHINES																
ABSORPTION		---	D	---	---	SP	1.0	---	SP	1.0	---	SP	1.7	---	SP	1.7
PACKAGED HERMETIC		---	D	---	---	SP	1.0	---	SP	1.7	---	SP	1.7	R	SP	2.5
OPEN CENTRIFUGAL		B	D	---	B	SP	1.0	---	SP	1.7	B	SP	1.7	B	SP	3.5
RECIPROCATING:																
500 - 750 RPM		---	D	---	---	SP	1.7	R	SP	1.7	R	SP	2.5	R	SP	3.5
751 RPM & OVER		---	D	---	---	SP	1.0	---	---	1.7	R	SP	2.5	R	SP	2.5
b. COMPRESSORS AND VACUUM PUMPS																
UP THROUGH 1-1/2 HP		---	D,L,W	---	----	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
2 HP AND OVER:																
500 - 750 RPM		---	D	---	---	S	1.7	---	S	2.5	---	S	2.5	---	S	2.5
750 RPM & OVER		---	D	---	---	S	1.0	---	S	1.7	---	S	2.5	---	S	2.5
c. 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	1.0	I	S	1.0	I	S	1.7	I	S	1.7
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	1.7	I	S	1.7	I	S	1.7

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	1.7	I	S	2.5	I	S	2.5
d. ROOF VENTILTORS															
ABOVE OCCUPIED AREAS:															
5 HP & OVER	---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
e. CENTRIFUGAL BLOWERS															
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	1.7	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	1.7	B	S	1.7	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	1.0	B	S	1.0	B	S	1.7	B	S	2.5
60 HP & OVER:															
UP TO 300 RPM	B	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301 - 500 RPM	B	S	1.7	I	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM & OVER	B	S	1.0	I	S	1.7	I	S	1.7	I	S	2.5	I	S	2.5
COOLING TOWERS															
UP TO 500 RPM	---	---	---	---	SP	1.0	---	SP	1.7	---	SP	2.5	---	SP	3.5
501 RPM & OVER	---	---	---	---	SP	1.0	---	SP	1.0	---	SP	1.7	---	SP	2.5
INTERNAL COMBUSTION ENGINES															
UP TO 25 HP	I	N	0.3	I	N	0.3	I	S	1.7	I	S	2.5	I	S	2.5

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
30 THRU 100 HP	I	N	0.3	I	N	1.7	I	S	2.5	I	S	3.5	I	S	3.5
125 HP & OVER	I	N	0.3	I	N	2.5	I	S	3.5	I	S	4.5	I	S	4.5
AIR HANDLING UNIT PACKAGES															
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	1.7	---	H, THR	1.7	---	H, THR	1.7	---	H, THR	1.7
501 RPM & OVER	---	---	---	---	H, THR	1.0	---	H, THR	1.0	---	H,THR	1.7	---	H,THR	1.7
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	1.7	R	S, THR	1.7	R	S, THR	1.7	R	S, THR	1.7
501 RPM & OVER	---	D	---	---	S, THR	1.0	---	S, THR	1.0	R	S, THR	1.7	R	S, THR	1.7
IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)															
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	1.7	R	S	1.7	R	S	2.5	R	S	2.5
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	1.7	R	S	2.5
60 HP AND OVER:															
301 - 500 RPM	R	S	1.0	R	S	1.7	R	S	1.7	R	S	2.5	R	S	3.5

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 RPM & OVER	R	S	1.0	R	S	1.7	R	S	1.7	R	S	1.7	R	S	2.5

3.3 NOTES:

1. Edit the Table above to suit where isolator, other than those shown, are used, such as for seismic restraints and position limit stops.
2. For suspended floors lighter than 100 mm (4 inch) thick concrete, select deflection requirements from next higher span.
3. For separate chiller building on grade, pump isolators may be omitted.
4. Direct bolt fire pumps to concrete base. Provide pads (D) for domestic water booster pump package.
5. For projects in seismic areas, use only SS & DS type isolators and snubbers.
6. For floor mounted in-line centrifugal blowers (ARR 1): use "B" type in lieu of "R" type base.
7. Suspended: Use "H" isolators of same deflection as floor mounted.

END OF SECTION

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
   1. Planning systematic TAB procedures.
   2. Design Review Report.
   3. Systems Inspection report.
   4. Duct Air Leakage test report.
   5. Systems Readiness Report.
   6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
   7. Vibration and sound measurements.
   8. Recording and reporting results.

B. Definitions:
   1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of ASHRAE Handbook, "HVAC Applications".
   2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
   3. AABC: Associated Air Balance Council.
   4. NEBB: National Environmental Balancing Bureau.
   5. Hydronic Systems: Includes chilled water, and heating hot water .
   6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
   7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

1.2 RELATED WORK

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General Mechanical Requirements.

B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise and Vibration Requirements.

C. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Piping and Equipment Insulation.

D. Section 23 64 00, PACKAGED WATER CHILLERS: Testing Refrigeration Equipment.

E. Section 23 36 00, AIR TERMINAL UNITS: Terminal Units Performance.

F. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.

G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.

1.3 QUALITY ASSURANCE

A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Qualifications:
   1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
   2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
   3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the Resident Engineer and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any duties related to the HVAC systems, including TAB. All work specified in this Section and in other related Sections performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.
      a. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the Resident Engineer. The responsibilities would specifically include:
      b. Shall directly supervise all TAB work.
      c. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
      d. Would follow all TAB work through its satisfactory completion.
      e. Shall provide final markings of settings of all HVAC adjustment devices.
      f. Permanently mark location of duct test ports.
   4. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing.

C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.

D. Tab Criteria:
   1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.
   2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.

a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus l0 percent.
b. Air terminal units (maximum values): Minus 2 percent to plus l0 percent.
c. Exhaust hoods/cabinets: 0 percent to plus l0 percent.
d. Minimum outside air: 0 percent to plus 10 percent.
e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus l0 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
g. Chilled water pumps: 0 percent to plus 5 percent.
h. Chilled water coils: 0 percent to plus 5 percent.

3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms) and one hydronic system (pumps and three coils) as follows:
   a. When field TAB work begins.
   b. During each partial final inspection and the final inspection for the project if requested by VA.

1.4 SUBMITTALS

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

B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.

C. For use by the Resident Engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.

D. Submit Following for Review and Approval:
   1. Design Review Report // within 90 days for conventional design projects // and within 60 days for design-build projects // after the system layout on air and water side is completed by the Contractor.
   2. Systems inspection report on equipment and installation for conformance with design.
   3. Duct Air Leakage Test Report.
   4. Systems Readiness Report.
   5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
   6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

E. Prior to request for Final or Partial Final inspection, submit completed Test and Balance report for the area.

1.5 APPLICABLE PUBLICATIONS

A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.

B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
   2003 HVAC Applications ASHRAE Handbook, Chapter 37, Testing, Adjusting, and Balancing and Chapter 47, Sound and Vibration Control

C. Associated Air Balance Council (AABC):
   2002 AABC National Standards for Total System Balance

D. National Environmental Balancing Bureau (NEBB):
7th Edition 2005 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems
1st Edition 1994 Procedural Standards for the Measurement and Assessment of Sound and Vibration
2nd Edition 1999 Procedural Standards for Building Systems Commissioning

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
3rd Edition 2002 HVAC SYSTEMS-Testing, Adjusting and Balancing

PART 2 - PRODUCTS

2.1 PLUGS

A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

2.2 INSULATION REPAIR MATERIAL

A. See Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION. Provide for repair of insulation removed or damaged for TAB work.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to TAB Criteria in Article, Quality Assurance.

B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

3.2 DESIGN REVIEW REPORT

A. The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

3.3 SYSTEMS INSPECTION REPORT

A. Inspect equipment and installation for conformance with design.

B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

3.4 DUCT AIR LEAKAGE TEST REPORT

A. See paragraphs "Duct leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS AND CASINGS for TAB agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

3.5 SYSTEM READINESS REPORT

A. Inspect each System to ensure that it is complete including installation and operation of controls.

B. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

3.6 TAB REPORTS

A. Submit an intermediate report for 50 percent of systems and equipment tested and balanced to establish satisfactory test results.

B. The TAB contractor shall provide raw data immediately in writing to the Resident Engineer if there is a problem in achieving intended results before submitting a formal report.

C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval.

D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

3.7 TAB PROCEDURES

A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.

B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.

C. Coordinate TAB procedures with any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.

D. Allow sufficient time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.

E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets, and laboratory hoods and cabinets.
   1. Artificially load air filters by partial blanking to produce air pressure drop of at least 90 percent of the design final pressure drop.
   2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
   3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
   4. Constant air volume systems:
      a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates as necessary to achieve pressure differentials shown . Balance air distribution from ATU on maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode.

5. Record final measurements for air handling equipment performance data sheets.

F. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, and coolers :

1. Coordinate water chiller flow balancing with Section 23 64 00, PACKAGED WATER CHILLERS.
2. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
3. Primary-secondary (variable volume) systems: Coordinate TAB with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Balance systems at design water flow and then verify that variable flow controls function properly.
4. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling unit heating and cooling coils and reheat coils. Make air and water temperature measurements at the same time.

3.8 VIBRATION TESTING

A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including centrifugal/screw compressors, cooling towers, pumps, fans and motors.

B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the Resident Engineer.

3.9 SOUND TESTING

A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

1. Take readings in rooms, approximately thirty (30) percent of all rooms. The Resident Engineer may designate the specific rooms to be tested.

B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.

C. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.

D. Determine compliance with specifications as follows:

1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT:
   a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.

b. Measure octave band sound pressure levels with specified equipment "off."
c. Measure octave band sound pressure levels with specified equipment "on."
d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

e. Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.
f. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.

2. When sound power levels are specified:
   a. Perform steps 1.a. thru 1.d., as above.
   b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
   c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 10 meters (30 feet) for sound level location.
3. Where sound pressure levels are specified in terms of dB(A), as in Section 23 65 00, , measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.

E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.

3.10 MARKING OF SETTINGS

A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the Resident Engineer.

3.11 IDENTIFICATION OF TEST PORTS

A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

END OF SECTION

SECTION 23 07 11
HVAC, PLUMBING, 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. Plumbing piping and equipment.

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, and electrical equipment rooms or exposed to outdoor weather. Penthouse where air handling units are located are considered to be mechanical rooms. Shafts and chases, 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 and plumbing equipment or piping handling media above 41 degrees C (105 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. HPS: High pressure steam (415 kPa [60 psig] and above).
   13. HPR: High pressure steam condensate return.
   14. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig].
   15. MPR: Medium pressure steam condensate return.
   16. LPS: Low pressure steam (103 kPa [15 psig] and below).
   17. LPR: Low pressure steam condensate gravity return.
   18. PC: Pumped condensate.
   19. HWH: Hot water heating supply.
   20. HWHR: Hot water heating return.
   21. CPD: Condensate pump discharge.
   22. R: Pump recirculation.
   23. CW: Cold water.
   24. SW: Soft water.
   25. HW: Hot water.
   26. CH: Chilled water supply.
   27. CHR: Chilled water return.
   28. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.

B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

C. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING and Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.

D. SECTION 23 64 00, PACKAGED WATER CHILLERS: Compressor, evaportator and piping.

E. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING: Piping and equipment.

F. Section 23 21 13, HYDRONIC PIPING: Heating water and Chilled water piping.

G. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.

1.3 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

   a. **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 4.3.3.1.2 or 4.3.3.1.3, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

   b. **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.)*

   c. **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.

   d. **4.3.3.1.3** Smoke detectors required by 6.4.4 shall not be required to meet flame spread index or smoke developed index requirements.

   e. **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

f. **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.

g. **4.3.3.3.1** In no case shall the test temperature be below 121°C (250°F).

h. **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.

i. **4.3.3.5*** Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

j. **4.3.3.6** Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

k. **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.

l. **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.

m. **4.3.10.2.6.2** Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

n. **4.3.10.2.6.3** Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.

o. **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.

p. **4.3.10.2.6.5** Loudspeakers and recessed lighting fixtures, including their assemblies and accessories, shall be permitted in the ceiling cavity plenum where listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less when tested in accordance with UL 2043, Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.

q. **4.3.10.2.6.6** Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

r. **4.3.10.2.6.7** Smoke detectors shall not be required to meet the provisions of this section.

s. **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.
   a. 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.
3. 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)-91 Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.

C. Military Specifications (Mil. Spec.):
MIL-A-3316C (2)-90 Adhesives, Fire-Resistant, Thermal Insulation
MIL-A-24179A (1)-87 Adhesive, Flexible Unicellular-Plastic Thermal Insulation
MIL-C-19565C (1)-88 Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
MIL-C-20079H-87 Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

D. American Society for Testing and Materials (ASTM):
A167-99 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
B209-04 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C411-97 Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
C449-00 Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
C533-04 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
C534-05 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C547-06 Standard Specification for Mineral Fiber pipe Insulation
C552-03 Standard Specification for Cellular Glass Thermal Insulation
C553-02 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
C585-90 Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)
C612-04 Standard Specification for Mineral Fiber Block and Board Thermal Insulation
C1126-04 Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
C1136-06 Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
D1668-97a (2006) Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
E84-06 Standard Test Method for Surface Burning Characteristics of Building Materials
E119-05a Standard Test Method for Fire Tests of Building Construction and Materials

E136-04 Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C (1380 F)

E. National Fire Protection Association (NFPA):
90A-02 Installation of Air Conditioning and Ventilating Systems
96-04 Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations
101-06 Life Safety Code
251-06 Standard methods of Tests of Fire Endurance of Building Construction Materials
255-06 Standard Method of tests of Surface Burning Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):
723 UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 08/03

G. Manufacturer's Standardization Society of the Valve and Fitting Industry (MSS):
SP58-2002 Pipe Hangers and Supports Materials, Design, and Manufacture

PART 2 - PRODUCTS

2.1 MINERAL FIBER

A. ASTM C612 (Board, Block), Class 1 or 2, k = 0.037 Watt per meter, per degree C (0.26), external insulation for temperatures up to 204 degrees C (400 degrees F).

B. ASTM C553 (Blanket, Flexible) Type I, Class B-3, Density 16 kg/m^3 (1 pcf), k = 0.045 (0.31) , for use at temperatures up to 204 degrees C (400 degrees F)

C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) for use at temperatures 230 degrees C (450 degrees F).

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), for temperatures up to 121 degrees C (250 degrees F) with vapor retarder and all service jacket with polyvinyl chloride premolded fitting covering.

B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1, k = 0.021 (0.15), for temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, vapor retarder and all service jacket.

2.4 CELLULAR GLASS CLOSED-CELL

A. Comply with Standard ASTM C177, C518, density 120 kg/m^3 (7.5 pcf) nominal, k = 0.033 (0.29) at 0 degrees C (75 degrees F).

B. Pipe insulation for temperatures up to 200 degrees C (400 degrees F).

2.5 POLYISOCYANURATE CLOSED-CELL RIGID

A. Preformed (fabricated) pipe insulation, ASTM C591, type IV, K=0.027(0.19), for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service jacket vapor retarder with polyvinyl chloride premolded fitting covers.

B. Equipment and duct insulation, ASTM C 591,type IV, K=0.027(0.19), 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 Watt per meter, per degree C (0.27), at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.7 CALCIUM SILICATE

A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.

C. Equipment Insulation: ASTM C533, Type I and Type II

D. Characteristics:

Insulation Characteristics		
ITEMS	**TYPE I**	**TYPE II**
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m^3 (lb/ ft3)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft^2 degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.8 INSULATION FACINGS AND JACKETS

A. Vapor Retarder, higher strength with low water permeance $\underline{=}$ 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 5 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 100 mm (4 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. 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.

E. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.

F. 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.

G. Aluminum Jacket-Piping systems : 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 20 mm (0.75 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

2.9 PIPE COVERING PROTECTION SADDLES

A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m^3 (3.0 pcf).

2.10 ADHESIVE, MASTIC, CEMENT

A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.

B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.

C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.

D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.

E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.

F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.

G. Other: Insulation manufacturers' published recommendations.

2.11 MECHANICAL FASTENERS

A. Pins, anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.

B. Staples: Outward clinching monel or stainless 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: 20 mm (3/4 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.12 REINFORCEMENT AND FINISHES

A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).

B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.

C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.

D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.

E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.

F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

2.13 FIRESTOPPING MATERIAL

A. Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

2.14 FLAME AND SMOKE

A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.

C. Where removal of insulation of piping, ductwork and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification.

D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).

E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.

F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

G. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.

H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.

I. HVAC work not to be insulated:
   1. Internally insulated ductwork and air handling units.
   2. Relief air ducts (Economizer cycle exhaust air).
   3. Exhaust air ducts and plenums.
   4. Equipment: Expansion tanks, flash tanks, hot water pumps, steam condensate pumps.
   5. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves , vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.

J. Plumbing work not to be insulated:
   1. Piping and valves of fire protection system.
   2. Chromium plated brass piping.
   3. Water piping in contact with earth.
   4. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).

K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.

L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.

M. Firestop Pipe and Duct insulation:
   1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
   2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
      a. Pipe risers through floors
      b. Pipe or duct chase walls and floors
      c. Smoke partitions
      d. Fire partitions

N. Provide metal jackets over insulation as follows:
   1. All piping exposed to outdoor weather.
   2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers and cage wash equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
   3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION

A. Mineral Fiber Board:
   1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
   2. Plain board:
      a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
      b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
      c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
      d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
   3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, and duct work exposed to outdoor weather:
      a. Thick insulation faced with ASJ (white all service jacket): Supply air duct
      b. Outside air intake ducts: no insulation required.
   4. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with ASJ.
      a. Chilled water pumps, chemical feeder pot or tank.
      b. Cold storage water and surge tanks.
   5. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.

b. Convertors, air separators, steam condensate pump receivers.
c. Reheat coil casing .
d. Domestic water heaters .

B. Flexible Mineral Fiber Blanket:
1. Adhere insulation to metal with 100 mm (4 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
3. Concealed supply air ductwork.
   a. Above ceilings at a roof level: 50 mm (2 inch) thick insulation faced with FSK.
   b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
   a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
   b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
   c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
   d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
3. Nominal thickness in millimeters and inches specified in table below, for piping above ground:

Nominal Thickness of Molded Mineral Fiber Insulation				
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4- 3)	100-150 (4-6)	200 (8) and above
a. 122-177 degrees C (251-350 F) (HPS, MPS,)	50 (2.0)	65 (2.5)	90 (3.5)	90 (3.5)

Nominal Thickness of Molded Mineral Fiber Insulation				
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4- 3)	100-150 (4-6)	200 (8) and above
b. 100-121 degrees C HPR, MPR (212-250 degrees F) (Vent piping from PRV safety valves, condensate receivers, and flash tanks)	25 (1.0)	50 (2.0)	50 (2.0)	50 (2.0)
c. 38-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR,) 1. Runouts to fan coil units 2. Runouts to reheat coils	25 (1.0) 15 (0.5) 15 (0.5)	40 (1.5) - -	50 (2.0) - -	50 (2.0) - -
d. Domestic hot water supply and return	15 (0.5)	20(0.75)	25 (1.0)	40 (1.5)

D. Rigid Cellular Phenolic Foam:
1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges**.**
7. Minimum thickness in millimeters (inches) specified in table below, for piping above ground:

Nominal Thickness of Rigid Closed-Cell Phenolic Foam Insulation					
Nominal Pipe Size millimeters (inches):	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200-300 (8-12)	350 (14) & above
1. 100-121 degrees C (212-250 degrees F), LPS, Vent piping from receivers and flash tanks.	15 (0.5)	25 (1)	25 (1)	--	--
2. 38-99 degrees C (100-211 degrees F), LPR, PC, HWH, and HWHR .	15 (0.5)	20 (0.75)	25 (1)	--	--
a. Run outs to Fan Coil units and reheat coils .	15 (0.5)	--	--	--	--
3. 4-16 degrees C (40-60 degrees F), CH, and CHR .	20 (0.75)	20 (0.75)	25 (1)	40 (1.5)	50 (2.0)
a. Run outs to Fan Coil Units .	15 (0.5)	--	--	--	--

Nominal Thickness of Rigid Closed-Cell Phenolic Foam Insulation					
Nominal Pipe Size millimeters (inches):	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200-300 (8-12)	350 (14) & above
4. Domestic hot water supply and return.	15 (0.5)	15 (0.5)	20 (0.75)	20 (0.75)	--

8. Condensation control insulation: Minimum 20 mm (0.75 inch) thick for all pipe sizes.
   a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.
   b. Plumbing piping as follows:
      1) Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
      2) Waste piping from electric water coolers and icemakers to drainage system.

E. Cellular Glass Insulation:
   1. Pipe and tubing, covering nominal thickness in millimeters and inches as tabulated below for chilled water piping.

Nominal Thickness of Cellular Glass Insulation				
Millimeters (inches)	Thru 38 (11/2)	50- 150 (2-6)	200-300 (8-12)	over 350 (14)
1. 4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and pipe chase)	50 (2.0)	80 (3.0)	80 (3.0)	100 (4.0)
2. 4-16 degrees C (40-60 degrees F) (CH and CHR outside chiller room)	40 (1.5)	50 (2.0)	50 (2.0)	65 (2.5)

   2. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.

F. Polyisocyanurate Closed-Cell Rigid Insulation:
   1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for piping, equipment and ductwork for temperature up to 149 degree C (300 degree F) provided insulation thickness requirement does not exceed 38 mm (1.5 inches).
   2. Install insulation, vapor retarder and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.
   3. Install insulation with all joints tightly butted (except expansion) joints in hot applications).
   4. If insulation thickness exceeds 63 mm (2.5 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.

5. For cold applications, vapor retarder shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall be used to attach the vapor retarder or jacketing. No wire ties capable of penetrating the vapor retarder shall be used to hold the insulation in place. Banding shall be used to attach PVC or metal jacketing.
6. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill PVC elbow jacket is prohibited on cold applications.
7. For cold applications, the vapor retarder on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor retarder adhesive tape.
8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints).
9. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph 1.3B. Refer to paragraph 3.1 for items not to be insulated.
10. Minimum thickness in millimeter (inches) specified in table below, for piping:

Nominal Thickness of Polyisocyanurate Rigid Insulation				
Nominal Pipe Size millimeters(inches):	25(1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200-300 (8-12)
1. 122-149 degree C(251-300 degree F) (HPS, MPS)	40 (1.5)	--	--	--
2. 100-121 degrees C (211-250 degrees F), HPR, MPR, LPS, Vent piping from receivers and flash tanks	20 (0.75)	40(1.5)	40(1.5)	40(1.50)
3. 38-99 degrees C (100-211 degrees F), LPR, PC, HWH, and HWHR.	20 (0.75)	25(1.0)	40(1.5)	40(1.50)
a. Run outs to fan coil units and reheat coils	20 (0.75)	--	--	--
4. 4-16 degrees C (40-60 degrees F), CH and CHR,	25 (1.00	25 (1.0)	40 (1.50	40(1.5)
a. Run outs to fan coil units	20 (0.75)	25 (1.)	--	--
5. 4-16 degrees C(40-60 degrees F) CH and CHR, for relative humidity 80 to 90 percent or higher (cage wash)	40 (1.50	40 (1.5)	40 (1.5)	40 (1.5)
a. Run out to fan coils units	40 (1.5)	40 (1.5)	--	--

Nominal Thickness of Polyisocyanurate Rigid Insulation				
6. Domestic hot water supply and return	15 (0.5)	20 (0.74)	25 (1.0)	25(1.0)

11. Condensation control insulation: Minimum 20 mm (0.75 inch) thick for all pipe sizes.
    a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.
    b. Plumbing piping as follows:
        1) Body of roof and overflow drains and horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
        2) Waste piping from electric water coolers to drainage system.

G. Flexible Elastomeric Cellular Thermal Insulation:
1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
2. Pipe and tubing insulation:
    a. Use proper size material. Do not stretch or strain insulation.
    b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
    c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in table below for piping above ground:

Nominal Thickness of Flexible Elastomeric Cellular Insulation				
Nominal Pipe Size millimeters (inches)	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200 (8)
1. 38-93 degrees C (100-200 degrees F) (HWH, HWHR,)	25 (1.0)	40 (1.5)	-	-
a. Runouts to fan coil units and reheat coils	20 (0.75)	40 (1.5)	-	-
2. 4-16 degrees C (40-60 degrees F) (CH, and CHR,)	25 (1.0)	40 (1.5)	-	-

Nominal Thickness of Flexible Elastomeric Cellular Insulation				
Nominal Pipe Size millimeters (inches)	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)	200 (8)
a. Runouts to fan coil units and cooling coil condensate piping	20 (0.75)	40 (1.5)	-	-
3. Domestic hot water supply and return	15 (0.50)	20 (0.75)	25 (1.0)	40 (1.50)

5. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
   a. Chilled water pumps
   b. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.

H. Calcium Silicate:
   1. Minimum thickness in millimeter (inches) specified below for piping .

Nominal Thickness Of Calcium Silicate Insulation (Non-Boiler Plant)				
Nominal Pipe Size Millimeters (Inches)	Thru 25 (1)	32 to 75 (1-1/4 to 3)	100-200 (4 to 6)	Over 200 (6)
93-260 degrees C(200-500 degrees F)(HPS, HPR)	67 (2-1/2)	75(3)	100(4)	100(4)

END OF SECTION

SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 23.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the HVAC systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. SPEC WRITER NOTE: Paragraph C is for LEED projects. Delete paragraph or subparagraphs as necessary for specific projects.

D. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.
   1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
   2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.

E. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
   1. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and Building Control Station with monitor and keyboard. Provide a remote user using a standard web browser to access the control system graphics and change adjustable setpoints with the proper password.
   2. The direct-digital control system(s) shall be native BACnet as manufactured by Siemens, Johnson, Honeywell, or Tridium. All new workstations, controllers, devices and components shall be listed by BACnet Testing Laboratories. All new workstations, controller, devices and components shall be accessible using a Web browser interface and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications, specifically shown on the design drawings and specifically requested otherwise by the VA.
      a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
      b. If used, gateways shall provide all object properties and read/write services shown on VA-approved interoperability schedules.
   3. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.
   4. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the Building Control Station shall have no effect on the field controllers, including those involved with global strategies.
   5. The control system shall accommodate 1 Building Control Station and the control system shall accommodate 5 web-based Users simultaneously, and the access to the system should be limited only by operator password.

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

1. Control valves.
2. Flow switches.
3. Flow meters.
4. Sensor wells and sockets in piping.
5. Terminal (air valve) unit controllers.

C. Some products are installed but not furnished by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the procurement of the products. These products include the following:
   1. Factory-furnished accessory thermostats and sensors furnished with unitary equipment.

D. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the particulars of the products. These products include the following:
   1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.
   2. Chiller controls. These controls, if not native BACnet, will require a BACnet Gateway.
   3. Air Valve units velocity sensors
   4. Unitary HVAC equipment fan coil units, packaged pumping stations controls. These include:
      a. Economizer control.
      b. Status alarm.
   5. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway.
   6. The following systems have limited control (as individually noted below) from the Building Control Station:
      a. Laboratory gas systems: low pressure and status alarms.
      b. Domestic water heating systems: low temperature, high temperature and status alarms.
      c. Biological safety cabinets: status alarms

E. Responsibility Table:

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
Terminal air valve units	23	23	N/A	26
Controllers for terminal air valve units	23 09 23	23	23 09 23	
LAN conduits and raceway	23 09 23	23 09 23	N/A	N/A
Automatic dampers (not furnished with equipment)	23 09 23	23	N/A	N/A
Automatic damper actuators	23 09 23	23 09 23	23 09 23	23 09 23
Manual valves	23	23	N/A	N/A
Automatic valves	23 09 23	23	23 09 23	23 09 23
Pipe insertion devices and taps, flow and pressure stations.	23	23	N/A	N/A
Thermowells	23 09 23	23	N/A	N/A

Work/Item/System	Furnish	Install	Low Voltage Wiring	Line Power
Current Switches	23 09 23	23 09 23	23 09 23	N/A
Control Relays	23 09 23	23 09 23	23 09 23	N/A
Power distribution system monitoring interfaces	23 09 23	23 09 23	23 09 23	26
Interface with chiller controls	23 09 23	23 09 23	23 09 23	26
Chiller controls interface with control system	23	23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Smoke detectors	28 31 00	28 31 00	28 31 00	28 31 00
Smoke Dampers	23	23	28 31 00	28 31 00
Fire Dampers	23	23	N/A	N/A
Chiller/starter interlock wiring	N/A	N/A	26	26
Chiller Flow Switches	23	23	23	N/A
Water treatment system	23	23	23	26
VFDs	23 09 23	26	23 09 23	26
Laboratory Environmental Controls	23 09 23	23 09 23	23 09 23	26
Laboratory gas panels	22	22	26	26
Fire Alarm shutdown relay interlock wiring	28	28	28	26
Control system monitoring of fire alarm smoke control relay	28	28	23 09 23	28
Fan Coil Unit controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Starters, HOA switches	23	23	N/A	26

F. This campus' existing direct-digital control system is a METASYS model manufactured by Johnson Controls. All new DDC Control system shall interface with the campus METASYS system Engineering control Center (ECC) through the Building Control Station in the future, such that all inputs, outputs, alarms and set-points can be read, trended, modified or reset at the existing METASYS ECC.

G. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by preselected controls service companies.

1. The contractor administered by this Section of the technical specifications shall provide for future intergration of the ASHRAE Standard 135, BACnet/IP control network(s) with the Control System Integrator's area control through an Ethernet connection provided by the contractor . The Ethernet connection shall extend from the Building Control Station to the ECC room in the building 6.
2. The contractor administered by this Section of the technical specifications shall provide a peer-to-peer networked, stand-alone, distributed control system. This direct digital control (DDC) system shall include one permanent operator terminal – Building Control Station, one portable operator terminal laptop, microprocessor-based controllers, instrumentation, end control devices, wiring, piping, software, and related systems. This contractor is responsible for all device mounting and wiring.
3. Responsibility Table:

Item/Task	Section 23 09 23 contactor	VA
Building Control Station Installation and Graphics	X	
ECC programming		X
Devices, controllers, control panels and equipment	X	
Point addressing: all hardware and software points including setpoint, calculated point, data point(analog/ binary), and reset schedule point	X	
Point mapping	X	
Network Programming	X	
ECC Graphics		X
Controller programming and sequences	X	
Integrity of LAN communications	X	
Electrical wiring	X	
Operator system training	X	
LAN connections to devices	X	
LAN connections to ECC		
IP addresses		X
Overall system verification	X	
Controller and LAN system verification	X	

H. Unitary standalone systems including Unit Heaters, Cabinet Unit Heaters, Fan Coil Units, Base Board Heaters, thermal comfort ventilation fans, and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents. Application of standalone unitary controls is limited to at least those systems wherein remote monitoring, alarm and start-up are not necessary. Examples of such systems include:
   1. Mechanical or electrical room heating and ventilation.

I. The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system. Use electricity as the motive force for all damper and valve actuators, unless use of pneumatics as motive force is specifically granted by the VA.

1.2 RELATED WORK

A. Section 22 11 23, Domestic Water Pumps.

B. Section 22 35 00, Domestic Water Heat Exchangers.

C. Section 22 63 00, Gas Systems for Laboratory Facilities.

D. Section 23 21 13, Hydronic Piping.

E. Section 23 22 13, Steam and Condensate Heating Piping.

F. Section 23 31 00, HVAC Ducts and Casings.

G. Section 23 36 00, Air Terminal Units.

H. Section 23 64 00, Packaged Water Chillers.

I. Section 23 73 00, Indoor Central-Station Air-Handling Units.

J. Section 26 05 11, Requirements for Electrical Installations.

K. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables (600 Volts and Below).

L. Section 26 05 26, Grounding and Bonding for Electrical Systems.

M. Section 26 05 33, Raceway and Boxes for Electrical Systems.

N. Section 26 27 26, Wiring Devices.

O. Section 26 29 11, Motor Starters.

P. Section 27 15 00, Communications Horizontal Cabling

Q. Section 28 31 00, Fire Detection and Alarm.

1.3 DEFINITION

A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.

B. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.

C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc.

D. BACnet: A Data Communication Protocol for Building Automation and Control Networks , ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.

E. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.

F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may use different LAN technologies.

G. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.

H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.

I. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.

J. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.

K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.

L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).

M. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.

N. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.

O. Building Control Station (BCS): The centralized building control point for the building intelligent control network. The BCS comprises of a personal computer, monitor and keyboard and connected devices to form a single workstation.

P. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.

Q. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls

R. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).

S. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.

T. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.

U. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.

V. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.

W. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.

X. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Building Control Station and the Engineering Control Center. Upon the loss of communication with the Building Control Station and the Engineering Control Center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.

Y. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.

Z. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.

AA. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.

BB. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.

CC. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation. The ECC at this campus is existing, and located in Building 6.

DD. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.

EE. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.

FF. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.

GG. GIF: Abbreviation of Graphic interchange format.

HH. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.

II. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

JJ. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.

KK. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to “sockets” without confirmation of receipt. Transmission Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.

LL. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.

MM. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.

NN. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.

OO. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VA health-care facilities. It uses twisted-pair wiring for relatively low speed and low cost communication.

PP. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.

QQ. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.

RR. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.

SS. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.

TT. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.

UU. Operating system (OS): Software, which controls the execution of computer application programs.

VV. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.

WW. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.

XX. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.

YY. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.

ZZ. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.

AAA. Repeater: A network component that connects two or more physical segments at the physical layer.

BBB. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.

CCC. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.

DDD. Thermostats : devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

1.4 QUALITY ASSURANCE

A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

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

1.5 PERFORMANCE

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

8. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
9. Reporting Accuracy: Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	±0.5°C (±1°F)
Ducted air temperature	±0.5°C [±1°F]
Outdoor air temperature	±1.0°C [±2°F]
Water temperature	±0.5°C [±1°F]
Water flow	±1% of reading
Air flow (terminal Air Valve)	±10% of reading
Air pressure (ducts)	±25 Pa [±0.1"w.c.]
Air pressure (space)	±0.3 Pa [±0.001"w.c.]
Electrical Power	±0.5% of reading

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

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.)	0–1.5 kPa (0–6 in. w.g.)
Air Pressure	±3 Pa (±0.01 in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0ºC (±2.0ºF)	
Duct Temperature	±1.5ºC (±3ºF)	

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

1.6 WARRANTY

A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.

B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.

C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to or connect via (through password-limited access) VPN through the internet monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.

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

1.7 SUBMITTALS

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

B. Manufacturer's literature and data for all components including the following:
   1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
   2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
   3. Control dampers and control valves schedule, including the size and pressure drop.
   4. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), Building Control Station DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it is supposed to represent.
   5. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
   6. Color prints of proposed graphics with a list of points for display.
   7. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
   8. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
   9. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
   10. Riser diagrams of wiring between central control unit and all control panels.
   11. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.
   12. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.
   13. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.

C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.

D. Licenses: Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.

E. As Built Control Drawings:
   1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
   2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
   3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.

F. Operation and Maintenance (O/M) Manuals):
   1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
   2. Include the following documentation:
      a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
      b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
      c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
      d. Complete troubleshooting procedures and guidelines for all systems.
      e. Complete operating instructions for all systems.
      f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
      g. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.
      h. Licenses, guaranty, and other pertaining documents for all equipment and systems.

G. Submit Performance Report to Resident Engineer prior to final inspection.

1.8 INSTRUCTIONS

A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below.
   1. First Phase: Formal instructions to the VA facilities personnel for a total of 16 hours, given in multiple training sessions (each no longer than four hours in length), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
   2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 8 hours of instructions, given in multiple training sessions (each no longer than four hours in length), to the VA facilities personnel.

3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.
4. Training shall be given by direct employees of the controls system subcontractor.

1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)

A. The BCS and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.

B. The CUs used in the penthouse and outdoors shall be mounted in NEMA 1 (Penthouse) and NEMA 4 waterproof enclosures for outdoors, and shall be rated for operation at –40 to 65°C (-40 to 150°F).

C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.

D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

1.10 APPLICABLE PUBLICATIONS

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

B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   Standard 135-08 BACNET Building Automation and Control Networks

C. American Society of Mechanical Engineers (ASME):
   B16.18-05 Cast Copper Alloy Solder Joint Pressure Fittings.
   B16.22-05 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. American Society of Testing Materials (ASTM):
   B32-04 Standard Specification for Solder Metal
   B88-03 Standard Specifications for Seamless Copper Water Tube
   B88M-05 Standard Specification for Seamless Copper Water Tube (Metric)
   B280-03 Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service
   D2737-03 Standard Specification for Polyethylene (PE) Plastic Tubing

E. Federal Communication Commission (FCC):
   Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.

F. Institute of Electrical and Electronic Engineers (IEEE):
   802.3-05 Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks-Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access method and Physical Layer Specifications

G. National Fire Protection Association (NFPA):
   70-08 National Electric Code
   90A-09 Standard for Installation of Air-Conditioning and Ventilation Systems

H. Underwriter Laboratories Inc (UL):
   94-06 Tests for Flammability of Plastic Materials for Parts and Devices and Appliances

294-05	Access Control System Units
486A/486B-04-	Wire Connectors
555S-06	Standard for Smoke Dampers
916-07	Energy Management Equipment
1076-05	Proprietary Burglar Alarm Units and Systems

PART 2 - PRODUCTS

2.1 MATERIALS

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

2.2 CONTROLS SYSTEM ARCHITECTURE

A. General
   1. The Controls Systems shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
   2. The BCS, building controllers and principal communications network equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels – not "Clones" assembled by a third-party subcontractor.
   3. The networks shall, at minimum, comprise, as necessary, the following:
      a. A fixed BCS and a portable operator's terminal.
      b. Network computer processing, data storage and BACnet-compliant communication equipment including Servers and digital data processors.
      c. BACnet-compliant routers, bridges, switches, hubs, modems, gateways, interfaces and similar communication equipment.
      d. Active processing BACnet-compliant building controllers connected to other BACNet-compliant controllers together with their power supplies and associated equipment.
      e. Addressable elements, sensors, transducers and end devices.
      f. Third-party equipment interfaces and gateways as described and required by the Contract Documents.
      g. Other components required for a complete and working Control Systems as specified.

B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.

C. Network Architecture
   1. The Controls communication network shall utilize BACnet communications protocol operating over a standard Ethernet LAN and operate at a minimum speed of 100 Mb/sec.
   2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations.
   3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the VA.

D. Third Party Interfaces:
   1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades, as shown on the drawings

2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.

E. Servers:
   1. Provide data storage server(s) to archive historical data including trends, alarm and event histories and transaction logs.
   2. Equip these server(s) with the same software tool set that is located in the BACnet building controllers for system configuration and custom logic definition and color graphic configuration.
   3. Access to all information on the data storage server(s) shall be through the same browser functionality used to access individual nodes. When logged onto a server the operator will be able to also interact with any other controller on the control system as required for the functional operation of the controls systems. The contractor administered by this Section of the technical specifications shall provide all necessary digital processor programmable data storage server(s).
   4. These server(s) shall be utilized for controls systems application configuration, for archiving, reporting and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and similar. These server(s) shall utilize IT industry standard data base platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE) or approved equal.

2.3 COMMUNICATION

A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
   1. The Data link / physical layer protocol (for communication) acceptable to the VA throughout its facilities is Ethernet (ISO 8802-3) and BACnet/IP.
   2. The MS/TP data link / physical layer protocol is not acceptable to the VA in any new BACnet network or sub-network in its healthcare or lab facilities.

B. Each controller shall have a communication port for connection to an operator interface.

C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.

D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
   1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.
   2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.

E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.

F. ECCs and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

2.4 BUILDING CONTROL STATION (BCS)

A. The BCS shall reside on a high-speed network with controllers as shown on system drawings. The BCS and each standard browser connected to server shall be able to access all system information.

B. BCS and controllers shall communicate using BACnet protocol. ECC and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.

C. Hardware: BCS shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.
   1. BCS shall be commercial standard with supporting 32- or 64-bit hardware (as required by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.
      a. The hard drive shall be at the minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, and shall have sufficient memory to store:
         1) All required operator workstation software
         2) A DDC database at least twice the size of the delivered system database
         3) One year of trend data based on the points specified to be trended at their specified trend intervals.
      b. Real-time clock:
         1) Accuracy: Plus or minus 1 minute per month.
         2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
         3) Clock shall function for one year without power.
         4) Provide automatic time correction once every 24 hours by synchronizing clockwith the Time Service Department of the U.S. Naval Observatory.
      c. Serial ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
      d. Parallel port: Enhanced.
      e. Sound card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
      f. Color monitor: PC compatible, not less than 22 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, noninterlaced, and a maximum dot pitch of 0.28 mm.
      g. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
      h. Mouse: Standard, compatible with installed software.
      i. Removable disk storage: Include the following, each with appropriate controller:
         1) Minimum 1 TB removable hard disk, maximum average access time of 10 ms.
      j. Network interface card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.
   2. Cable modem: 42.88 MBit/s, DOCSIS 2.0 Certified, also backwards compatible with DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.

3. Optical modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.
4. Auto-dial modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
5. Audible Alarm: Manufacturer's standard.
6. Printers:
   a. Provide a dedicated, minimum resolution 600 dpi, color laser printer, connected to the ECC through a USB interface.
      1) If a network printer is used instead of this dedicated printer, it shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.
      2) RAM: 512 MB, minimum.
      3) Printing Speed: Minimum twenty six pages per minute (color); minimum 30 pages per minute (black/white).
      4) Paper Handling: Automatic sheet feeder with 250-sheet x 8.5 inch x 11 inch paper cassette and with automatic feed.
   b. Provide a dedicated black/white tractor-feed dot matrix printer for status/alarm message printing, minimum 10 characters per inch, minimum 160 characters per second, connected to the ECC through a USB interface.
      1) Paper: One box of 2000 sheets of 8-1/2x11 multi-fold type printer paper.
7. RS-232 ASCII Interface
   a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
   b. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
   c. Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
   d. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
   e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
      1) NFPA 70, Type CMP.
      2) Flame Resistance: NFPA 262, Flame Test.
8. Self-contained uninterruptible power supply (UPS):
   a. Size: Provide a minimum of six hours of operation of ECC equipment, including two hours of alarm printer operation.
   b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
   c. Accessories:
      1) Transient voltage suppression.
      2) Input-harmonics reduction.
      3) Rectifier/charger.
      4) Battery disconnect device.
      5) Static bypass transfer switch.
      6) Internal maintenance bypass/isolation switch.

7) External maintenance bypass/isolation switch.
8) Output isolation transformer.
9) Remote UPS monitoring.
10) Battery monitoring.
11) Remote battery monitoring.

D. BCS Software:
1. Provide for automatic system database save and restore on the BCS's hard disk a copy of the current database of each Controller. This database shall be updated whenever a change is made in any system panel. In the event of a database loss in a building management panel, the BCS shall automatically restore the database for that panel. This capability may be disabled by the operator.
2. Provide for manual database save and restore. An operator with proper clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. Provide a method of configuring the system. This shall allow for future system changes or additions by users with proper clearance.
4. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications. Acceptable operating systems are Windows XP, Windows System 7, Linux, and UNIX.
5. System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
6. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
7. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, converters, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
8. The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the BCS. The operating system shall be Windows XP or better, and shall support the third party software.
9. Provide graphical user software, which shall minimize the use of keyboard through the use of the mouse and "point and click" approach to menu selection.

10. The software shall provide a multi-tasking type environment that will allow the user to run several applications simultaneously. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able automatically export data to and work in Microsoft Word, Excel, and other Windows based software programs, while concurrently on-line system alarms and monitoring information.
11. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
12. User access shall be protected by a flexible and Owner re-definable software-based password access protection. Password protection shall be multi-level and partition able to accommodate the varied access requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.
13. The system shall be completely field-programmable from the common operator's keyboard thus allowing hard disk storage of all data automatically. All programs for the CUs shall be able to be downloaded from the hard disk. The software shall provide the following functionality as a minimum:
    a. Point database editing, storage and downloading of controller databases.
    b. Scheduling and override of building environmental control systems.
    c. Collection and analysis of historical data.
    d. Alarm reporting, routing, messaging, and acknowledgement.
    e. Definition and construction of dynamic color graphic displays.
    f. Real-time graphical viewing and control of environment.
    g. Scheduling trend reports.
    h. Program editing.
    i. Operating activity log and system security.
    j. Transfer data to third party software.
14. Provide functionality such that using the least amount of steps to initiate the desired event may perform any of the following simultaneously:
    a. Dynamic color graphics and graphic control.
    b. Alarm management.
    c. Event scheduling.
    d. Dynamic trend definition and presentation.
    e. Program and database editing.
    f. Each operator shall be required to log on to the system with a user name and password to view, edit or delete the data. System security shall be selectable for each operator, and the password shall be able to restrict the operator's access for viewing and changing the system programs. Each operator shall automatically be logged off the system if no keyboard or mouse activity is detected for a selected time.
15. Graphic Displays:
    a. The workstation shall allow the operator to access various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Graphic software shall permit the importing of AutoCAD or scanned pictures in the industry standard format (such as PCX, BMP, GIF, and JPEG) for use in the system.

b. System Graphics shall be project specific and schematically correct for each system. (ie: coils, fans, dampers located per equipment supplied with project.) Standard system graphics that do not match equipment or system configurations are not acceptable. Operator shall have capability to manually operate the entire system from each graphic screen at the BCS. Each system graphic shall include a button/tab to a display of the applicable sequence of operation.
c. Dynamic temperature values, flow rates, and status indication shall be shown in their locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh values.
d. Color shall be used to indicate status and change in status of the equipment. The state colors shall be user definable.
e. A clipart library of HVAC equipment, such as chillers, converters , air handling units, fans, terminal units, pumps, coils, standard ductwork, piping, valves and laboratory symbols shall be provided in the system. The operator shall have the ability to add custom symbols to the clipart library.
f. A dynamic display of the site-specific architecture showing status of the controllers, the BCS and network shall be provided.
g. The windowing environment of the workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of graphic associated with an alarm to be viewed without interrupting work in progress. The graphic system software shall also have the capability to split screen, half portion of the screen with graphical representation and the other half with sequence of operation of the same HVAC system.

16. Trend reports shall be generated on demand or pre-defined schedule and directed to monitor display, printers or disk. As a minimum, the system shall allow the operator to easily obtain the following types of reports:
    a. A general list of all selected points in the network.
    b. List of all points in the alarm.
    c. List of all points in the override status.
    d. List of all disabled points.
    e. List of all points currently locked out.
    f. List of user accounts and password access levels.
    g. List of weekly schedules.
    h. List of holiday programming.
    i. List of limits and dead bands.
    j. Custom reports.
    k. System diagnostic reports, including, list of digital controllers on the network.
    l. List of programs.
17. Scheduling and Override:
    a. Provide override access through menu selection from the graphical interface and through a function key.
    b. Provide a calendar type format for time-of-day scheduling and overrides of building control systems. Schedules reside in the BCS. The digital controllers shall ensure equipment time scheduling when the BCSis off-line. The BCS shall not be required to execute time scheduling. Provide the following spreadsheet graphics as a minimum:
        1) Weekly schedules.
        2) Zone schedules, minimum of 100 zones.
        3) Scheduling up to 365 days in advance.
        4) Scheduled reports to print at workstation.
18. Collection and Analysis of Historical Data:

a. Provide trending capabilities that will allow the operator to monitor and store records of system activity over an extended period of time. Points may be trended automatically on time based intervals or change of value, both of which shall be user definable. The trend interval could be five (5) minutes to 120 hours. Trend data may be stored on hard disk for future diagnostic and reporting. Additionally trend data may be archived to network drives or removable disk media for off-site retrieval.
b. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow pre-defined groups of up to 250 trended points to be easily accessible by other industry standard word processing and spreadsheet packages. The reports shall be time and date stamped and shall contain a report title and the name of the facility.
c. System shall have the set up to generate spreadsheet reports to track energy usage and cost based on weekly or monthly interval, equipment run times, equipment efficiency, and/or building environmental conditions.
d. Provide additional functionality that will allow the operator to view real time trend data on trend graph displays. A minimum of 20 points may be graphed regardless of whether they have been predefined for trending. In addition, the user may pause the graph and take snapshots of the screens to be stored on the workstation disk for future reference and trend analysis. Exact point values may be viewed and the graph may be printed. Operator shall be able to command points directly on the trend plot by double clicking on the point.

19. Alarm Management:
    a. Alarm routing shall allow the operator to send alarm notification to selected printers or operator workstation based on time of day, alarm severity, or point type.
    b. Alarm notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. The critical alarms shall display on the screen at the time of its occurrence, while others shall display by clicking on their icon.
    c. Alarm display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message in English language. The operator shall be able to sort out the alarms.
    d. Alarm messages shall be customized for each point to display detailed instructions to the operator regarding actions to take in the event of an alarm.
    e. An operator with proper security level access may acknowledge and clear the alarm. All that have not been cleared shall be archived at workstation disk.
20. Remote Communications: The system shall have the ability to dial out in the event of an alarm. Receivers shall include operator workstations, e-mail addresses, and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself.
21. System Configuration:
    a. Network control strategies shall not be restricted to a single digital controller, but shall be able to include data from all other network devices to allow the development of global control strategies.
    b. Provide automatic backup and restore of all digital controller databases on the workstation hard disk. In addition to all backup data, all databases shall be performed while the workstation is on-line without disturbing other system operations.

2.5 PORTABLE OPERATOR'S TERMINAL (POT)

A. Provide a portable operator's terminal (POT) that shall be capable of accessing all system data. POT may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. POT shall communicate using BACnet protocol. POT may be connected to any point on the system network or it may be connected directly to controllers using the BACnet PTP (Point-To-Point) Data Link/ Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) BACnet Services. POT shall be an IBM-compatible notebook-style PC including all software and hardware required.

B. Hardware: POT shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.
   1. POT shall be commercial standard with supporting 32- or 64-bit hardware (as limited by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 500 GB 7200 rpm SATA hard drive with 16 MB cache, minimum 2GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, minimum 16 inch (diagonal) screen, 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector, 56,600 bps modem, an ASCII RS-232 interface, and a 16 speed high density DVD-RW+/- optical drive.

C. Software: POT shall include software equal to the software on the ECC.

2.6 BACNET PROTOCOL ANALYZER

A. For ease of troubleshooting and maintenance, provide a BACnet protocol analyzer. Provide its associated fittings, cables and appurtenances, for connection to the communications network. The BACnet protocol analyzer shall be able to, at a minimum: capture and store to a file all data traffic on all network levels; measure bandwidth usage; filter out (ignore) selected traffic.

2.7 NETWORK AND DEVICE NAMING CONVENTION

A. Network Numbers
   1. BACnet network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VA campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internet work.
   2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:
      a. FFF = Facility code (see below)
      b. NN = 00-99 This allows up to 100 networks per facility or building

B. Device Instances
   1. BACnet allows 4194305 unique devices instances per BACnet internet work. Using Agency's unique device instances are formed as follows: "Dev #" = "FFFNNDD" where
      a. FFF and N are as above and
      b. DD = 00-99, this allows up to 100 devices per network.
   2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
   3. Facility code assignments:
   4. 000-400 Building/facility number

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

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

2.8 BACNET DEVICES

A. All BACnet Devices – controllers, gateways, routers, actuators and sensors shall conform to BACnet Device Profiles and shall be BACnet Testing Laboratories (BTL) -Listed as conforming to those Device Profiles. Protocol Implementation Conformance Statements (PICSs), describing the BACnet capabilities of the Devices shall be published and available of the Devices through links in the BTL website.
   1. BACnet Building Controllers, historically referred to as NACs, shall conform to the BACnet B-BC Device Profile, and shall be BTL-Listed as conforming to the B-BC Device Profile. The Device’s PICS shall be submitted.
   2. BACnet Advanced Application Controllers shall conform to the BACnet B-AAC Device Profile, and shall be BTL-Listed as conforming to the B-AAC Device Profile. The Device’s PICS shall be submitted.
   3. BACnet Application Specific Controllers shall conform to the BACnet B-ASC Device Profile, and shall be BTL-Listed as conforming to the B-ASC Device Profile. The Device’s PICS shall be submitted.
   4. BACnet Smart Actuators shall conform to the BACnet B-SA Device Profile, and shall be BTL-Listed as conforming to the B-SA Device Profile. The Device’s PICS shall be submitted.
   5. BACnet Smart Sensors shall conform to the BACnet B-SS Device Profile, and shall be BTL-Listed as conforming to the B-SS Device Profile. The Device’s PICS shall be submitted.
   6. BACnet routers and gateways shall conform to the BACnet B-OTH Device Profile, and shall be BTL-Listed as conforming to the B-OTH Device Profile. The Device’s PICS shall be submitted.

2.9 CONTROLLERS

A. General. Provide an adequate number of BTL-Listed B-BC building controllers and an adequate number of BTL-Listed B-AAC advanced application controllers to achieve the performance specified in the Part 1 Article on “System Performance.” Each of these controllers shall meet the following requirements.
   1. The controller shall have sufficient memory to support its operating system, database, and programming requirements.

2. The building controller shall share data with the BCS and the other networked building controllers IE, ECC. The advanced application controller shall share data with its building controller and the other networked advanced application controllers.
3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
5. The controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
   a. assume a predetermined failure mode, and
   b. generate an alarm notification.
6. The controller shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute and Initiate) and Write (Execute and Initiate) Property services.
7. Communication.
   a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
   b. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
8. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. Provide a system security password shall be available to prevent unauthorized use of the keypad and display.
9. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
10. Memory. The controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
11. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

B. Provide BTL-Listed B-ASC application specific controllers for each piece of equipment for which they are constructed. Application specific controllers shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute) Property service.
   1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.
   2. Each B-ASC will contain sufficient I/O capacity to control the target system.
   3. Communication.
      a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
      b. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.
   4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
   5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

6. Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
7. Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

C. Direct Digital Controller Software
1. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.
2. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the the BCS and ECC (Future).
3. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
4. All controllers shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the BCS and ECC in the future. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
5. All DDC control loops shall be able to utilize any of the following control modes:
   a. Two position (on-off, slow-fast) control.
   b. Proportional control.
   c. Proportional plus integral (PI) control.
   d. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
   e. Automatic tuning of control loops.
6. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
7. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the BCS, or via a portable operator's terminal, when it is necessary, to access directly the programmable unit.
   a. Unoccupied Ventilation Setback Control: The system shall provide the ability to automatically adjust air change rate set points for this mode of operation.
   b. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
      1) Time, day.
      2) Commands such as on, off, auto.

3) Time delays between successive commands.
4) Manual overriding of each schedule.
5) Allow operator intervention.

c. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the BCS and ECC in the future based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.

d. Remote Communications: The system shall have the ability to dial out in the event of an alarm to the BCS and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.

e. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

2.10 SPECIAL CONTROLLERS/MONITORS

A. Laboratory rooms shall be controlled to allow for a variable flow of conditioned air into the room, general exhaust from the room, and proper space pressurization.

B. Room Differential Pressure Controller: Refer to specification section: 23 36 00 – Air Terminal Units.

C. Room Pressure Monitor:

1. The room pressure monitors shall be wall mounted outside each Animal Holding Room on the corridor side adjacent to the door and outside each Procedure Room on the Animal Holding Room side adjacent to the door, with the exception of the ABSL-2 Procedure Room which shall be mounted in the corridor. Mount all monitors at 5 feet above the finished floor.
2. The case shall be of fire retardant plastic, with approximate dimensions of 8-inch high by 5-inch wide by 1.8 inches deep. The unit shall mount in a double gang electrical junction box with plaster ring, as required.
3. The display shall be LCD, with 128 x 128, RGB backlit. Status indications shall include Green LED for normal and Red LED for alarm.
4. Power consumptions shall be 5 watts with an input of 18 – 32 VAC, 60 HZ. Unit shall include one SPDT relay for remote alarm output.
5. Range shall be +/- 0.05 inch WC.
6. Unit shall be suitable for installation in spaces operating at 32 to 120 degrees F, 5 to 95% RH (non-condensing).
7. Compliant with ANSI/UL61010-1 – Safety Requirements for Electrical Equipment for Measurement, Control.
8. Provide room pressure snubbers (wall mounted pressure taps) on both sides of the wall with required interconnecting tubing from the snubbers to the monitor. Pressure snubbers shall be mounted at approximately 8 feet above the finished floor.
9. Unit shall be Setra Model SRPM-R05WB-A1-E, or equal. Pressure snubber shall be Setra Model RPS, or equal.

2.11 SENSORS (AIR, WATER AND STEAM)

A. Sensors' measurements shall be read back to the DDC system, and shall be visible by the BCS and ECC in the future.

B. Temperature Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
   1. Temperature Sensors: Resistance Temperature Device (RTD) with an integral transmitter type.
      a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
      b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
      c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on sensor cover, and communication port. Provide a tooled-access cover.
      d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
      e. Wire: Twisted, shielded-pair cable.
      f. Output Signal: 4-20 ma.

C. Static Pressure Sensors: Non-directional, temperature compensated.
   1. 4-20 ma output signal.
   2. 0 to 5 inches wg for duct static pressure range.

D. Water flow sensors (Chilled Water System):
   1. Type: Insertion vortex type with retractable probe assembly and 2 inch full port gate valve.
      a. Pipe size: 3 to 24 inches.
      b. Retractor: ASME threaded, non-rising stem type with hand wheel.
      c. Mounting connection: 2 inch 150 PSI flange.
      d. Sensor assembly: Design for expected water flow and pipe size.
      e. Seal: Teflon (PTFE).
   2. Controller:
      a. Integral to unit.
      b. Locally display flow rate and total.
      c. Output flow signal to BMCS: Digital pulse type.
   3. Performance:
      a. Turndown: 20:1
      b. Response time: Adjustable from 1 to 100 seconds.
      c. Power: 24 volt DC
   4. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.

E. Water Flow Sensors (heating water system): shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minute 1 mm (0.05 inch); wetted parts shall be constructed of stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.
   1. Performance characteristics:

a. Ambient conditions: -40°C to 60°C (-40°F to 140°F), 5 to 100% humidity.
b. Operating conditions: 850 kPa (125 psig), 0°C to 120°C (30°F to 250°F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
c. Nominal range (turn down ratio): 10 to 1.
d. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet).
e. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
f. Ambient temperature effects, less than 0.005 percent calibrated span per °C (°F) temperature change.
g. RFI effect - flow meter shall not be affected by RFI.
h. Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.

F. Flow switches:
1. Shall be either paddle or differential pressure type.
a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.

G. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

2.12 CONTROL CABLES

A. General:
1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
5. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the VA. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.
6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.

B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 21.

C. Copper digital communication cable between the BCS and the B-BC and B-AAC controllers shall be 100BASE-TX Ethernet, Category 5e or 6, not less than minimum 24 American Wire Gauge (AWG) solid, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP), with thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, as specified in Section 27 15 00.
   1. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media.
   2. Communication cable between the BCS and ECC shall be 100 base-TX Ethernet, category 5e or 6.

D. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

2.13 THERMOSTATS

A. Room thermostats controlling unitary standalone cooling devices not connected to the DDC system shall have two modes of operation (cooling - null or dead band). Wall mounted thermostats shall manufacturer's recommendation finish, setpoint range and temperature display and external adjustment.
   1. Thermostats shall be line voltage or low voltage to suit application. Coordinate with specific equipment.

B. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element. Freezestats shall be manually-reset.

2.14 FINAL CONTROL ELEMENTS AND OPERATORS

A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.

B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.

C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
   1. Leakage: maximum leakage in closed position shall not exceed 75 L/S/ square meter (15 CFM/sq. ft.) at 50 mm (2 inches) differential pressure .
   2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
   3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
   4. Bearing shall be nylon, bronze sleeve or ball type.
   5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
   6. Maximum air velocity and pressure drop through free area the dampers:
      a. Smoke damper in air handling unit: 305 meter per minute (1000 fpm).
      b. Duct mounted damper: 600 meter per minute (2000 fpm).
      c. Maximum static pressure loss: 50 Pascal (0.20 inches water gage).

D. Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS. Control of these dampers is specified under this Section.

E. Control Valves:
   1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
   2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
   3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
   4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
   5. Flow characteristics:
      a. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
      b. Two-way 2-position valves shall be ball, gate or butterfly type.
   6. Maximum pressure drop:
      a. Two position steam control: 20 percent of inlet gauge pressure.
      b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
      c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
   7. Two position water valves shall be line size.

F. Damper and Valve Operators and Relays:
   1. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient closeoff torque.
      a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
   2. See drawings for required control operation.

2.15 AIR FLOW CONTROL

A. Airflow and static pressure shall be controlled via digital controllers with inputs from static pressure inputs as specified. Controller outputs shall be analog output signals. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.

B. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:
   1. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
   2. Provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually-reset.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
   2. Work Coordination: GENERAL CONDITIONS.
   3. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
   4. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
   5. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
   6. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
   7. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
   8. Install equipment level and plum.

B. Electrical Wiring Installation:
   1. All wiring cabling shall be installed in conduits. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling: these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
   2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 21. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, Communications Horizontal Cabling.
   3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
   4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
   5. Install all system components in accordance with local Building Code and National Electric Code.
      a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
      b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
      c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
      d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
   6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.

7. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
8. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.

C. Install Sensors and Controls:
1. Temperature Sensors:
   a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
   b. Calibrate sensors to accuracy specified, if not factory calibrated.
   c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
   d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
   e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors from contact with metal casings and coils using insulated standoffs.
   f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
   g. All pipe mounted temperature sensors shall be installed in wells.
   h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
   i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
2. Pressure Sensors:
   a. Install duct static pressure sensor tips facing directly downstream of airflow.
   b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
   c. Install snubbers and isolation valves on steam pressure sensing devices.
3. Actuators:
   a. Mount and link damper and valve actuators according to manufacturer's written instructions.
   b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
   c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
4. Flow Switches:
   a. Install flow switch according to manufacturer's written instructions.
   b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
   c. Assure correct flow direction and alignment.
   d. Mount in horizontal piping-flow switch on top of the pipe.

D. Installation of network:
1. Ethernet:
   a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.

b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 100 Base TX (Category 5e cabling) for the communications between the ECC and BCS, the BCS and the B-BC and the B-AAC controllers.

2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.

E. Installation of digital controllers and programming:
1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, or space temperature could be located on any of the remote control units.
2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, air handling unit, fan, terminal unit, hot water converter, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

3.2 SYSTEM VALIDATION AND DEMONSTRATION

A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the contractor is to perform a complete validation of all aspects of the controls and instrumentation system.

B. Validation
1. Prepare and submit for approval a validation test plan including test procedures for the performance verification tests. Test Plan shall address all specified functions of the BCS and all specified sequences of operation. Explain in detail actions and expected results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a test check list to be used by the Installer’s agent to check and initial that each test has been successfully completed. Deliver test plan documentation for the performance verification tests to the owner’s representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.
2. After approval of the validation test plan, installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to insure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. Demonstration
1. System operation and calibration to be demonstrated by the installer in the presence of the Architect or VA's representative on random samples of equipment as dictated by the Architect or VA’s representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the VA.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible , personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.

4. The following witnessed demonstrations of field control equipment shall be included:
   a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
   b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
   c. Demonstrate the software ability to edit the control program off-line.
   d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations and cell phones.
   e. Demonstrate ability of software program to function for the intended applications-trend reports, changes in status etc.
   f. Demonstrate via graphed trends to show the sequence ofoperation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., occupied/unoccupied mode, and back-up condition.
   g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
   h. Prepare and deliver to the VA graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.
   i. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.
5. Witnessed demonstration of BCS functions shall consist of:
   a. Running each specified report.
   b. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
   c. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
   d. Execute digital and analog commands in graphic mode.
   e. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
   f. Demonstrate EMS performance via trend logs and command trace.
   g. Demonstrate scan, update, and alarm responsiveness.
   h. Demonstrate spreadsheet/curve plot software, and its integration with database.
   i. Demonstrate on-line user guide, and help function and mail facility.
   j. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.
   k. Demonstrate multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
   l. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

END OF SECTION

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following HVAC systems will be commissioned:
   1. Air Handling Systems (including supply air terminal units (air valve).
   2. Air Handling Systems (Fans, motors, Variable Speed Drives, cooling coils and control valves, heating coils and control valves, filters, dampers, safeties such as smoke detectors or freezestats and damper end switches, controls, gages, and vibration isolation).
   3. Heating Hot Water Systems (Converters, controls, instrumentation and gages, flues, heating water pumps and motors, Variable Speed Drives, mixing valves).
   4. Condensate Return Systems (Condensate receivers and transfer pumps, motors, controls, pump alternator, alarms and instrumentation, and motors, safeties).
   5. Chilled Water Systems (Chilled water pumps and motors, Variable Speed Drives, chiller motor/compressor, controls, instrumentation and safeties, isolation valves, blending valves, side stream water cleaners/scrubbers/filters).
   6. Exhaust Fans systems (Fan, motor, Exhaust air valves outside air by-pass , controls and safeties).
   7. Steam System (Boilers, controls, gages and instrumentation, safety relief valves, combustion burners/fans/motors, fuel delivery pumps and motors, flues).
   8. Direct Digital Control System (BACnet or similar Local Area Network (LAN), Operator Work Station hardware and software, building controller hardware and software, terminal unit controller hardware and software, all sequences of operation, system accuracy and response time).
   9. Laboratory Ventilation Systems (Supply air terminal units and controls, pressure controls and alarms, fans, motors, and Variable Speed Drives).
   10. Room Pressurization Equipment (Pressure sensors, terminal units/dampers, and controls and alarms).
   11. HVAC Water Treatment Systems (Closed circuits – including shot feeders and final water analysis).
   12. Animal drinking water system.

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 TRAINING OF VA PERSONNEL

A. Training of the VA's 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. The instruction shall be scheduled in coordination with the 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.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Water piping to connect HVAC equipment, including the following:
   1. Chilled water, heating hot water and drain piping.
   2. Extension of domestic water make-up piping.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 31 20 00, EARTH MOVING: Excavation and backfill.

D. Section 03 30 00, CAST-IN-PLACE CONCRETE.

E. Section 07 12 00, BUILT-UP BITMUMINOUS WATERPROOFING, and Section 07 13 52, MODIFIED BITUMINOUS SHEET WATERPROOFING.

F. Section 33 10 00, WATER UTILITIES: Underground piping.

G. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.

H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

I. Section 23 21 23, HYDRONIC PUMPS: Pumps.

J. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION: Piping insulation.

K. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.

L. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS: VAV and CV units, fan coil units, and radiant ceiling panels.

M. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.

1.3 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, which includes welding qualifications.

B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one year old.

C. For mechanical pressed sealed fittings, only tools of fitting manufacturer shall be used.

D. Mechanical pressed fittings shall be installed by factory trained workers.

E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be the same manufacturer as the grooved components.
   1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Pipe and equipment supports.
   2. Pipe and tubing, with specification, class or type, and schedule.
   3. Pipe fittings, including miscellaneous adapters and special fittings.
   4. Flanges, gaskets and bolting.
   5. Grooved joint couplings and fittings.
   6. Valves of all types.
   7. Strainers.
   8. Flexible connectors for water service.
   9. Pipe alignment guides.
   10. All specified hydronic system components.
   11. Water flow measuring devices.
   12. Gages.
   13. Thermometers and test wells.
   14. Seismic bracing details for piping.

C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
   1. Heat Exchangers (Water to Water)
   2. Air separators.
   3. Expansion tanks.

D. Submit the welder’s qualifications in the form of a current (less than one year old) and formal certificate.

E. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

F. As-Built Piping Diagrams: Provide drawing as follows for chilled water, and heating hot water system and other piping systems and equipment.
   1. One wall-mounted stick file with complete set of prints. Mount stick file in the control room along with control diagram stick file.
   2. One complete set of reproducible drawings.
   3. One complete set of drawings in electronic Autocad and pdf format.

1.5 APPLICABLE PUBLICATIONS

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

B. American Society of Mechanical Engineers/American National Standards Institute, Inc. (ASME/ANSI):

B1.20.1-83(R2006)	Pipe Threads, General Purpose (Inch)
B16.4-06	Gray Iron Threaded FittingsB16.18-01 Cast Copper Alloy Solder joint Pressure fittings
B16.23-02	Cast Copper Alloy Solder joint Drainage fittings
B40.100-05	Pressure Gauges and Gauge Attachments

C. American National Standards Institute, Inc./Fluid Controls Institute (ANSI/FCI):

70-2-2006	Control Valve Seat Leakage

D. American Society of Mechanical Engineers (ASME):

B16.1-98	Cast Iron Pipe Flanges and Flanged Fittings
B16.3-2006	Malleable Iron Threaded Fittings: Class 150 and 300
B16.4-2006	Gray Iron Threaded Fittings: (Class 125 and 250)
B16.5-2003	Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard
B16.9-07	Factory Made Wrought Butt Welding Fittings
B16.11-05	Forged Fittings, Socket Welding and Threaded
B16.18-01	Cast Copper Alloy Solder Joint Pressure Fittings
B16.22-01	Wrought Copper and Bronze Solder Joint Pressure Fittings.
B16.24-06	Cast Copper Alloy Pipe Flanges and Flanged Fittings
B16.39-06	Malleable Iron Threaded Pipe Unions
B16.42-06	Ductile Iron Pipe Flanges and Flanged Fittings
B31.1-08	Power Piping

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

A47/A47M-99 (2004)	Ferritic Malleable Iron Castings
A53/A53M-07	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106/A106M-08	Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
A126-04	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A183-03	Standard Specification for Carbon Steel Track Bolts and Nuts
A216/A216M-08	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
A234/A234M-07	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
A307-07	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A536-84 (2004)	Standard Specification for Ductile Iron Castings
A615/A615M-08	Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
A653/A 653M-08	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) By the Hot-Dip Process
B32-08	Standard Specification for Solder Metal
B62-02	Standard Specification for Composition Bronze or Ounce Metal Castings
B88-03	Standard Specification for Seamless Copper Water Tube
B209-07	Aluminum and Aluminum Alloy Sheet and Plate
C177-04	Standard Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus
C478-09	Precast Reinforced Concrete Manhole Sections
C533-07	Calcium Silicate Block and Pipe Thermal Insulation
C552-07	Cellular Glass Thermal Insulation
D3350-08	Polyethylene Plastics Pipe and Fittings Materials
C591-08	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
D1784-08	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compound

D1785-06	Poly (Vinyl Chloride0 (PVC) Plastic Pipe, Schedules 40, 80 and 120
D2241-05	Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
F439-06	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
F441/F441M-02	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
F477-08	Elastomeric Seals Gaskets) for Joining Plastic Pipe

F. American Water Works Association (AWWA):

C110-08	Ductile Iron and Grey Iron Fittings for Water
C203-02	Coal Tar Protective Coatings and Linings for Steel Water Pipe Lines Enamel and Tape Hot Applied

G. American Welding Society (AWS):

B2.1-02	Standard Welding Procedure Specification

H. Copper Development Association, Inc. (CDA):

CDA A4015-06	Copper Tube Handbook

I. Expansion Joint Manufacturer's Association, Inc. (EJMA):

EMJA-2003	Expansion Joint Manufacturer's Association Standards, Ninth Edition

J. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:

SP-67-02a	Butterfly Valves
SP-70-06	Gray Iron Gate Valves, Flanged and Threaded Ends
SP-71-05	Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-80-08	Bronze Gate, Globe, Angle and Check Valves
SP-85-02	Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
SP-110-96	Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
SP-125-00	Gray Iron and Ductile Iron In-line, Spring Loaded, Center-Guided Check Valves

K. National Sanitation Foundation/American National Standards Institute, Inc. (NSF/ANSI):

14-06	Plastic Piping System Components and Related Materials
50-2009a	Equipment for Swimming Pools, Spas, Hot Tubs and other Recreational Water Facilities – Evaluation criteria for materials, components, products, equipment and systems for use at recreational water facilities
61-2008	Drinking Water System Components – Health Effects

L. Tubular Exchanger Manufacturers Association: TEMA 9th Edition, 2007

1.6 SPARE PARTS

A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.2 PIPE AND TUBING

A. Chilled Water, Heating Hot Water, and Vent Piping:
   1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 40.
   2. Copper water tube option: ASTM B88, Type K or L, hard drawn.

B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.

C. Cooling Coil Condensate Drain Piping:
   1. From air handling units: Copper water tube, ASTM B88, Type M, or schedule 40 PVC plastic piping.
   2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and Type M for mains.

D. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
   1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
   2. Forged steel, socket welding or threaded: ASME B16.11.
   3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
   4. Unions: ASME B16.39.
   5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints. Contractor’s option: Grooved mechanical couplings and fittings are optional.
   1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
   2. Welding flanges and bolting: ASME B16.5:
      a. Water service: Weld neck or slip-on, plain face, with 6 mm (1/8 inch) thick full face neoprene gasket suitable for 104 degrees C (220 degrees F).
         1) Contractor's option: Convoluted, cold formed 150 pound steel flanges, with teflon gaskets, may be used for water service.
      b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

D. Grooved Mechanical Pipe Couplings and Fittings (Contractor’s Option): Grooved Mechanical Pipe Couplings and Fittings may be used, with cut or roll grooved pipe, in water service up to 110 degrees C (230 degrees F) in lieu of welded, screwed or flanged connections. All joints must be rigid type.
   1. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A449 and A183.
   2. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.

3. Grooved end fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

2.4 FITTINGS FOR COPPER TUBING

A. Joints:
   1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
   2. Contractor's Option: Mechanical press sealed fittings, double pressed type, NSF 50/61 approved, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements for up 65 mm (2-1/2 inch) and below are optional for above ground water piping only.
   3. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 99 degrees C (210 degrees F).

E. Contractor's option: On pipe sizes 2" and smaller, screwed end brass ball valves or dielectric nipples may be used in lieu of dielectric unions.

2.6 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer.

C. Shut-Off Valves
   1. Ball Valves (Pipe sizes 2" and smaller): MSS-SP 110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2760 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.

2. Butterfly Valves (Pipe Sizes 2-1/2" and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS-SP 67, flange lug type or grooved end rated 1205 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated pressure. Not permitted for direct buried pipe applications.
   a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
   b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
   c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
      1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
      2) Gate Valves (Contractor's Option in lieu of Ball or Butterfly Valves):
         a) 50 mm (2 inches) and smaller: MSS-SP 80, Bronze, 1034 kPa (150 psig), wedge disc, rising stem, union bonnet.
         b) 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke. MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

D. Globe and Angle Valves
   1. Globe Valves
      a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.
      b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.
   2. Angle Valves:
      a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.
      b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle.

E. Check Valves
   1. Swing Check Valves:
      a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.), 45 degree swing disc.
      b. 65 mm (2 1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.
   2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
      a. Body: MSS-SP 125 cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type.
      b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

F. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
   1. Ball or Globe style valve.

2. A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.

G. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
1. Gray iron (ASTM A126) or brass body rated 1205 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
2. Brass or ferrous body designed for 2067 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

2.8 WATER FLOW MEASURING DEVICES

A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.

B. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.

C. Wafer Type Circuit Sensor: Cast iron wafer-type flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process.

D. Self-Averaging Annular Sensor Type: Brass or stainless steel metering tube, shutoff valves and quick-coupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed down-stream when unit is not in use.

E. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

F. Flow Measuring Device Identification:
1. Metal tag attached by chain to the device.
2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in l/m (gpm).

G. Portable Water Flow Indicating Meters:
1. Minimum 150 mm (6 inch) diameter dial, forged brass body, beryllium-copper bellows, designed for 1205 kPa (175 psig) working pressure at 121 degrees C (250 degrees F).
2. Bleed and equalizing valves.
3. Vent and drain hose and two 3000 mm (10 feet) lengths of hose with quick disconnect connections.
4. Factory fabricated carrying case with hose compartment and a bound set of capacity curves showing flow rate versus pressure differential.
5. Provide one portable meter for each range of differential pressure required for the installed flow devices.

H. Permanently Mounted Water Flow Indicating Meters: Minimum 150 mm (6 inch) diameter, or 450 mm (18 inch) long scale, for 120 percent of design flow rate, direct reading in lps (gpm), with three valve manifold and two shut-off valves.

2.9 STRAINERS

A. Y Type.
   1. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (0.125 inch) diameter perforations.

B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

2.10 FLEXIBLE CONNECTORS FOR WATER SERVICE

A. Flanged Spool Connector:
   1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
   2. Working pressures and temperatures shall be as follows:
      a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165psig) at 121 degrees C (250 degrees F).
      b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
   3. Provide ductile iron retaining rings and control units.

B. Mechanical Pipe Couplings:
   1. See other fittings specified under Part 2, PRODUCTS.

2.11 HYDRONIC SYSTEM COMPONENTS

A. Tangential Air Separator: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. If scheduled on the drawings, provide a removable stainless steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.

B. Diaphragm Type Pre-Pressurized Expansion Tank: ASME Pressure Vessel Code construction for 861 kPa (125 psig) working pressure, welded steel shell, rust-proof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 116 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).

C. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).

D. Pressure Relief Valve: Bronze or iron body and bronze or stainless steel trim, with testing lever. Comply with ASME Code for Pressure Vessels, Section 8, and bear ASME stamp.

E. Automatic Air Vent Valves (where shown): Cast iron or semi-steel body, 1034 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

2.12 WATER FILTERS AND POT CHEMICAL FEEDERS

A. See section 23 25 00, HVAC WATER TREATMENT, Article 2.2, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

2.13 GAGES, PRESSURE AND COMPOUND

A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gages in water service.

C. Range of Gages: Provide range equal to at least 130 percent of normal operating range.

2.14 PRESSURE/TEMPERATURE TEST PROVISIONS

A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.

B. Provide one each of the following test items to the Resident Engineer:
   1. 6 mm (1/4 inch) FPT by 3 mm (1/8 inch) diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
   2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gage, ——100 kPa (30 inches) Hg to 700 kPa (100 psig) range.
   3. 0 - 104 degrees C (220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (one inch) dial, 125 mm (5 inch) long stainless steel stem, plastic case.

2.15 THERMOMETERS

A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.

B. Case: Chrome plated brass or aluminum with enamel finish.

C. Scale: Not less than 225 mm (9 inches), range as described below, two degree graduations.

D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.

E. Scale ranges:
   1. Chilled Water : 0-38 degrees C (32-100 degrees F).
   2. Hot Water : -1 – 116 degrees C (30-240 degrees F).

2.16 FIRESTOPPING MATERIAL

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

PART 3 - EXECUTION

3.1 GENERAL

A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION. Install heat exchangers at height sufficient to provide gravity flow of condensate to the condensate pump.

D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.

G. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

H. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.

I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
   1. Water treatment pot feeders .
   2. Flow elements , control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

J. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.

K. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

L. Where copper piping is connected to steel piping, provide dielectric connections.

3.2 PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.

D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

E. Solvent Welded Joints: As recommended by the manufacturer.

3.3 SEISMIC BRACING ABOVEGROUND PIPING

A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.4 LEAK TESTING ABOVEGROUND PIPING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

3.5 FLUSHING AND CLEANING PIPING SYSTEMS

A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.

2. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/S (6 feet per second). Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
3. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

3.6 WATER TREATMENT

A. Install water treatment equipment and provide water treatment system piping.

B. Close and fill system as soon as possible after final flushing to minimize corrosion.

C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

D. Utilize this activity, by arrangement with the Resident Engineer, for instructing VA operating personnel.

3.7 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Adjust red set hand on pressure gages to normal working pressure.

END OF SECTION

SECTION 23 21 23
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Hydronic pumps for Heating, Ventilating and Air Conditioning.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

F. Section 23 21 13, HYDRONIC PIPING.

G. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

H. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Design Criteria:
   1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
   2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
   3. Head-capacity curves shall slope up to maximum head at shut-off. Curves shall be relatively flat for closed systems. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
   4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
   5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
   6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
   7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.

8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

C. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
1. Pumps and accessories.
2. Motors and drives.
3. Variable speed motor controllers.

C. Manufacturer's installation, maintenance and operating instructions, in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.

1.5 APPLICABLE PUBLICATIONS

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

B. American Iron and Steel Institute (AISI):

AISI 1045	Cold Drawn Carbon Steel Bar, Type 1045
AISI 416	Type 416 Stainless Steel

C. American National Standards Institute (ANSI):

ANSI B15.1-00(R2008)	Safety Standard for Mechanical Power Transmission Apparatus
ANSI B16.1-05	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

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

A48-03 (2008)	Standard Specification for Gray Iron Castings
B62-2009	Standard Specification for Composition Bronze or Ounce Metal Castings

E. Maintenance and Operating Manuals in accordance with Section 01 00 00, General Requirements.

1.6 DEFINITIONS

A. Capacity: Liters per second (L/s) (Gallons per minute (GPM) of the fluid pumped.

B. Head: Total dynamic head in kPa (feet) of the fluid pumped.

C. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.

1.7 SPARE MATERIALS

A. Furnish one spare seal and casing gasket for each pump to the Resident Engineer.

PART 2 - PRODUCTS

2.1 CENTRIFUGAL PUMPS, BRONZE FITTED

A. General:
   1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
   2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1½ times the designed pressure.
   3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
   4. General Construction Requirements
      a. Balance: Rotating parts, statically and dynamically.
      b. Construction: To permit servicing without breaking piping or motor connections.
      c. Pump Motors: Provide high efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMNTS FOR HVAC and STEAM GENERATION EQUIPMENT. Motors shall be Open Drip Proof and operate at 1750 rpm unless noted otherwise.
      d. Heating pumps shall be suitable for handling water to 225ºF.
      e. Provide coupling guards that meet ANSI B15.1, Section 8 and OSHA requirements.
      f. Pump Connections: Flanged.
      g. Pump shall be factory tested.
      h. Performance: As scheduled on the Contract Drawings.
   5. Variable Speed Pumps:
      a. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip-proof motor.
      b. Variable Speed Motor Controllers: Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS and to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION paragraph, Variable Speed Motor Controllers. Furnish controllers with pumps and motors.
      c. Pump operation and speed control shall be as shown on the drawings.

B. In-Line Type, Base Mounted End Suction or Double Suction Type:
   1. Casing and Bearing Housing: Close-grained cast iron, ASTM A48.
   2. Casing Wear Rings: Bronze.
   3. Suction and Discharge: Plain face flange, 850 kPa (125 psig), ANSI B16.1.
   4. Casing Vent: Manual brass cock at high point.
   5. Casing Drain and Gage Taps: 15 mm (1/2-inch) plugged connections minimum size.
   6. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.
   7. Shaft: Steel, AISI Type 1045 or stainless steel.
   8. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.
   9. Shaft Sleeve: Bronze or stainless steel.
   10. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
   11. Base Mounted Pumps:
      a. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
      b. Impeller Wear Rings: Bronze.

c. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, ANSI B15.1, bolted to the baseplate.
d. Bearings (Double-Suction pumps): Regreaseable ball or roller type.
e. Provide lip seal and slinger outboard of each bearing.
f. Base: Cast iron or fabricated steel for common mounting to a concrete base.

12. Provide line sized shut-off valve and suction strainer, maintain manufacturer recommended straight pipe length on pump suction (with blow down valve). Provide suction diffuser where shown.
    a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 5 mm (3/16-inch) diameter openings for pump protection. Provide taps for strainer blowdown and gage connections.
    b. Provide adjustable foot support for suction piping.
    c. Strainer free area: Not less than five times the suction piping.
    d. Provide disposable start-up strainer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's written instructions for pump mounting and start-up. Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

B. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.

C. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

3.2 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Field modifications to the bearings and or impeller (including trimming) are not permitted. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.

F. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.

G. After several days of operation, replace the disposable start-up strainer with a regular strainer in the suction diffuser.

END OF SECTION

SECTION 23 22 13
STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Steam, condensate and vent piping inside buildings. Outside steam distribution piping is covered in specification Section 33 63 00, STEAM ENERGY DISTRIBUTION.

1.2 RELATED WORK

A. Excavation and backfill: Section 31 20 00, EARTH MOVING.

B. Underground steam and condensate distribution: Section 33 63 00, STEAM ENERGY DISTRIBUTION.

C. Seismic restraints for piping: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

E. Pumps: Section 23 22 23, STEAM CONDENSATE PUMPS.

F. Piping insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

G. Water treatment for open and closed systems: Section 23 25 00, HVAC WATER TREATMENT.

H. Temperature and pressure sensors and valve operators: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

1.3 QUALITY ASSURANCE

A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, which includes welding qualifications.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
1. Pipe and equipment supports.
2. Pipe and tubing, with specification, class or type, and schedule.
3. Pipe fittings, including miscellaneous adapters and special fittings.
4. Flanges, gaskets and bolting.
5. Valves of all types.
6. Strainers.
7. Pipe alignment guides.
8. All specified steam system components.
9. Gages.
10. Thermometers and test wells.

C. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
   1. Heat Exchangers (Steam-to-Hot Water).
   2. Flash tanks.

D. Coordination Drawings: Refer to Article, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

E. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.
   1. One wall-mounted stick file for prints. Mount stick file in the control room along with control diagram stick file.
   2. One set of reproducible drawings.

1.5 APPLICABLE PUBLICATIONS

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

B. American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI):

B1.20.1-83(R2006)	Pipe Threads, General Purpose (Inch)
B16.4-2006	Gray Iron Threaded Fittings

C. American Society of Mechanical Engineers (ASME):

B16.1-2005	Gray Iron Pipe Flanges and Flanged Fittings
B16.3-2006	Malleable Iron Threaded Fittings
B16.9-2007	Factory-Made Wrought Buttwelding Fittings
B16.11-2005	Forged Fittings, Socket-Welding and Threaded
B16.14-91	Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads
B16.22-2001	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
B16.23-2002	Cast Copper Alloy Solder Joint Drainage Fittings
B16.24-2006	Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500
B16.39-98	Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300
B31.1-2007	Power Piping
B31.9-2008	Building Services Piping
B40.100-2005	Pressure Gauges and Gauge Attachments

Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels, Division 1

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

A47-99	Ferritic Malleable Iron Castings
A53-2007	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
A106-2008	Seamless Carbon Steel Pipe for High-Temperature Service
A126-2004	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A181-2006	Carbon Steel Forgings, for General-Purpose Piping
A183-2003	Carbon Steel Track Bolts and Nuts
A216-2008	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
A285-01	Pressure Vessel Plates, Carbon Steel, Low-and-Intermediate-Tensile Strength
A307-2007	Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
A516-2006	Pressure Vessel Plates, Carbon Steel, for Moderate-and- Lower Temperature Service
A536-84(2004)e1	Standard Specification for Ductile Iron Castings

B32-2008	Solder Metal
B61-2008	Steam or Valve Bronze Castings
B62-2009	Composition Bronze or Ounce Metal Castings
B88-2003	Seamless Copper Water Tube
F439-06	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
F441-02(2008)	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

E. American Welding Society (AWS):

A5.8-2004	Filler Metals for Brazing and Braze Welding
B2.1-00	Welding Procedure and Performance Qualifications

F. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:

SP-67-95	Butterfly Valves
SP-70-98	Cast Iron Gate Valves, Flanged and Threaded Ends
SP-71-97	Gray Iron Swing Check Valves, Flanged and Threaded Ends
SP-72-99	Ball Valves with Flanged or Butt-Welding Ends for General Service
SP-78-98	Cast Iron Plug Valves, Flanged and Threaded Ends
SP-80-97	Bronze Gate, Globe, Angle and Check Valves
SP-85-94	Cast Iron Globe and Angle Valves, Flanged and Threaded Ends

G. Military Specifications (Mil. Spec.):

MIL-S-901D-1989	Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems

H. National Board of Boiler and Pressure Vessel Inspectors (NB): Relieving Capacities of Safety Valves and Relief Valves

I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000

PART 2 - PRODUCTS

2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES

A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

2.2 PIPE AND TUBING

A. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40.

B. Steam Condensate and Pumped Condensate Piping:
   1. Concealed above ceiling, in wall or chase: Copper water tube ASTM B88, Type K, hard drawn.
   2. All other locations: Copper water tube ASTM B88, Type K, hard drawn; or steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80.

C. Vent Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 40, galvanized.

2.3 FITTINGS FOR STEEL PIPE

A. 50 mm (2 inches) and Smaller: Screwed or welded.

1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
2. Forged steel, socket welding or threaded: ASME B16.11.
3. Screwed: 150 pound malleable iron, ASME B16.3. 125 pound cast iron, ASME B16.4, may be used in lieu of malleable iron, except for steam and steam condensate piping. Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
4. Unions: ASME B16.39.

B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
2. Welding flanges and bolting: ASME B16.5:
a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 750 degrees F and 1500 psi.
b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.

C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.

2.4 FITTINGS FOR COPPER TUBING

A. Solder Joint:
1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

C. Fittings: ANSI/ASME B16.18 cast copper or ANSI/ASME B16.22 solder wrought copper.

2.5 DIELECTRIC FITTINGS

A. Provide where copper tubing and ferrous metal pipe are joined.

B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.

C. 65 mm (2 1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.

D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.

2.6 SCREWED JOINTS

A. Pipe Thread: ANSI B1.20.

B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

2.7 VALVES

A. Asbestos packing is not acceptable.

B. All valves of the same type shall be products of a single manufacturer.

D. Shut-Off Valves
1. Gate Valves:

a. 50 mm (2 inches) and smaller: MSS-SP80, Bronze, 1034 kPa (150 lb.), wedge disc, rising stem, union bonnet.

b. 65 mm (2 1/2 inches) and larger: Flanged, outside screw and yoke.

1) High pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.

2) All other services: MSS-SP 70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.

E. Globe and Angle Valves:

1. Globe Valves:

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Globe valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger:

1) Globe valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for globe valves.

2. Angle Valves

a. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 lb.) Angle valves shall be union bonnet with metal plug type disc.

b. 65 mm (2 1/2 inches) and larger:

1) Angle valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system): Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

2) All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-85 for angle valves.

F. Swing Check Valves

1. 50 mm (2 inches) and smaller: MSS-SP 80, bronze, 1034 kPa (150 psig), 45 degree swing disc.

2. 65 mm (2-1/2 inches) and Larger:

a. Check valves for high pressure steam 413 kPa (60 psig) and above nominal MPS system: Cast steel body, ASTM A216 grade WCB, flanged, OS&Y, 1034 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.

b. All other services: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS-SP-71 for check valves.

2.8 STRAINERS

A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.

B. High Pressure Steam: Rated 1034 kPa (150 psig) saturated steam.

1. 50 mm (2 inches) and smaller: Iron, ASTM A116 Grade B, or bronze, ASTM B-62 body with screwed connections (250 psig).

2. 65 mm (2-1/2 inches) and larger: Flanged cast steel or 1723 kPa (250 psig) cast iron.

C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
   1. 50 mm (2 inches) and smaller: Cast iron or bronze.
   2. 65 mm (2-1/2 inches) and larger: Flanged, iron body.

D. Screens: Bronze, monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
   1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
   2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (0.125 inch) diameter perforations for liquids.

2.9 PIPE ALIGNMENT

A. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors.

2.11 STEAM SYSTEM COMPONENTS

A. Heat Exchanger (Steam to Hot Water): Shell and tube type, U-bend removable tube bundle, steam in shell, water in tubes, equipped with support cradles.
   1. Maximum tube velocity: 2.3 m/s (7.5 feet per second).
   2. Tube fouling factor: TEMA Standards, but not less than 0.00018 m^2K/W (0.001 ft^2hrF/Btu).
   3. Materials:
      a. Shell: Steel.
      b. Tube sheet and tube supports: Steel or brass.
      c. Tubes: 20 mm (3/4 inch) OD copper.
      d. Head or bonnet: Cast iron or steel.
   4. Construction: In accordance with ASME Pressure Vessel Code for 861 kPa (125 psig) working pressure for shell and tubes. Provide manufacturer's certified data report, Form No. U-1.

B. Optional Heat Transfer Package: In lieu of field erected individual components, the Contractor may provide a factory or shop assembled package of heat exchangers, pumps, and other components supported on a welded steel frame.

C. Steam Pressure Reducing Valves in PRV Stations:
   1. Type: Single-seated, diaphragm operated, spring-loaded, external or internal steam pilot-controlled, normally closed, adjustable set pressure. Pilot shall sense controlled pressure downstream of main valve.
   2. Service: Provide controlled reduced pressure to steam piping systems.
   3. Pressure control shall be smooth and continuous with maximum drop of 10 percent. Maximum flow capability of each valve shall not exceed capacity of downstream safety valve(s).
   4. Main valve and pilot valve shall have replaceable valve plug and seat of stainless steel, monel, or similar durable material.
      a. Pressure rating for high pressure steam: Not less than 1034 kPa (150 psig) saturated steam.
      b. Connections: Flanged for valves 65 mm (2-1/2 inches) and larger; flanged or threaded ends for smaller valves.
   5. Select pressure reducing valves to develop less than 85 dbA at 1500 mm (5 feet) elevation above adjacent floor, and 1500 mm (5 feet) distance in any direction. Inlet and outlet piping for steam pressure reducing valves shall be Schedule 80 minimum for required distance to achieve required levels or sound attenuators shall be applied.

D. Safety Valves and Accessories: Comply with ASME Boiler and Pressure Vessel Code, Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown.

E. Steam PRV for Individual Equipment: Cast iron or bronze body, screwed or flanged ends, rated 861 kPa (125 psig) working pressure. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.

F. Flash Tanks: Horizontal or vertical vortex type, constructed of copper bearing steel, ASTM A516 or ASTM A285, for a steam working pressure of 861 kPa (125 psig) to comply with ASME Code for Unfired Pressure Vessels and stamped with "U" symbol. Perforated pipe inside tank shall be ASTM A53 Grade B, Seamless or ERW, or A106 Grade B Seamless, Schedule 80. Corrosion allowance of 1.6 mm (1/16 inch) may be provided in lieu of the copper bearing requirement. Provide data Form No. U-1.

G. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (200 feet) intervals on the horizontal main lines.
   1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:
      a. For equipment with modulating control valve: 1.7 kPa (1/4 psig), based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
      b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
   2. Trap bodies: Bronze, cast iron, or semi-steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping. For systems without relief valve traps shall be 5.
   3. Mechanism: Brass, stainless steel or corrosion resistant alloy. rated for the pressure upstream of the PRV supplying the system.
   4. Balanced pressure thermostatic elements: Phosphor bronze, stainless steel or monel metal.
   5. Valves and seats: Suitable hardened corrosion resistant alloy.
   6. Floats: Stainless steel.
   7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.

H. Thermostatic Air Vent (Steam): Brass or iron body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.

2.12 GAGES, PRESSURE AND COMPOUND

A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.

B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.

C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

Low pressure steam and steam condensate to 103 kPa(15 psig)	0 to 207 kPa (30 psig).

Medium pressure steam and steam condensate nominal 413 kPa (60 psig)	0 to 689 kPa (100 psig).
High pressure steam and steam condensate nominal 620 kPa to 861 kPa (90 to 125 psig)	0 to 1378 kPa (200 psig).
Pumped condensate, steam condensate, gravity or vacuum (30" HG to 30 psig)	0 to 415 kPa (60 psig)

2.13 FIRESTOPPING MATERIAL

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

PART 3 - EXECUTION

3.1 GENERAL

A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, converters, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.

B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.

C. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.

D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (one inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (one inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.

E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.

F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.

G. Tee water piping runouts or branches into the top of mains . Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.

H. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
   1. Flow elements , control valve bodies, flow switches, pressure taps with valve, and wells for sensors.

I. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

J. Where copper piping is connected to steel piping, provide dielectric connections.

K. Pipe vents to the exterior. Where a combined vent is provided, the cross sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping one inch in 40 feet (0.25 percent) in direction of flow. Provide a drip trap elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 0.3 M (12 inches) above the roof or through the wall minimum 2.5 M (8 feet) above grade with down turned elbow.

3.2 PIPE JOINTS

A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.

C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.

3.3 STEAM TRAP PIPING

A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (25 pounds) independently of connecting piping.

3.4 SEISMIC BRACING

A. Provide is accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 LEAK TESTING

A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.

B. An operating test at design pressure, and for hot systems, design maximum temperature.

C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

3.6 FLUSHING AND CLEANING PIPING SYSTEMS

A. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.

3.7 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

A. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Adjust red set hand on pressure gages to normal working pressure.

END OF SECTION

SECTION 23 22 23
STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Steam condensate pumps for Heating, Ventilating and Air Conditioning.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

F. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.

G. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Design Criteria:
   1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
   2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
   3. Select pumps so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
   4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve including one pump operation in a parallel or series pumping installation.
   5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
   6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
   7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
   8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
   9. Furnish one spare seal and casing gasket for each pump to the Resident Engineer .

C. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Pumps and accessories.
   2. Motors and drives.

C. Manufacturer's installation, maintenance and operating instructions, in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump.

1.5 APPLICABLE PUBLICATIONS

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

B. American Iron and Steel Institute (AISI):

AISI 1045	Cold Drawn Carbon Steel Bar, Type 1045
AISI 416	Type 416 Stainless Steel

C. American National Standards Institute (ANSI):

ANSI B15.1-00(R2008)	Safety Standard for Mechanical Power Transmission Apparatus
ANSI B16.1-05	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

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

A48-03(2008)	Standard Specification for Gray Iron Castings
B62-09	Standard Specification for Composition Bronze or Ounce Metal Castings

E. Maintenance and Operating Manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1.6 DEFINITIONS

A. Capacity: Liters per second (L/s) (Gallons per minute (GPM)) of the fluid pumped.

B. Head: Total dynamic head in kPa (feet) of the fluid pumped.

PART 2 - PRODUCTS

2.1 CONDENSATE PUMP, PAD-MOUNTED, DUPLEX TYPE

A. General: Factory assembled unit consisting of vented receiver tank, motor-driven pumps, interconnecting piping and wiring, motor controls (including starters, if necessary) and accessories, designed to receive, store, and pump steam condensate.

B. Receiver Tank: Cast iron with threaded openings for connection of piping and accessories and facilities for mounting float switches.

C. Furnish seals for condensate pump with a minimum temperature rating of 121 degrees C (250 degrees F).

D. Centrifugal Pumps: Bronze fitted with mechanical shaft seals.

1. Designed to allow removal of rotating elements without disturbing connecting piping or pump casing mounting.
2. Shafts: Stainless steel, AISI Type 416 or alloy steel with bronze shaft sleeves.
3. Bearings: Regreaseable ball or roller type.
4. Casing wearing rings: Bronze.

E. Motors: Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

F. Pump Operation:
1. Float Switches: NEMA 1, mounted on receiver tank, to start and stop pumps in response to changes in the water level in the receiver and adjustable to permit the controlled water levels to be changed. Floats and connecting rods shall be copper, bronze or stainless steel.
2. Alternator: Provide for duplex units to automatically start the second pump when the first pump fails in keeping the receiver water level from rising and to alternate the order of starting the pumps. For units 0.25 kW (1/3 horsepower) and smaller, the alternator may be the mechanical type for use in lieu of float switches.

G. Control Cabinet for 3 Phase (0.37 kW (1/2 hp) and larger) Units: NEMA 1, UL approved, factory wired, enclosing all controls, with indicating lights, manual switches and resets mounted on the outside of the panel. Attach cabinet to the pump set with rigid steel framework, unless remote mounting is noted on the pump schedule.
1. Motor starters: Magnetic contact types with circuit breakers or combination fusible disconnect switches. Provide low voltage control circuits (120 volt maximum) and "hand-off-automatic" (H-O-A) switches for each pump.
2. Indicating lights for each pump: Green to show that power is on, red to show that the pump is running.

H. Electric Wiring: Suitable for 93 degrees C (200 degrees F) service; enclosed in liquid-tight flexible metal conduit where located outside of control cabinet.

I. Receiver Accessories:
1. Thermometer: 34-216 degrees C (100 - 420 degrees F), mounted below minimum water level.
2. Water level gage glass: Brass with gage cocks which automatically stop the flow of water when the glass is broken. Provide drain on the lower gage cock and protection rods for the glass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's written instructions for pump mounting and start-up. Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.

B. Permanently support in-line pumps by the connecting piping only, not from the casing or the motor eye bolt.

C. Sequence of installation for base-mounted pumps:
1. Level and shim the unit base and grout to the concrete pad.
2. Shim the driver and realign the pump and driver. Correct axial, angular or parallel misalignment of the shafts.
3. Connect properly aligned and independently supported piping.
4. Recheck alignment.

D. Pad-mounted Condensate Pump : Level, shim, bolt, and grout the unit base onto the concrete pad.

E. Coordinate location of thermometer and pressure gauges as per Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

3.2 START-UP

A. Verify that the piping system has been flushed, cleaned and filled.

B. Lubricate pumps before start-up.

C. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.

D. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.

E. Field modifications to the bearings and or impeller (including trimming) are not permitted. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.

END OF SECTION

SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
   1. Cleaning compounds.
   2. Chemical treatment for closed loop heat transfer systems.

1.2 RELATED WORK

A. Test requirements and instructions on use of equipment/system: Section 01 00 00, GENERAL REQUIREMENTS.

B. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

C. Piping and valves: Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

1.3 QUALITY ASSURANCE

A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 6 service calls and written status reports. Emergency calls are not included. Minimum service during construction/start-up shall be 6 hours.

C. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, as stated in paragraph 1.3.B, sample taking and testing, and review with VA personnel, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

D. Log Forms: Provide one year supply of preprinted water treatment test log forms.

E. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data including:

1. Cleaning compounds and recommended procedures for their use.
2. Chemical treatment for closed systems, including installation and operating instructions.

C. Water analysis verification.

D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.

E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

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

B. National Fire Protection Association (NFPA):
70-2008 National Electric Code (NEC)

C. American Society for Testing and Materials (ASTM):
F441/F441M-02 (2008) Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

PART 2 - PRODUCTS

2.1 CLEANING COMPOUNDS

A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

B. All chemicals to be acceptable for discharge to sanitary sewer.

C. Refer to Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS

A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

2.3 EQUIPMENT AND MATERIALS IDENTIFICATION

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Refer to Section 23 21 13 HYDRONIC PIPING for chemical treatment piping, installed as follows:
   1. Provide ball valves to allow for bypassing, isolation, and servicing of components.
   2. Drain or bleed off water piping shall be piped from pressure side of circulating water piping to a convenient drain.
   3. Provide piping for chemical feeder per manufacturer’s installation instructions. Provide ball valves to isolate and service feeder.
   4. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.

D. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging in the coils.

E. Do not valve in or operate system pumps until after system has been cleaned.

F. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.

G. Perform tests and report results in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

H. After cleaning is complete, and water PH is acceptable to manufacturer of water treatment chemical, add manufacturer-recommended amount of chemicals to systems.

I. Instruct VA personnel in system maintenance and operation in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Ductwork and accessories for HVAC including the following:
   1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
   2. Exhaust duct for chemical (BSC) hoods, and “wet exhaust” ducts.

B. Definitions:
   1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
   2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
   3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
   4. Exposed Duct: Exposed to view in a finished room.

1.2 RELATED WORK

A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.

B. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS and VENTS.

C. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

F. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION

G. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION

H. Air Flow Control Valves and Terminal Units: Section 23 36 00, AIR TERMINAL UNITS.

I. Duct Mounted Coils: Section 23 82 16, AIR COILS.

J. Supply Air Fans: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

K. Exhaust Air Fans: Section 23 34 00, HVAC FANS.

L. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.

M. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

N. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

O. Smoke Detectors: Section 28 31 00, FIRE DETECTION and ALARM.

1.3 QUALITY ASSURANCE

A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

B. Fire Safety Code: Comply with NFPA 90A.

C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.

D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.

E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Rectangular ducts:
      a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
      b. Sealants and gaskets.
      c. Access doors.
   2. Round and flat oval duct construction details:
      a. Manufacturer's details for duct fittings.
      c. Sealants and gaskets.
      d. Access sections.
      e. Installation instructions.
   3. Volume dampers, back draft dampers.
   4. Upper hanger attachments.
   5. Fire dampers, fire doors, and smoke dampers with installation instructions.
   6. Flexible connections.
   7. Instrument test fittings.
   8. Details and design analysis of alternate or optional duct systems.
   9. COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05

1.5 APPLICABLE PUBLICATIONS

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

B. American Society of Civil Engineers (ASCE):

ASCE7-05	Minimum Design Loads for Buildings and Other Structures

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

A167-99(2009)	Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A653-09	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process

A1011-09a	Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
B209-07	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C1071-05e1	Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
E84-09a	Standard Test Method for Surface Burning Characteristics of Building Materials

D. National Fire Protection Association (NFPA):

90A-09	Standard for the Installation of Air Conditioning and Ventilating Systems

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

2nd Edition – 2005	HVAC Duct Construction Standards, Metal and Flexible
1st Edition - 1985	HVAC Air Duct Leakage Test Manual
6th Edition – 2003	Fibrous Glass Duct Construction Standards

F. Underwriters Laboratories, Inc. (UL):

181-08	Factory-Made Air Ducts and Air Connectors
555-06	Standard for Fire Dampers
555S-06	Standard for Smoke Dampers

PART 2 - PRODUCTS

2.1 DUCT MATERIALS AND SEALANTS

A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.

B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.

C. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.
   1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
   2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
   3. Gaskets in Flanged Joints: Soft neoprene.

D. Approved factory made joints may be used.

2.2 DUCT CONSTRUCTION AND INSTALLATION

A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:

B. Duct Pressure Classification:
   1. 0 to 50 mm (2 inch)

2. > 50 mm to 75 mm (2 inch to 3 inch)
3. > 75 mm to 100 mm (3 inch to 4 inch)
4. Show pressure classifications on the floor plans.

C. Seal Class: All ductwork shall receive Class A Seal

D. Wet Air Exhaust Ducts and Accessories: Ducts from clean and soiled cage wash including; cage washers and steam sterilizer hoods shall be 1.3 mm (18 gage) stainless steel made liquid tight with continuous external weld for all seams and joints. Extent of stainless steel ductwork is shown on the drawings. Provide neoprene gaskets at flanged connections. Ducts shall be self draining back to the equipment.

E. Biological Safety Cabinet, Exhaust and Associated Ductwork: 1.3 mm (18 gage) all welded stainless steel.

F. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
   1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
   2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
   3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
      a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
      b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
   4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Resident Engineer.

G. Canopy Hoods, : Constructed of 1.3 mm (18 gage) stainless steel.

H. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide drain for outside air louver plenum. Drain piping shall be routed to the nearest floor drain.

I. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.

J. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS

A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
   1. Each duct mounted coil .

2. Each fire damper (for link service), smoke damper and automatic control damper.
3. Each duct mounted smoke detector.
4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.

B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.
1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

2.4 FIRE DAMPERS

A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

C. Minimum requirements for fire dampers:
1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
2. Submit manufacturer's installation instructions conforming to UL rating test.

2.5 SMOKE DAMPERS

A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).

B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.

C. Minimum requirements for dampers:
1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
4. Shafts: Galvanized steel.
5. Bearings: Nylon, bronze sleeve or ball type.
6. Hardware: Zinc plated.
7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.

D. Motor operator (actuator): Provide electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.6 FLEXIBLE AIR DUCT

A. General:Flexible air ducts are not permitted.

2.7 FLEXIBLE DUCT CONNECTIONS

A. Where duct connections are made to fans , install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

2.8 FIRESTOPPING MATERIAL

A. Refer to Section 07 84 00, FIRESTOPPING.

2.9 SEISMIC RESTRAINT FOR DUCTWORK

A. Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.10 DUCT MOUNTED TEMPERATURE SENSOR (AIR)

A. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

2.11 INSTRUMENT TEST FITTINGS

A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.

B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil and cooling coil .

2.12 AIR FLOW CONTROL VALVES (AFCV)

A. Refer to Section 23 36 00 , AIR TERMINAL UNITS .

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.

B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:

1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.

2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.

C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.

D. Install fire dampers and smoke dampers, in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers at locations indicated and where ducts penetrate fire rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.

E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.

F. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.

G. Control Damper Installation:
1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.

H. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.

I. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

3.2 DUCT LEAKAGE TESTS AND REPAIR

A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.

B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter sections.

C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.

D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.

E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.

F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.

G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.

H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

3.4 TESTING, ADJUSTING AND BALANCING (TAB)

A. Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

3.5 OPERATING AND PERFORMANCE TESTS

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Fans for heating, ventilating and air conditioning.

B. Product Definitions: AMCA Publication 99, Standard l-66.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

F. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

G. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

I. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

J. Section 23 82 16, AIR COILS.

K. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Fans and power ventilators shall be listed in the current edition of AMCA 26l, and shall bear the AMCA performance seal.

C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).

D. Fans and power ventilators shall comply with the following standards:
   1. Testing and Rating: AMCA 2l0.
   2. Sound Rating: AMCA 300.

E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

F. Performance Criteria:
   1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.

2. Select the fan operating point as follows:
   a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point
   b. Air Foil, Backward Inclined, or Tubular: At or near the peak static efficiency
   c. Mixed flow fans: right hand side of mid-peak pressure point.

G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.

H. Corrosion Protection:
   1. Except for fans in laboratory exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

I. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), the fan construction shall be as recommended by AMCA's Classification for Spark Resistant Construction. Drive set shall be comprised of non-static belts for use in an explosive.

1.4 SUBMITTALS

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

B. Manufacturers Literature and Data:
   1. Fan sections, motors and drives.
   2. Centrifugal fans, motors, drives, accessories and coatings.
      a. In-line centrifugal fans.
      b. Tubular Centrifugal Fans.
      c. Industrial fans.
      d. Utility fans and vent sets.
   3. Prefabricated roof curbs.
   4. Power roof ventilators.
   5. Centrifugal ceiling fans.

C. Certified Sound power levels for each fan.

D. Motor ratings types, electrical characteristics and accessories.

E. Roof curbs.

F. Belt guards.

G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

I. Laboratory Exhaust Fans
   1. Provide dimensional drawings, product data and performance on each induced flow exhaust fan unit.
   2. Provide fan curves for each fan at the specified point of operation. Airflow, static pressure and brake horsepower shall be clearly shown on the submittal. For multiple fan assemblies, fan curves shall be adjusted to show assembly operation.

3. Primary airflow from laboratory exhaust system, optional bypass airflow through mixing box, overall airflow through fan, and discharge nozzle airflow shall be provided. Outlet nozzle velocity and plume rise calculated per ASHRAE Applications Handbook shall also be provided for the specified fan performance and wind velocity.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Movement and Control Association International, Inc. (AMCA):

99-03 .....Standards Handbook

204-96 .....Balance Quality and Vibration Levels for Fans

2l0-06 .....Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

211-05 .....Certified Ratings Program- Product Rating Manual for Fan Air Performance

26l-09 .....Directory of Products Licensed to bear the AMCA Certified Ratings Seal - Published Annually

300-08 .....Reverberant Room Method for Sound Testing of Fans

311-05 .....Certified Ratings Program – Product Rating Manual for Fan Sound Performance

500-D-98 .....Laboratory Methods of Testing Dampers for Rating

500-L-99.....Laboratory Methods of Testing Louvers for Rating

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

B117-07a.....Standard Practice for Operating Salt Spray (Fog) Apparatus

D1735-08 .....Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus

D3359-08 .....Standard Test Methods for Measuring Adhesion by Tape Test

G152-06 .....Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

G153-04 .....Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Non-Metallic Materials

D. National Fire Protection Association (NFPA):

NFPA 96-08 .....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

E. National Sanitation Foundation (NSF):

37-07 .....Air Curtains for Entrance Ways in Food and Food Service Establishments

F. Underwriters Laboratories, Inc. (UL):
181-2005 .....Factory Made Air Ducts and Air Connectors

1.6 EXTRA MATERIALS

A. Provide one additional set of belts for all belt-driven fans.

PART 2 - PRODUCTS

2.1 FAN SECTION (CABINET FAN)

A. Refer to specification Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

2.2 CENTRIFUGAL FANS

A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.

B. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.
   1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets without duct connections.
   2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
   3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
   4. Bearings: Heavy duty ball or roller type sized to produce a Bl0 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
   5. Belts: Oil resistant, non-sparking and non-static.
   6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
   7. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
   8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION for specifications. Provide protective sheet metal enclosure for fans located outdoors.
   9. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section, MOTOR STARTERS. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION for controller/motor combination requirements.

C. In-line Centrifugal Fans: In addition to the requirements of paragraphs A and 2.2.B3 thru 2.2.B9, provide minimum 18 Gauge galvanized steel housing with inlet and outlet flanges, backward inclined aluminum centrifugal fan wheel, bolted access door and supports as required. Motors shall be factory pre-wired to an external junction box. Provide factory wired disconnect switch.

D. Spark Resistant/Explosion Proof Fans: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), provide AMCA construction option: A, B or C as indicated. Drive set shall be comprised of non-static belts for use in an explosive atmosphere. Motor shall be explosion proof type if located in air stream.

2.3 POWER ROOF VENTILATOR

A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.

B. Type: Centrifugal fan, backward inclined blades. Provide down-blast or up-blast type as indicated.

C. Construction: Steel or aluminum, completely weatherproof, for curb mounting, exhaust cowl or entire drive assembly readily removable for servicing, aluminum bird screen on discharge, UL approved safety disconnect switch, conduit for wiring, vibration isolators for wheel, motor and drive assembly. Provide self acting back draft damper.

D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.

E. Prefabricated Roof Curb:
   1. Provide insulated roof curb suited to the equipment provided.
   2. Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip. For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

2.4 LABORATORY EXHAUST FANS-INDUCED FLOW

A. General
   1. Performance ratings: Fans shall be licensed to bear the AMCA Certified Ratings Seal for Sound and Air Performance. Acceptable manufacturers whose equipment is not licensed to bear the AMCA Certified Ratings Seal for Sound and Air Performance shall submit sound and air performance data obtained and calculated in accordance with AMCA Standards 210, 211, 300, and 311. These tests shall be performed by a laboratory that is accredited by AMCA.
   2. Fans shall be manufactured at an ISO 9001 Certified facility.
   3. Units shall be Spark Resistant Construction and shall conform to AMCA Standard 99-0401-86, “Classifications for Spark Resistant Construction.”
   4. Fan impeller shall be statically and dynamically balanced in accordance with AMCA Standard 204-96, “Balance Quality and Vibration Levels for Fans.” Vibration tests shall be conducted and recorded on each assembled fan before shipment at the specified fan RPM. These readings shall conform to the AMCA 204-96 Standard.
   5. Fan entrainment design shall have been verified by computational fluid dynamics (CFD). Computational fluid dynamics (CFD) evaluation of fan discharge and entrainment airflow may also be provided as requested by the owner.
   6. Fan performance data shall follow AMCA Standard Conditions of 0 Ft elevation and 70 Deg F. (Air Density shall be 0.075 lb/ft)
   7. Fans selected shall allow for +/- 15% variation of scheduled static pressure and airflow.
   8. Fan shall be AMCA Arrangement 9, Belt Drive, Upblast Mixed Flow as dictated on the plans and specifications.
   9. Fan systems shall incorporate integral lifting lugs for ease of installation.

B. Fan Housing and Construction
   1. Fan housing shall be a minimum 14 gauge steel construction.
   2. Adjustable motor plate, where applicable shall utilize threaded studs for positive belt tensioning.

3. Fan shall be constructed with an integral housing drain to alleviate rainwater.
4. Fan shall include a bolted and gasketed access door.
5. Belt driven fan shafts shall be stainless steel and accurately turned, ground, and polished. Shafting shall be sized for a critical speed of at least 125% of maximum fan RPM.
6. Unit fasteners exposed to corrosive airstream shall be of stainless steel construction.
7. Unit components fabricated of steel shall be coated with an electrostatically applied, baked epoxy powder coating with an ultraviolet protective topcoat. Finish color shall be dark gray. Coating thickness shall be 5.0 mils. Coating shall be salt spray tested per ASTM B117 for in excess of 1000 hours without failure, humidity resistance tested per ASTM D2247 for in excess of 1000 hours without failure, and impact resistance tested per ASTM D2784 and shall pass a minimum of 100 in-lbs.

8. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM.
9. Units specified as Spark Resistant Construction shall be constructed to the AMCA Spark Resistant Construction level "B".

D. Dilution Nozzle
1. Fans shall incorporate a double concentric accelerator fiberglass reinforced plastic (FRP) induction nozzle selected for optimal performance. Nozzle shall be constructed and designed to avoid extreme variations in velocity flows across the outlet, even against wind loading. Where required, CFD shall be provided demonstrating this on submitted nozzle. Bifurcated designs shall not be allowed.
2. Induction nozzle shall be constructed and designed to efficiently handle up to 7000 feet per minute outlet velocity and shall have a optimally matched accelerator for the specified design conditions.

E. Mixed Flow Fan Impeller
1. Fan impeller shall be non-overloading, high efficiency mixed-flow type. Blades shall be contoured single thickness blades incorporating 3-D curvature for maximum efficiency across the entire surface of the blade or airfoil type and shall be continuously welded to the backplate and inlet shroud.
2. Fan impeller hub shall be keyed and securely attached to the fan shaft.
3. Fan impeller shall be statically and dynamically balanced in accordance with AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans."
4. Fan impeller shall be coated with a finish to match the fan housing.
5. Belt driven fan bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreaseable ball or roller type in a cast iron pillow block housing utilizing concentric mounting locking collars.
6. Belt driven fan bearings shall be selected for a minimum L50 life of not less than 200,000 hours.
7. Belt driven fan units shall have stainless steel lube lines installed from the fan bearings with Zerk fittings to allow for easy lubrication.

F. BYPASS AIR PLENUM
1. For constant volume systems the fan and nozzle assembly shall be directly connected to the roof curb and exhaust duct.
2. Bypass air plenum shall be designed to support fan assembly (assemblies) and configuration(s) as shown on the contract drawings.
3. Bypass air plenum shall introduce outside air above the roof level and shall have rain hood(s) and bird screen protection over the bypass air damper(s).
4. Bypass air plenum shall be constructed of welded steel, minimum 14 gauge, with a finish to match the fan housing.

5. Bypass dampers shall be opposed blade design, coated to match the fan housing and plenum.
6. A fan isolation damper gravity type coated to match fan housing and plenum shall be provided for each fan.

G. Fan motors and drives
1. Fan motors shall be premium efficiency, NEMA frame, nominal 1800 or 3600 RPM Totally Enclosed Fan Cooled (TEFC) with a 1.15 service factor.
2. Belt driven fan drive belts shall be oil and heat resistant, non-static type. Fixed drives shall be sized for a minimum 1.5 service factor (150% of the motor horsepower) and shall be readily and easily accessible for service, if required.
3. Belt driven fans shall utilize precision machined cast iron type sheaves, keyed and securely attached to the wheel and motor shafts.

H. Acceptable Manufacturers
1. Loren Cook Company, Vari-Plume™ Induced Flow Exhaust Fan, Model QMXVP or QMXHPVP, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install fan, motor and drive in accordance with manufacturer's instructions.

B. Align fan and motor sheaves to allow belts to run true and straight.

C. Bolt equipment to curbs with galvanized lag bolts.

D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

3.2 PRE-OPERATION MAINTENANCE

A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.

B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.

C. Clean fan interiors to remove foreign material and construction dirt and dust.

3.3 START-UP AND INSTRUCTIONS

A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.

B. Check vibration and correct as necessary for air balance work.

C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

END OF SECTION

SECTION 23 36 00
AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Air flow control valves, and reheat coils.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.

B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

C. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise requirements.

D. Section 23 31 00, HVAC DUCTS AND CASINGS: Ducts and flexible connectors.

E. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.

F. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Flow rates adjusting and balancing.

G. Section 23 82 16, AIR COILS: Heating and Cooling Coils pressure ratings.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Air flow control valves.
   2. Laboratory control system

C. Certificates:
   1. Compliance with paragraph, QUALITY ASSURANCE.
   2. Compliance with specified standards.

D. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning and Refrigeration Institute (AHRI)/(ARI):

880-08 Air Terminals Addendum to ARI 888-98 incorporated into standard posted 15th December 2002

C. National Fire Protection Association (NFPA):
90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems

D. Underwriters Laboratories, Inc. (UL):
181-08 Standard for Factory-Made Air Ducts and Air Connectors

E. American Society for Testing and Materials (ASTM):
C 665-06 Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing

1.6 GUARANTY

A. In accordance with the GENERAL CONDITIONS

PART 2 - PRODUCTS

2.1 GENERAL

A. Coils:
1. Provide aluminum fins and copper coils for all hot water reheat coils.
2. Water Heating Coils:
   a. ARI certified, continuous plate or spiral fin type, leak tested at 2070 kPa (300 PSI).
   b. Capacity: As indicated, based on scheduled entering water temperature.
   c. Headers: Copper or Brass.
   d. Fins: Aluminum, maximum 315 fins per meter (8 fins per inch).
   e. Tubes: Copper, arrange for counter-flow of heating water.
   f. Water Flow Rate: Minimum 0.032 Liters/second (0.5 GPM).
   g. Provide vent and drain connection at high and low point, respectively of each coil.
   h. Coils shall be guaranteed to drain.

B. Labeling: Components shall be clearly marked with an identification label that lists such information as nominal CFM, maximum and minimum factory-set airflow limits, coil type and coil connection orientation, where applicable.

C. Factory calibrate air terminal units to air flow rate indicated. All settings including maximum and minimum air flow shall be field adjustable.

2.2 AIR FLOW CONTROL VALVE (SAV/EAV)

A. Acceptable manufacturers:
1. Terminal air valves:
   a. Tek-Air, blade damper airflow control valve, or equal

B. Laboratory Room Controllers
1. Laboratory room controllers shall provide closed loop pressure independent control of all laboratory room ventilation requirements. The laboratory room controller shall continuously monitor all the supply and auxiliary exhaust airflow devices in the room.

2. Air Flow Measurement shall control supply and exhaust airflow devices in order to maintain a volumetric offset (negative). Offset shall be maintained regardless of any change in flow or static pressure. The offset shall be field adjustable and represents the volume of air which will enter the room from the corridor or adjacent spaces

3. Volumetric offset shall be the only acceptable means of controlling room pressurization.
4. All laboratory room controllers shall include all inputs and control outputs necessary to perform the specified control sequences. Each laboratory room controller shall operate as a stand alone unit, performing its specified control responsibilities independently. All input point and control output point databases as well as the control programs shall be stored in non-volatile EEPROM, EPROM and PROM memory, or a minimum of 100-hour battery backup shall be provided.

5. Momentary or extended losses of power shall not change or affect any laboratory room controller setpoints or stored data. Upon resumption of power the controller shall resume full normal operation exactly as before without any need for manual intervention. Upon a power failure or operational failure within the controller, the air terminal shall remain in current position. automatically be positioned to the predetermined fully open or fully closed (failsafe) position as indicated on the air terminal schedules in the project plans.

6. All controllers and associated air terminal actuators serving Labs/Suites shall be provided with UPS power sized to provide continuous power for 10 minutes during the Emergency Generator switchover

C. Terminal Air Valves
1. The Airflow Control Valve shall Tek-Air blade damper, or equal
2. All Airflow Control Valves will have a factory mounted controller on all supply/ makeup air applications. The controllers must be of the same manufacture as the Airflow Control Valves. No other substitutions will be acceptable.
3. The Airflow Control Valve shall consist of a blade damper , factory mounted digital VorTek , or equal airflow measuring device and a factory mounted high speed actuator.
4. Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of at least 8 to 1.
5. The airflow control valve shall respond within one second of a change in duct static pressure when provided with factory controls.
6. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.
7. Valves shall incorporate stainless steel materials of all components in contact with the exhaust airstream where scheduled. Supply air valves and exhaust valves not designated as stainless steel, may be constructed of galvanized steel. Stainless steel valves may be welded directly to the adjoining duct work or connected using a flange and gasket connection for a leak tight connection. Any bands slip fittings, rings, or any other installation will not be acceptable. The blade material and shaft shall be stainless steel, with nylon bushings.
8. Control
   a. Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of exhaust on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be field selectable fail-safe to either the open, closed or last position depending on the application.
   b. All critical components of the airflow control valve shall be easily accessible from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy.
9. Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater than 0.25” pressure drop at 1500 fpm and 0.4” pressure drop at 2000 fpm.
10. The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system.

11. Airflow measuring devices shall be of the Vortex Shedding type, or equal, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. A VorTek, or equal, airflow sensor, or equal, shall be provided in each chamber of the airflow control valve. Airflow measuring devices shall be capable of measuring velocity over the full range of 400 to 5000 FPM. Pitot or Thermal Airflow sensors shall not be acceptable.
12. Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant CPVC and ABS.
13. Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.
14. Velocity measurements from individual sensors shall be summed in the associated Airflow Controller via integral Airflow Measurement circuitry or and integral Airflow Transmitter. The measurement shall be input and conditioned digitally to eliminate Analog-to-Digital conversion error. The airflow measurement shall be incorporated in the control sequence as performed by the Airflow Controller, and communicated to other Airflow Controllers, via the network, as required. Measurement system accuracy shall be plus or minus 2% of volumetric airflow rate. Turndown capability shall be at least 8:1.
15. Velocity sensing methods other than those specified shall not be acceptable. For another velocity sensing method to be considered, it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal.
16. The airflow sensors shall be easily accessible in the valve for inspection.
17. Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.
18. Sensing methods employing thermal devices in the airstream shall not be acceptable.
19. Airflow Control Valve shall have factory installed electric actuator which shall operate on 24VAC. Actuator shall accept either a 4-20maDC or 2-10VDC signal and shall modulate the valve over the range of CFM. The actuator shall modulate the valve between 0 to full scale CFM in under 2 seconds.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Work shall be installed as shown and according to the manufacturer’s diagrams and recommendations.

B. Handle and install units in accordance with manufacturer's written instructions.

C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

D. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. See VA Standard Detail.

3.2 OPERATIONAL TEST

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Roof Curbs

B. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

1.2 RELATED WORK

A. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS AND VENTS.

B. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

C. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

D. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

E. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

1.3 QUALITY ASSURANCE

A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Fire Safety Code: Comply with NFPA 90A.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Diffusers, registers, grilles and accessories.

C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Diffusion Council Test Code:
   1062 GRD-84 Certification, Rating, and Test Manual 4th Edition

C. American Society of Civil Engineers (ASCE):
   ASCE7-05 Minimum Design Loads for Buildings and Other Structures

D. American Society for Testing and Materials (ASTM):
   A167-99 (2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip

B209-07 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

E. National Fire Protection Association (NFPA):
90A-09 Standard for the Installation of Air Conditioning and Ventilating Systems

F. Underwriters Laboratories, Inc. (UL):
181-08 UL Standard for Safety Factory-Made Air Ducts and Connectors

PART 2 - PRODUCTS

2.1 AIR OUTLETS AND INLETS

A. Materials:
1. Steel or aluminum except that all supply air outlets and exhaust air grilles installed in animal and procedure rooms and shall be stainless steel. Use stainless steel air outlets and inlets for facilities located in high-humidity areas such as cage wash. Exhaust air registers located in combination toilets and shower stalls shall be constructed from aluminum. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT for NC criteria.

C. Air Supply Outlets:
1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
   a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
   b. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
   c. Perforated face type: Manual adjustment for one-, two-, three-, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. SPEC WRITER NOTE: Make sure slot diffuser boots are insulated externally in addition to factory installed lined insulation to match the duct insulation.
3. Animal holding and procedure Room Air Distribution Devices:
   a. Diffusers, radial throw type:
      1. Size, type and manufacturer: As scheduled.
      2. Provide with steel housing with hinged face to allow cleaning.
      3. Diffusers: Capable of 90 or 180 degfree radial throw pattern, as shown.
      4. Provide gasket material around frame body on frame face of air seal.
      5. Finish: 304 stainless steel, 2B mill finish.
4. Supply Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
   a. Margin: Flat, 30 mm (1-1/4 inches) wide.

b. Bar spacing: 20 mm (3/4 inch) maximum.
c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.

D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
3. Perforated Face Type: To match supply units.

G. Acoustic Transfer Grille: Aluminum, suitable for partition or wall mounting.

2.2 WIRE MESH GRILLE

A. Fabricate grille with 2 x 2 mesh 13 mm (1/2 inch) galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately 40 mm (1-1/2 inch) margin.

B. Use grilles where shown in unfinished areas such as mechanical rooms.

2.3 FILTER EXHAUST GRILLE

A. In animal holding rooms provide stainless steel grille with in stream 2-inch deep MERV 4 filter and removable or hinged face.
1. Finish: Stainless Steel shall be No. 4 finish.
2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin, or perforated face.
3. Stainless steel .
4. Standard face connected to a mounting frame with space for a throwaway filter. Hold face closed by a locking screw. Provide retaining clips to hold filter in place. Provide fiberglass throwaway filter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.

B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

3.3 TESTING, ADJUSTING AND BALANCING (TAB)

A. Refer to Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

3.4 OPERATING AND PERFORMANCE TESTS

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION

END OF SECTION

SECTION 23 40 00
HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Air filters for heating, ventilating and air conditioning.

B. Definitions: Refer to ASHRAE Standard 52.1 for definitions of face velocity, net effective filtering area, media velocity, resistance pressure drop), atmospheric dust spot efficiency and dust-holding capacity. ASHRAE Standard 52.1 measures arrestance, dust spot efficiency and dust holding capacity of filters.

C. Refer to ASHRAE Standard 52.2 for definitions of MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency) and particle size ranges for each MERV number. ASHRAE Standard 52.2 measures particle size efficiency (PSE).

1.2 RELATED WORK

A. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Filter housing and racks: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

1.3 QUALITY ASSURANCE

A. Air Filter Performance Report for Extended Surface Filters:
   1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standards 52.1 and 52.2 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.

B. Filter Warranty for Extended Surface Filters: Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no cost to the Government.

C. Comply with UL Standard 586 for flame test.

D. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency, and UL classification,

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data:
   1. Extended surface filters.
   2. Holding frames. Identify locations.

3. Magnehelic gages.

C. Air Filter performance reports.

D. Suppliers warranty.

1.5 APPLICABLE PUBLICATIONS

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

B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):

52.1-92R	Gravimetric and Dust-Spot procedures for Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter
52.2-2007	Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

C. American Society of Mechanical Engineers (ASME):

NQA-1-2008	Quality Assurance Requirements for Nuclear Facilities Applications

D. Underwriters Laboratories, Inc. (UL):

586;Amendment 20 March 2000	High-Efficiency, Particulate, Air Filter Units
900;Revision 15 July 2009	Test Performance of Air Filter Units

PART 2 - PRODUCTS

2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED

A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS, provide one complete set of spare filters to the Resident Engineer.

B. The Resident Engineer will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.

2.2 EXTENDED SURFACE AIR FILTERS

A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.

B. Filter Classification: UL approved Class 1 or Class 2 conforming to UL Standard 900.

C. Filter Grades, Percent, Average ASHRAE Efficiency and Controlled Containment:

Table 2.2C

Filter Grades				
MERV Value ASHRAE 52.2	Application	Dust-Spot Efficiency ASHRAE 52.1	Particle Size	Thickness /Type
7	Pre-Filter	25 to 30%	3 to 10 Microns	50 mm (2-inch) Throwaway
8	Pre-Filter	30 to 35%	3 to 10 Microns	50 mm (2-inch) Throwaway
11	After-Filter	60 to 65%	1 to 3 Microns	150 mm (6-inch)

				Rigid Cartridge
13	After-Filter	80 to 90%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge
14	After-Filter	90 to 95%	0.3 to 1 Micron	300 mm (12-inch) Rigid Cartridge

D. Filter Media:
   1. MERV 11, 13, and 14 Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, (metal backing or aluminum separators) shall be sealed in a proper enclosing frame to insure no air leakage for life of filter. Staples and stays are prohibited.
   2. MERV 7 and 8 (Pleated) Type: Media shall be composed of synthetic/natural fibers. Media shall maintain uniform pleat shape and stability for proper air flow and maximum dust loading. The media frame shall be constructed of aluminized steel. Bond the pleated media pack on all four edges to insure no air leakage for the life of the filter. Staples and stays are prohibited.

E. Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with ASHRAE Standard 52.1, and MERV value in accordance with ASHRAE Standard 52.2.

F. Maximum initial resistance, recommended change over pressure drop, and maximum recommended final resistance, PA (inches of water), for each filter cartridge when operated at 150 m/min (500 feet per minute) face velocity shall be as specified in Table 2.2.F:

Table 2.2.F

Filter Initial and Final Resistance			
	Initial Resistance	Maximum Recommended Change Over Pressure Drop	Maximum Final Resistance
MERV 7 (2-inch deep)	78 (0.31)	156 (0.62)	250 (1.00)
MERV 8 (2-inch deep)	95 (0.38)	190 (0.76)	250 (1.00)
MERV 11 (12-inch deep)	60 (0.24)	120 (0.48)	375 (1.50)
MERV 13 (12-inch deep)	125 (0.50)	250 (1.00)	375 (1.50)
MERV 14 (12-inch deep)	170 (0.68)	340 (1.36)	375 (1.50)

2.3 INSTRUMENTATION

A. Magnehelic Differential Pressure Filter Gages: Nominal 100 mm (four inch) diameter, zero to 500 Pa (zero to two inch water gage). Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.

B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 23 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.

D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

2.4 HVAC EQUIPMENT FACTORY FILTERS

A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.

B. Cleanable filters are not permitted.

C. Automatic Roll Type filters are not permitted.

2.5 FILTER RETURN GRILLES

A. Refer to Section 23 37 00 AIR OUTLETS AND INLETS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supports, filters and gages in accordance with manufacturer's instructions.

3.2 START-UP AND TEMPORARY USE

A. Clean and vacuum air handling units and plenums prior to starting air handling systems.

B. Install or deliver replacement filter units as directed by the Resident Engineer.

END OF SECTION

SECTION 23 64 00
PACKAGED WATER CHILLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scroll air-cooled chillers complete with accessories.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.

C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

E. Section 23 21 23, HYDRONIC PUMPS.

F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

G. Section 23 21 13, HYDRONIC PIPING.

H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.

I. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 DEFINITION

A. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.

B. BACNET: Building Automation Control Network Protocol, ASHRAE Standard 135.

C. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.

D. FTT-10: Echelon Transmitter-Free Topology Transceiver.

1.4 QUALITY ASSURANCE

A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, and comply with the following.

B. Refer to PART 3 herein after and Section 01 00 00, GENERAL REQUIREMENTS for test performance.

C. Comply with AHRI requirements for testing and certification of the chillers.

D. Refer to paragraph, WARRANTY, in GENERAL CONDITIONS.

E. Refer to OSHA 29 CFR 1910.95(a) and (b) for Occupational Noise Exposure Standard

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning, Heating and Refrigeration Institute (AHRI):

370-01	Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment
495-1999 (R2002)	Refrigerant Liquid Receivers
550/590-03	Standard for Water Chilling Packages Using the Vapor Compression Cycle
560-00	Absorption Water Chilling and Water Heating Packages
575-94	Methods for Measuring Machinery Sound within Equipment Space

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

ANSI/ASHRASE-15-2007	Safety Standard for Mechanical Refrigeration Systems
GDL 3-1996	Guidelines for Reducing Emission of Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems

D. American Society of Mechanical Engineers (ASME):

2007	ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels - Division 1"

E. American Society of Testing Materials (ASTM):

C 534/ C 534M-2008	Preformed, Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C 612-04	Mineral-fiber Block and Board Thermal Insulation

F. National Electrical Manufacturing Association (NEMA):

250-2008	Enclosures for Electrical Equipment (1000 Volts Maximum)

G. National Fire Protection Association (NFPA):

70-2008	National Electrical Code

H. Underwriters Laboratories, Inc. (UL):

1995-2005	Heating and Cooling Equipment

1.6 SUBMITTALS

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

B. Manufacturer's Literature and Data.
   1. Modular packaged scroll type compressor water chillers, including motor starters, control panels, and vibration isolators, and remote condenser data shall include the following:
      a. Rated capacity.
      b. Pressure drop.
      c. Efficiency at full load and part load without applying any tolerance indicated in the AHRI 550/590/Standard.
      d. Refrigerant
      e. Fan performance (Air-Cooled Chillers only.)
      f. Accessories.
      g. Installation instructions.
      h. Start up procedures.
      i. Wiring diagrams, including factor-installed and field-installed wiring.
      j. Sound/Noise data report. Manufacturer shall provide sound ratings. Noise warning labels shall be posted on equipment.

C. Maintenance and operating manuals for each piece of equipment in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

D. Run test report for all chillers.

E. Product Certificate: Signed by chiller manufacturer certifying that chillers furnished comply with AHRI requirements. The test report shall include calibrated curves, calibration records, and data sheets for the instrumentation used in factory tests.

F. Provide seismic restraints for refrigeration equipment to withstand seismic forces.

PART 2 - PRODUCTS

2.1 MODULAR PACKAGED AIR-COOLED CHILLER

A. Operating Conditions
   1. Provide outdoor packaged air-cooled liquid chiller with the capacity as scheduled on drawings at job site elevation listed in Section 23 64 00.
   2. Chiller shall be designed to operate using R-410A Refrigerant.
   3. Chiller shall be designed for parallel evaporator water flow.
   4. The liquid to be chilled will be water containing corrosion inhibitors and antifreeze solution as required.
   5. Chiller shall be designed to operate using 480 volt, 3 phase, 60 Hz electrical power supply.

B. Outdoor Packaged Air-Cooled Chiller
   1. Approved manufacturer is MULTISTACK AIRSTACK, or equal.
   2. System Description: Chiller shall incorporate Scroll type compressors and consist of multiple independent refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor set, evaporator, thermal expansion valve, liquid line solenoid valve, filter drier, cooper-finned/copper-tube condenser coil with Heresite Coating (see definition below,), and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits.
      a. Finned Tube Coating Specification
         1) Finned tube coils shall be protected with a pure phenolic thermosetting resinous coating. Metal preparation to provide a surface profile shall include degreasing and phosphatizing by immersion.
         2) The coating shall be applied in multiple coats by immersion. After each immersion, the coating shall be partially cured in an oven. Following the final immersion and the application of one (1) spray coat, the coating shall be totally cured in an oven.
         3) The total D.F.T.(dry film thickness) of the coating shall be approximately 2 mils, thereby providing good protection without adversely affecting heat transfer. D.F.T. varies depending upon fin spacing and the number of tube rows in depth. The coating shall withstand dry heat up to 205ºC. (400ºF.), and show no sign of attack after 5,000 hours of salt spray test to A.S.T.M. Specification B117.
         4) The coating shall be applied in accordance with the written instructions of the coating material supplier.
         5) The coating shall be Heresite P-413C baking phenolic with plasticizer or equal.
      b.
   3. General

a. Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236, and bear the ASME UM stamp on all water-to-refrigerant heat exchangers.
b. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment.
c. Compressors, heat exchangers, condenser fans, piping and controls shall be mounted on a heavy gauge steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module. Module shall be provided within a steel enclosure suitable for outdoor use. Exposed steel surfaces shall be provided with a powder coat paint finish.

4. Chilled Water Mains: Each module shall include supply and return mains for chilled water. Grooved end connections shall be provided for interconnection to four inch standard (4.5" outside diameter) piping with Victaulic type couplings. Provide isolation valves for each modual such that a modual may be removed without impairing adjacent units.
5. Evaporators: Each evaporator shall be a brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with ASME code for 650 psig working pressure. Evaporator heat exchanger shall not be mounted above the compressor, to prevent the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.
6. Compressor: Each module shall contain two hermetic scroll compressors in a tandem piping arrangement mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure safety cut-outs.
7. Condenser Fans: Each module shall contain dual condenser fans for each refrigerant circuit. These fans shall be multi-blade vaneaxial type made of plastic composite material for quiet operation. Fans shall be direct drive at maximum RPM of 1,150. Fan motors shall all be pressure controlled and suitable for outdoor use.
8. Central Control System.
   a. Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
   b. The Master Controller shall monitor and report the following on each refrigeration system:
      1) Discharge Pressure Fault
      2) Suction Pressure Fault
      3) Compressor Winding Temperature
      4) Suction Temperature
      5) Evaporator Leaving Chilled Water Temp.
   c. The Master Controller shall monitor and report the following system parameters:
      1) Chilled Water Entering and Leaving Temperature
      2) Discharge Refrigerant Temperature
      3) Chilled Water Flow
   d. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).
   e. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

f. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to fine tune the chiller to different existing building conditions.

9. Chiller shall have external inputs and outputs to be compatible with the building management system to include Remote Start/Stop capability and Cooling Alarm output. Chiller manufacturer shall coordinate and provide necessary interface to achieve control and alarm functions.
10. Each refrigerant circuit shall include all refrigerant specialties including a properly sized refrigerant receiver to provide reliable operation down to 40°F Ambient.
11. SINGLE POINT POWER CONNECTION Chiller shall be provided with a single point power connection. This will include pre-engineered wiring for field installation and connection to a factory mounted chiller junction box. Junction box shall include individual fusing for each Module Set and provide a single point of connection to building power.

C. SAFETIES, CONTROLS AND OPERATION

1. The chiller safety controls shall be provided (minimum) as follows:
   a. Low evaporator refrigerant pressure
   b. Loss of water flow through the evaporator
   c. High condenser refrigerant pressure
   d. High compressor motor temperature
   e. Low suction gas temperature
   f. Low leaving evaporator water temperature
2. Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be enunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.
3. The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:
   a. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
   b. Provisions for connection to automatically enable the chiller from a remote energy management system.
   c. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.
4. Normal Chiller Operation
   a. When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.
   b. The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, piping and electrical to verify actual locations and sizes before chiller installation and other conditions that might affect chiller performance, maintenance, and operation.

1. Equipment locations shown on drawings are approximate. Determine exact locations before proceeding with installation.

3.2 EQUIPMENT INSTALLATION

A. Install chiller on concrete base with isolation pads or vibration isolators.
   1. Concrete base is specified in Section 03 30 00, CAST-IN-PLACE CONCRETE
   2. Vibration isolator types and installation requirements are specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
   3. Anchor chiller to concrete base according to manufacturer's written instructions and for seismic restraint on vibration isolators.
   4. Charge the chiller with refrigerant, if not factory charged.
   5. Install accessories and any other equipment furnished loose by the manufacturer, including remote temperature sensors, according to the manufacturer written instructions and electrical requirements.
   6. Chillers shall be installed in a manner as to provide easy access for tube pull and removal of compressor and motors etc.

B. Install thermometers and gages as recommended by the manufacturer and/or as shown on drawings.

C. Piping Connections:
   1. Make piping connections to the chiller for chilled water and other connections as necessary for proper operation and maintenance of the equipment.
   2. Make equipment connections with flanges and couplings for easy removal and replacement of equipment from the equipment room.

3.3 STARTUP AND TESTING

A. Engage manufacturer's factory-trained representative to perform startup and testing service.

B. Inspect, equipment installation, including field-assembled components, and piping and electrical connections.

C. After complete installation startup checks, according to the manufacturers written instructions, do the following to demonstrate to the VA that the equipment operate and perform as intended.
   1. Check refrigerant charge is sufficient and chiller modules have been tested for refrigerant leaks.
   2. Check bearing lubrication and oil levels.
   3. Verify proper motor rotation.
   4. Verify pumps associated with chillers are installed and operational.
   5. Verify thermometers and gages are installed.
   6. Operate chiller for run-in-period in accordance with the manufacturer's instruction and observe its performance.
   7. Check and record refrigerant pressure, water flow, water temperature, and power consumption of the chiller modules.
   8. Test and adjust all controls and safeties. Replace or correct all malfunctioning controls, safeties and equipment as soon as possible to avoid any delay in the use of the equipment.
   9. Prepare a written report outlining the results of tests and inspections, and submit it to the VA.

D. Engage manufacturer's certified factory trained representative to provide training for 8 hours for the VA maintenance and operational personnel to adjust, operate and maintain equipment.

END OF SECTION

SECTION 23 73 00
INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Air handling units including integral components specified herein.

B. Definitions: Air Handling Unit (AHU): A factory fabricated and tested assembly of modular sections consisting of fans, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, dehumidifying, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

1.2 RELATED WORK

A. Seismic restraints for equipment: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

B. General mechanical requirements and items, which are common to more than one section of Division 23: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

C. Sound and vibration requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

D. Piping and duct insulation: Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.

E. Piping and valves: Section 23 21 13 / 23 22 13, HYDRONIC PIPING / STEAM AND CONDENSATE HEATING PIPING.

F. Heating and cooling coils and pressure requirements: Section 23 82 16, AIR COILS.

G. Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining, and air leakage: Section 23 31 00, HVAC DUCTS and CASINGS.

H. Air filters and filters' efficiency: Section 23 40 00, HVAC AIR CLEANING DEVICES.

I. HVAC controls: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

J. Testing, adjusting and balancing of air and water flows: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

K. Types of motors: Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.

L. Types of motor starters: Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 QUALITY ASSURANCE

A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Air Handling Units Certification: Certify air-handling units in accordance with ARI 430.

C. Heating, Cooling, and Air Handling Capacity and Performance Standards: ARI 430, ARI 410, ASHRAE 51, and AMCA 210.

D. Performance Criteria:
   1. The fan schedule indicates design CFM – Design Cubic Feet per Minute – followed by L/s – Liters per Second in brackets. The Fan motor BHP (KW) at the operating point on the fan curves shall be increased by 10% (safety factor) to cover the drive losses and field conditions. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
   2. Operating Limits: AMCA 99.

E. Units shall be constructed by a manufacturer who has been manufacturing air handling units for at least five (5) years.

1.4 SUBMITTALS

A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, furnish a complete submission for all air handling units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.

B. Manufacturer's Literature and Data:
   1. Submittals for AHUs shall include fans, drives, motors, coils, isolation smoke dampers, filter housings, and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc).
   2. Submittal drawings of section or component only will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
   3. Submit sound power levels in each octave band for fan and at entrance and discharge of AHUs at scheduled conditions. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
   4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of operation and at maximum design Liters/Second (cubic feet per minute).
   5. Submit total fan static pressure, external static pressure, for AHU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.

C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter replacement, motor and drive replacement, spare part lists, and wiring diagrams.

D. Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.

E. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
   1. Units shall be shipped in one (1) piece and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
   2. Lifting lugs will be provided to facilitate rigging.

1.5 APPLICABLE PUBLICATIONS

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

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI)/(ARI):

410-01	Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
430-09	Central Station Air Handling Units

C. Air Movement and Control Association International, Inc. (AMCA):

210-07	Laboratory Methods of Testing Fans for Rating

D. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):

170-2008	Ventilation of Health Care Facilities

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

ASTM B117-07a	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D1654-08	Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
ASTM D1735-08	Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
ASTM D3359-08	Standard Test Methods for Measuring Adhesion by Tape Test

F. Military Specifications (Mil. Spec.):

MIL-P-21035B-2003	Paint, High Zinc Dust Content, Galvanizing Repair (Metric)

G. National Fire Protection Association (NFPA):

NFPA 90A	Standard for Installation of Air Conditioning and Ventilating Systems, 2009

H. Energy Policy Act of 2005 (P.L.109-58)

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS

A. Approved manufacturer: Haakon, Trane custom, York custom or equal.

B. General:

1. AHUs shall be entirely of double wall galvanized and stainless steel construction without any perforations except as specified in section 2.1.C.2. Casing is specified in paragraph 2.1.D. Foil face lining is not an acceptable substitute for double wall construction. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Casings shall be of galvanized steel on the exterior and stainless steel on the interior.

2. The contractor and the AHU manufacturer shall be responsible for insuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
3. AHUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The correct fit of all components and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled and tested.
4. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 PA (8 inch WG).

C. Base:
1. Provide a heavy duty steel base for supporting all major AHU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 100 mm (4 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability. Contractor shall provide supplemental steel supports as required to obtain proper operation heights for cooling coil condensate drain trap as shown on drawings.
2. AHUs shall be completely self supporting for installation on concrete housekeeping pads .
3. The AHU bases not constructed of galvanized steel shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.

D. Casing (including wall, floor and roof):
1. General: AHU casing shall be constructed as solid double wall, exterior galvanized steel and interior 316 stainless steel insulated panels without any perforations, integral of or attached to a structural frame. The thickness of insulation, mode of application and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU located in the non-conditioned spaces.
2. Casing Construction:

Table 2.1.C.2

Outer Panel	163 mm (16 Gage) Minimum
Inner Panel	0.8 mm (22 Gage) Minimum
Insulation Thickness Density	Fiberglass 50 mm (2 inch) Minimum 50 kg/m^3 (3.0 lb/ft^3) Minimum
Total R Value	1.4 m^2.K/W (8.0 ft^2.^{O}F.hr/Btu) Minimum

3. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.

4. Casing panels shall be secured to the support structure with stainless steel screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
5. Access Doors: Provide in each access section and where shown on drawings. Doors shall be a minimum of 50 mm (2 inch) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, coil section shall include a minimum 300 mm round (12 inch round) double thickness, with air space between the glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
   a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 lb) weight hung on latch side of door.
   b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785 radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inch WG).
   c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
6. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting shall be provided in the factory. Neatly seal all openings airtight.

E. Painted Exterior Finish: Galvanized steel (G90) exterior shall be mill prepared for painting by bonderizing and factory prepared for prime coat of paint by acid etch cleaning, as required, to assure paint adhesion. Provide factory applied prime coat and enamel finish coat of paint of color selected by owner. Paint corrosion resistance and adhesion shall have satisfactorily passed ASTM B117, D1654, D1735, D3359 and G23 for a minimum of 500 hours. Rating of failure at the scribe mark shall not be less than 6, average creepage not greater than 3 mm (1/8 inch). Rating of the inscribed area shall not be less than 10, no failure. Refer to Section 09 91 00, PAINTING.

F. Floor:
   1. Unit floor shall be level without offset space or gap and shall be constructed of 12 Gage aluminum checker plate. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.

G. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double-wall, double sloping type, and fabricated from stainless (304) with at least 50 mm (2 inch) thick insulation sandwiched between the inner and outer surfaces. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
   1. An intermediate, stainless-steel (304) condensate drip pan with copper downspouts shall be provided on stacked cooling coils. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
   2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
   3. Installation, including frame, shall be designed and sealed to prevent blow-by.

H. FAN ASSEMBLY
   1. Fans - general:
      a. Performance ratings: rated in accordance with laboratory tests conducted in accordance with AMCA Standard 210.
      b. Ratings: As indicated.
      c. Arrangement: As indicated
      d. Drive sheaves: Cast iron with split taper bushings dynamically balanced at factory.
         a) Provide wide range variable speed, adjustable sheaves to be used for balancing systems.
      e. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
   2. Fan Assembly Constrcution:
      a. General:
         1) The Fan Assembly, shall consist of:
            a) Multiple direct driven, plenum fans constructed per AMCA requirements for duty specified, (Class I, II, or III).
         2) All fans shall be selected to deliver design air flow at the specified operating TSP (Total Static Pressure) at the specified motor speed as scheduled.
         3) The fan assembly shall be selected to operate at a system TSP that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan speed.
      b. Performance:
         1) The fan assembly shall produce a uniform air flow profile and velocity not to exceed the specified cooling coil and filter bank face velocity when measured at a point 305 mm 12 IN from the intake side of the fan section wall.
         2) Fan shall be structurally designed to withstand the maximum motor RPM at 60 hertz.
         3) Each fan shall be individually wired to a panel containing VFD(s) each sized for the HP of each individual fan motor contained in the unit.
      c. Fan/motor cartridge:
         1) Each fan/motor cartridge shall consist of:
            a) Steel intake wall: 11 gauge A60 galvanized steel.
            b) Inlet funnel: 14 gauge spun steel.
            c) Motor support plate and structure: 11 gauge A60 galvanized steel.

d) All components to be powder coated epoxy for enhanced corrosion resistance.
e) Motors: See section 20 05 00.
(a) Shall be selected by the manufacturer and suitable for the application.
f) Each fan/motor cartridge shall be removable through a 24 IN wide, free area, access door located on the discharge side of the fan section of the unit.

d. Balancing:
1) Each fan assembly shall be dynamically balanced to meet the following requirements of AMCA standard 204:
a) Category: BV-5.
b) Grade: G 1.0.
c) Residual unbalance: equal to or less than .0028 oz-in/lb of rotor mass.
d) Individual spring isolators shall be provided for each fan.

e. Drives and wiring:
1) Each fan motor shall be individually wired to a panel containing a VFD for each fan AFD (Refer to 26 29 11 for AFD requirements.), sized for each motor in the Fan Assembly.
2) Wiring sizing shall be determined in accordance with NEC standards.

f. Safety screens at fan discharge: Provide on all fanwall array discharge modules.

g. Fan blank off panels: Provide for each fan assembly to provide temporary closure of a failed fan unit.

I. Fan Motor, Drive and Mounting Assembly:
1. Provide internally vibration isolated fan, motor and drive, mounted on a bolted or welded structural steel base. Provide spring vibration isolators and flexible duct connections at fan discharge to completely isolate fan assembly. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, for additional requirements.

I. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including one complete set for temporary use at site shall be provided independent of the AHU. The AHU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The AHU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for AHU testing.
2. Factory-fabricated filter section shall be of the same construction and finish as the AHU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in accordance holding frame housing requirements in Section 23 40 00, HVAC AIR CLEANING DEVICES.

J. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils shall be designed and installed to insure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections. For air handling units , provide copper fins for all coils. Refer to Drawings and Section 23 82 16, AIR COILS for additional coil requirements.
1. Water Coils.

K. Smoke Dampers: Provide a smoke damper at the supply air discharge from each unit. Smoke dampers shall meet the following:
   1. UL 555S leakage class 1, suitable for temperatures to 250 deg F and a maximum pressure of 6-inch w.g.
   2. Galvanized steel hat channel frame and airfoil shape blades constructed of heavy gauge extruded aluminum.
   3. Extruded silicone rubber blade seals and flexible stainless steel jamb seals.
   4. Stainless steel bearings.
   5. Electric actuator coordinated with the building control system (DDC) requirements.

L. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
   1. Vapor-proof lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, and filter section over 300 mm (12 inch) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt - one phase connection at junction box.
   2. Install compatible 100 watt bulb in each light fixture.
   3. Provide a convenience duplex receptacle next to the light switch.
   4. Disconnect switch and power wiring: Provide factory mounted variable frequency drives and disconnect switches. Coordinate with Division 26, ELECTRICAL.
   5. All wiring shall be provided from a single point 460 volt, 3 phase connection to the unit. The manufacturer shall provide all wiring, transformers, switches, and protection. Manufacturer to provide empty conduits for field installation of controls.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air handling unit in conformance with ARI 435.

B. Assemble air handling unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air handling units clean prior to operation.

C. Install seismic restraints for roof top units. Refer to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

D. Leakage and test requirements for air handling units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class (C_L) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.

E. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

F. Seal and/or fill all openings between the casing and AHU components and utility connections to prevent air leakage or bypass.

3.2 STARTUP SERVICES

A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.

B. After the air handling unit is installed and tested, provide startup and operating instructions to VA personnel.

C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

END OF SECTION

SECTION 23 82 00
CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Fan-coil units.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.

B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.

C. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise requirements.

D. Section 23 21 13, HYDRONIC PIPING: Heating hot water and chilled water piping.

E. Section 23 31 00, HVAC DUCTS AND CASINGS: Ducts and flexible connectors.

F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.

G. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Flow rates adjusting and balancing.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

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. Fan-Coil units.

C. Certificates:
   1. Compliance with paragraph, QUALITY ASSURANCE.
   2. Compliance with specified standards.

D. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning and Refrigeration Institute (ARI):
   440-05 Room Fan Coils

C. National Fire Protection Association (NFPA):
90A-02 Standard for the Installation of Air Conditioning and Ventilating Systems
70-05 National Electrical Code

D. Underwriters Laboratories, Inc. (UL):
181-05 Standard for Factory-Made Air Ducts and Air Connectors
1995-05 Heating and Cooling Equipment

1.6 GUARANTY

A. In accordance with FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 ROOM FAN-COIL UNITS

A. Capacity Certification: ARI 440.

B. Safety Compliance: NEC compliant and UL listed.

C. Noise Levels: Operating at full cooling capacity, sound power level shall not exceed by more than 5 dB the numerical value of sound pressure levels associated with noise criteria specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR BOILER PLANT. Select units at intermediate speed, for compliance with the noise criteria.

D. Chassis: Galvanized steel, acoustically and thermally insulated to attenuate noise and prevent condensation.

E. Cabinet Type: Not lighter than 1.3 mm (l8 gage) steel, reinforced and braced. Arrange components and provide adequate space for installation of piping package and control valves. Finish shall be factory-baked enamel in manufacturer's standard colorcolor as selected by the architect.
1. Horizontal Unit:
2. Enclosed type with inlet and outlet duct collars.

F. Fans: Centrifugal, direct drive, galvanized steel or polyester resin.
1. Motors: 3-speed permanent split capacitor type with integral thermal overload protection, for operation at not more than 1500 RPM.
2. Provide a fan speed selector switch, with off, low, medium, and high positions. Switch shall have a set of auxiliary contacts which are open when the switch is in the "off" position and closed when the switch in any of the other positions. Unit shall be controlled by wall mount thermostat.

G. Cooling Coils:
1. Hydronic : Copper tubes, 10 mm (three-eighths inch) minimum inside diameter, not less than 4.3 mm (0.0l7 inch) thick with copper or aluminum fins. Coils shall be pressure tested for bursting and strength in accordance with Underwriters Laboratories, Inc., requirements for pressure tested coils, and shall be designed to provide adequate heat transfer capacity. Provide manual air vent at high point of each coil and drain at each low point.

I. Drain pans: Furnish galvanized steel with solderless drain connections and molded polystyrene foam insulating liner:

J. Air Filter: Manufacturer's standard throwaway type, not less than one inch thick, supported to be concealed from sight and be tight fitting to prevent air by-pass. Filters shall have slide out frames and be easily replaced without removing enclosure or any part thereof.

K. Control valves and thermostats are to be field installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Work shall be installed as shown and according to the manufacturer’s diagrams and recommendations.

B. Handle and install units in accordance with manufacturer's written instructions.

C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

3.2 OPERATIONAL TEST

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

END OF SECTION

SECTION 23 82 16
AIR COILS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Heating and cooling coils for air handling unit and duct applications.

1.2 RELATED WORK

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

B. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

C. Reheat coils for VAV/CV terminals: Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

1.3 QUALITY ASSURANCE

A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with ARI Standard 4l0 and shall bear the ARI certification label.

1.4 SUBMITTALS

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

B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.

C. Provide installation, operating and maintenance instructions.

D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.

E. Coils may be submitted with Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning and Refrigeration Institute (ARI):

C. Directory of Certified Applied Air Conditioning Products
ARI 4l0-02 Forced-Circulation Air-Cooling Air-Heating Coils.

D. American Society for Testing and Materials (ASTM):
B75/75M-02 Seamless Copper Tube (Metric)

E. National Fire Protection Association (NFPA):

70-05 National Electric Code

F. National Electric Manufacturers Association (NEMA):
250-03 Enclosures for Electrical Equipment (1,000 Volts Maximum)

G. Underwriters Laboratories, Inc. (UL):
1996-01 Electric Duct Heaters

PART 2 - PRODUCTS

2.1 HEATING AND COOLING COILS

A. Conform to ASTM B75 and ARI 410.

B. Tubes: Minimum 16 mm (0.625 inch) tube diameter; Seamless copper tubing.

C. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.

D. Headers: Copper, welded steel or cast iron.

E. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.

F. Coil Casing: 1.6 mm (l6 gage) galvanized steel with tube supports at 1200 mm (48 inch) maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.

G. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	
Test	2070 (300)	1725 (250)	
Working	1380 (200)	520 (75)	

H. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.

I. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.

J. Cooling Coil Condensate Drain Pan: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

2.3 REHEAT COILS, DUCT MOUNTED

A. Continuous circuit booster type for hot water as shown on drawings. Material of coils same as noted in Articles 2.1 thru 2.3.

2.4 WATER COILS

A. Drainable Type (Self-Draining, Self-Venting); manufacturer standard:
1. Cooling, all types.
2. Heating or preheat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.

B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

END OF SECTION

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 wiring, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, generators, automatic transfer switches, and other items and arrangements for the specified items are shown on drawings.

C. Electrical service entrance equipment and arrangements for temporary and permanent connections to the utility's system shall conform to the utility's requirements. Coordinate fuses, circuit breakers and relays with the utility's system, and obtain utility approval for sizes and settings of these devices.

D. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:
   1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product which:
   a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
   b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
   c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:
   1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
   2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

A. Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:
   1. Components of an assembled unit need not be products of the same manufacturer.
   2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
   3. Components shall be compatible with each other and with the total assembly for the intended service.
   4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:
   1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.

2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.7 EQUIPMENT REQUIREMENTS

A. Where variations from the contract requirements are requested in accordance with Section 01 00 00, GENERAL REQUIREMENTS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
   1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
   2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
   3. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
   4. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
   5. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.9 WORK PERFORMANCE

A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by contract.

B. Job site safety and worker safety is the responsibility of the contractor.

C. Electrical work shall be accomplished with all affected circuits or equipment de-energized. When an electrical outage cannot be accomplished in this manner for the required work, the following requirements are mandatory:
   1. Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
   2. Electricians must wear personal protective equipment while working on energized systems in accordance with NFPA 70E.
   3. Before initiating any work, a job specific work plan must be developed by the contractor with a peer review conducted and documented by the Resident Engineer and Medical Center staff. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, safety equipment to be used and exit pathways.
   4. Work on energized circuits or equipment cannot begin until prior written approval is obtained from the Resident Engineer.

D. For work on existing stations, arrange, phase and perform work to assure electrical service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

E. New work shall be installed and connected to existing work neatly, safely and professionally. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

F. Coordinate location of equipment and conduit with other trades to minimize interferences.

1.10 EQUIPMENT INSTALLATION AND REQUIREMENTS

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

B. Working spaces shall not be less than specified in the NEC for all voltages specified.

C. Inaccessible Equipment:
   1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
   2. "Conveniently accessible" is defined as being capable of being reached quickly for operation, maintenance, or inspections without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.11 EQUIPMENT IDENTIFICATION

A. In addition to the requirements of the NEC, install an identification sign which clearly indicates information required for use and maintenance of items such as switchboards and switchgear, panelboards, cabinets, motor controllers (starters), fused and unfused safety switches, automatic transfer switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards, switchgear and motor control assemblies, control devices and other significant equipment.

B. Nameplates for Normal Power System equipment shall be laminated black phenolic resin with a white core with engraved lettering. Nameplates for Essential Electrical System (EES) equipment, as defined in the NEC, shall be laminated red phenolic resin with a white core with engraved lettering. Lettering shall be a minimum of 1/2 inch [12mm] high. Nameplates shall indicate equipment designation, rated bus amperage, voltage, number of phases, number of wires, and type of EES power branch as applicable. Secure nameplates with screws.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm^2), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

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

B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
   2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
   3. Submit each section separately.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
      Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed. Include sufficient fabrication information so that appropriate mounting and securing provisions may be designed and/or attached to the equipment.
   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 those replacement parts recommended by the equipment manufacturer.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
   1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
   2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
   3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
   4. The manuals shall include:
      a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
      b. A control sequence describing start-up, operation, and shutdown.
      c. Description of the function of each principal item of equipment.
      d. Installation instructions.
      e. Safety precautions for operation and maintenance.
      f. Diagrams and illustrations.
      g. Periodic maintenance and testing procedures and frequencies, including replacement parts numbers and replacement frequencies.

h. Performance data.
i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
j. List of factory approved or qualified permanent servicing organizations for equipment repair and periodic testing and maintenance, including addresses and factory certification qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
2. Each type of conduit coupling, bushing and termination fitting.
3. Conduit hangers, clamps and supports.
4. Duct sealing compound.
5. Each type of receptacle, toggle switch, occupancy sensor, outlet box, manual motor starter, device wall plate, engraved nameplate, wire and cable splicing and terminating material, and branch circuit single pole molded case circuit breaker.

1.13 SINGULAR NUMBER

A. Where any device or part of equipment is referred to in these specifications in the singular number (e.g., "the switch"), this reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

1.14 ACCEPTANCE CHECKS AND TESTS

A. The contractor shall furnish the instruments, materials and labor for field tests.

1.15 TRAINING

A. Training shall be provided in accordance with Article 1.25, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

B. Training shall be provided for the particular equipment or system as required in each associated specification.

C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

END OF SECTION

SECTION 26 05 21

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

1.2 RELATED WORK

A. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire-rated construction.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section.

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 cables and wiring.

E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Installation of low-voltage conductors and cables in manholes and ducts.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
   1. Manufacturer's Literature and Data: Showing each cable type and rating.
   2. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
      a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
      b. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.

B. American Society of Testing Material (ASTM):

D2301-04.....Standard Specification for Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape

C. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

D. National Electrical Manufacturers Association (NEMA):

WC 70-09.....Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy

E. Underwriters Laboratories, Inc. (UL):

44-05.....Thermoset-Insulated Wires and Cables

83-08.....Thermoplastic-Insulated Wires and Cables

467-071.....Electrical Grounding and Bonding Equipment

486A-486B-03.....Wire Connectors

486C-04.....Splicing Wire Connectors

486D-05.....Sealed Wire Connector Systems

486E-94.....Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors

493-07.....Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable

514B-04.....Conduit, Tubing, and Cable Fittings

1479-03.....Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.

B. Single Conductor:
   1. Shall be annealed copper.
   2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
   3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.

C. Insulation:
   1. XHHW-2 or THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.

D. Color Code:
   1. Secondary service feeder and branch circuit conductors shall be color-coded as follows:

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

      a. Lighting circuit “switch legs” and 3-way switch “traveling wires” shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC. Coordinate color coding in the field with the COTR.
   2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
   3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
      a. Solid color insulation or solid color coating.
      b. Stripes, bands, or hash marks of color specified above.
      c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
   4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

2.2 SPLICES AND JOINTS

A. In accordance with UL 486A, C, D, E, and NEC.

B. Aboveground Circuits (No. 10 AWG and smaller):
   1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220˚ F [105˚ C], with integral insulation, approved for copper and aluminum conductors.
   2. The integral insulator shall have a skirt to completely cover the stripped wires.
   3. The number, size, and combination of conductors, as listed on the manufacturer's packaging, shall be strictly followed.

C. Aboveground Circuits (No. 8 AWG and larger):
   1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material, listed for use with copper and aluminum conductors.
   2. Field-installed compression connectors for cable sizes 250 kcmil and larger shall have not fewer than two clamping elements or compression indents per wire.
   3. Insulate splices and joints with materials approved for the particular use, location, voltage, and temperature. Splice and joint insulation level shall be not less than the insulation level of the conductors being joined.

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

D. Underground Branch Circuits and Feeders:
   1. Submersible connectors in accordance with UL 486D, rated 600 V, 190˚ F [90˚ C], with integral insulation.

2.3 CONTROL WIRING

A. Unless otherwise specified elsewhere in these specifications, control wiring shall be as specified for power and lighting wiring, except that the minimum size shall be not less than No. 14 AWG.

B. Control wiring shall be large enough such that the voltage drop under in-rush conditions does not adversely affect operation of the controls.

2.4 WIRE LUBRICATING COMPOUND

A. Lubricating compound shall be suitable for the wire insulation and conduit, and shall not harden or become adhesive.

PART 3 - EXECUTION

3.1 GENERAL

A. Install in accordance with the NEC, and as specified.

B. Install all wiring in raceway systems.

C. Splice cables and wires only in outlet boxes, junction boxes, pull-boxes, manholes, or handholes.

D. Wires of different systems (e.g., 120 V, 277 V) shall not be installed in the same conduit or junction box system.

E. Install cable supports for all vertical feeders in accordance with the NEC. Provide split wedge type which firmly clamps each individual cable and tightens due to cable weight.

F. For panel boards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.

G. Seal cable and wire entering a building from underground between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

H. Wire Pulling:
   1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables. Use lubricants approved for the cable.
   2. Use nonmetallic ropes for pulling feeders.
   3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the COTR.
   4. All cables in a single conduit shall be pulled simultaneously.
   5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

I. No more than three single-phase branch circuits shall be installed in any one conduit.

3.2 INSTALLATION IN MANHOLES

A. Install and support cables in manholes on the steel racks with porcelain or equivalent insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 SPLICE INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure.

B. Tighten electrical connectors and terminals according to manufacturer's published torque values.

C. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.4 3.4 FEEDER IDENTIFICATION

A. A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

B. B. In each manhole and handhole, provide tags of the embossed brass type, showing the circuit identification and voltage. The tags shall be the embossed brass type, 1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

3.5 EXISTING WIRING

A. Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

3.6 CONTROL AND SIGNAL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.

B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

3.7 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION

A. Install a permanent wire marker on each wire at each termination.

B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

C. Wire markers shall retain their markings after cleaning.

D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.8 DIRECT BURIAL CABLE INSTALLATION

A. Tops of the cables:
   1. Below the finished grade: Minimum 24 in [600 mm] unless greater depth is shown.

2. Below road and other pavement surfaces: In conduit as specified, minimum 30 in [750 mm] unless greater depth is shown.
3. Do not install cables under railroad tracks.

B. Under road and paved surfaces: Install cables in concrete-encased galvanized steel rigid conduits. Size as shown on plans, but not less than 2 in [50 mm] trade size with bushings at each end of each conduit run. Provide size/quantity of conduits required to accommodate cables plus one spare.

C. Work with extreme care near existing ducts, conduits, cables, and other utilities to prevent any damage.

D. Cut the trenches neatly and uniformly:
1. Excavating and backfilling is specified in Section 31 20 00, EARTH MOVING.
2. Place a 3 in [75 mm] layer of sand in the trenches before installing the cables.
3. Place a 3 in [75 mm] layer of sand over the installed cables.
4. Install continuous horizontal, 1 in x 8 in [25 mm x 200 mm] preservative impregnated wood planking 3 in [75 mm] above the cables before backfilling.

E. Provide horizontal slack in the cables for contraction during cold weather.

F. Install the cables in continuous lengths. Splices within cable runs shall not be accepted.

G. Connections and terminations shall be listed submersible-type designed for the cables being installed.

H. Warning tape shall be continuously placed 12 in [300 mm] above the buried cables.

3.9 ACCEPTANCE CHECKS AND TESTS

A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be reused shall also be tested.

B. Applied voltage shall be 500VDC for 300-volt rated cable, and 1000VDC for 600-volt rated cable. Apply test for one minute or until reading is constant for 15 seconds, whichever is longer. Minimum insulation resistance values shall not be less than 25 megohms for 300-volt rated cable and 100 megohms for 600-volt rated cable.

C. Perform phase rotation test on all three-phase circuits.

D. The contractor shall furnish the instruments, materials, and labor for all tests.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the general grounding and bonding requirements for electrical equipment and operations to provide a low impedance path for possible ground fault currents.

B. "Grounding electrode system" refers to all electrodes required by NEC, as well as made, supplementary, and lightning protection system grounding electrodes.

C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.

C. Section 26 22 00, LOW-VOLTAGE TRANSFORMERS: Low voltage transformers.

D. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Low voltage distribution switchboards.

E. Section 26 24 16, PANELBOARDS: Low voltage panelboards.

F. Section 26 24 19, MOTOR CONTROL CENTERS: Low voltage motor control centers.

G. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Clearly present enough information to determine compliance with drawings and specifications.
   2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COTR:
   1. Certification that the materials and installation are in accordance with the drawings and specifications.

2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

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

B1-07	Standard Specification for Hard-Drawn Copper Wire
B3-07	Standard Specification for Soft or Annealed Copper Wire
B8-04	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
C2-07	National Electrical Safety Code

D. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)
99-2005	Health Care Facilities

E. Underwriters Laboratories, Inc. (UL):

44-05	Thermoset-Insulated Wires and Cables
83-08	Thermoplastic-Insulated Wires and Cables
467-07	Grounding and Bonding Equipment
486A-486B-03	Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 44 or UL 83 insulated stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG [25 mm²] and larger shall be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 10 AWG [6 mm²] and smaller shall be ASTM B1 solid bare copper wire.

C. Conductor sizes shall not be less than shown on the drawings, or not less than required by the NEC, whichever is greater.

2.2 GROUND RODS

A. Steel or copper clad steel, 0.75 in [19 mm] diameter by 10 ft [30 M] long, conforming to UL 467.

B. Quantity of rods shall be as required to obtain the specified ground resistance, as shown on the drawings.

2.3 CONCRETE ENCASED ELECTRODE

A. Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
   1. Bonding Jumpers: Compression-type connectors, using zinc-plated fasteners and external tooth lockwashers.
   2. Connection to Building Steel: Exothermic-welded type connectors.
   3. Ground Busbars: Two-hole compression type lugs, using tin-plated copper or copper alloy bolts and nuts.
   4. Rack and Cabinet Ground Bars: One-hole compression-type lugs, using zinc-plated or copper alloy fasteners.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 0.375 in [4 mm] thick x 0.75 in [19 mm] wide.

2.6 GROUND TERMINAL BLOCKS

A. At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.7 GROUNDING BUS

A. Pre-drilled rectangular copper bar with stand-off insulators, minimum 0.25 in [6.3 mm] thick x 4 in [100 mm] high in cross-section, length as shown on drawings, with 0.281 in [7.1 mm] holes spaced 1.125 in [28 mm] apart.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as specified herein.

B. System Grounding:
   1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
   2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.

C. Equipment Grounding: Metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits, shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are normally buried or otherwise inaccessible (except connections for which access for periodic testing is required), by exothermic weld.

3.3 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

B. Metallic Piping, Building Steel, and Supplemental Electrode(s):

1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
2. Provide a supplemental ground electrode and bond to the grounding electrode system.

C. Switchgear, Switchboards, Unit Substations, Panelboards, Motor Control Centers and Panelboards, Engine-Generators, and Automatic Transfer Switches:
1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
2. For service entrance equipment, connect the grounding electrode conductor to the ground bus.
3. Provide ground bars, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
4. Connect metallic conduits that terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

D. Transformers:
1. Exterior: Exterior transformers supplying interior service equipment shall have the neutral grounded at the transformer secondary. Provide a grounding electrode at the transformer.
2. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from the transformer to // the nearest component of the grounding electrode system // // the ground bar at the service equipment //.

3.4 RACEWAY

A. Conduit Systems:
1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
3. Conduit that only contains a grounding conductor, and is provided for its mechanical protection, shall be bonded to that conductor at the entrance and exit from the conduit.
4. Metallic conduits which terminate without mechanical connection to an electrical equipment housing by means of locknut and bushings or adapters, shall be provided with grounding bushings. Connect bushings with a bare grounding conductor to the equipment ground bus.

B. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

C. Boxes, Cabinets, Enclosures, and Panelboards:
1. Bond the equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (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. 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.

E. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

F. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.5 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.6 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping at the outlets directly to the room or patient ground bus.

3.7 ELECTRICAL ROOM GROUNDING

A. Building Earth Ground Busbars: Provide ground busbar and mounting hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

3.8 EXTERIOR LIGHT POLES

A. Provide 20 ft [6.1 M] of No. 4 bare copper coiled at bottom of pole base excavation prior to pour, plus additional unspliced length in and above foundation as required to reach pole ground stud.

3.9 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make any modifications or additions to the grounding electrode system necessary for compliance without additional cost to the Government. Final tests shall ensure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not fewer than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

D. Below-grade connections shall be visually inspected by the COTR prior to backfilling. The contractor shall notify the COTR 24 hours before the connections are ready for inspection.

3.10 GROUND ROD INSTALLATION

A. For outdoor installations, drive each rod vertically in the earth, until top of rod is 24 in [609 mm] below final grade.

B. For indoor installations, leave 4 in [100 mm] of rod exposed.

C. Where permanently concealed ground connections are required, make the connections by the exothermic process, to form solid metal joints. Make accessible ground connections with mechanical pressure-type ground connectors.

D. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

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 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.

B. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.

C. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.

D. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.

E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

F. 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.

G. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Underground conduits.

H. Section 31 20 00, EARTH MOVING: Bedding of conduits.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Manufacturer's Literature and Data: Showing each cable type and rating. The specific item proposed and its area of application shall be identified on the catalog cuts.

C. Shop Drawings:
   1. Size and location of main feeders.
   2. Size and location of panels and pull-boxes.
   3. Layout of required conduit penetrations through structural elements.

D. Certifications:
   1. Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
      a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
      b. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American National Standards Institute (ANSI):

C80.1-05	Electrical Rigid Steel Conduit
C80.3-05	Steel Electrical Metal Tubing
C80.6-05	Electrical Intermediate Metal Conduit

C. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

1-05	Flexible Metal Conduit
5-04	Surface Metal Raceway and Fittings
6-07	Electrical Rigid Metal Conduit - Steel
50-95	Enclosures for Electrical Equipment
360-093	Liquid-Tight Flexible Steel Conduit
467-07	Grounding and Bonding Equipment
514A-04	Metallic Outlet Boxes
514B-04	Conduit, Tubing, and Cable Fittings
514C-96	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-05	Schedule 40 and 80 Rigid PVC Conduit and Fittings
651A-00	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-07	Electrical Metallic Tubing
1242-06	Electrical Intermediate Metal Conduit - Steel

E. National Electrical Manufacturers Association (NEMA):

TC-2-03	Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
TC-3-04	PVC Fittings for Use with Rigid PVC Conduit and Tubing
FB1-07	Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 0.5 in [13 mm] unless otherwise shown. Where permitted by the NEC, 0.5 in [13 mm] flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:
   1. Rigid steel: Shall conform to UL 6 and ANSI C80.1.
   2. Rigid intermediate steel conduit (IMC): Shall conform to UL 1242 and ANSI C80.6.

3. Electrical metallic tubing (EMT): Shall conform to UL 797 and ANSI C80.3. Maximum size not to exceed 4 in [105 mm] and shall be permitted only with cable rated 600 V or less.
4. Flexible galvanized steel conduit: Shall conform to UL 1.
5. Liquid-tight flexible metal conduit: Shall conform to UL 360.
6. Direct burial plastic conduit: Shall conform to UL 651 and UL 651A, heavy wall PVC or high density polyethylene (PE).
7. Surface metal raceway: Shall conform to UL 5.

C. Conduit Fittings:
1. Rigid steel and IMC conduit fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Standard threaded couplings, locknuts, bushings, conduit bodies, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
   c. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
   d. Bushings: Metallic insulating type, consisting of an insulating insert, molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
   e. Erickson (union-type) and set screw type couplings: Approved for use in concrete are permitted for use to complete a conduit run where conduit is installed in concrete. Use set screws of case-hardened steel with hex head and cup point to firmly seat in conduit wall for positive ground. Tightening of set screws with pliers is prohibited.
   f. Sealing fittings: Threaded cast iron type. Use continuous drain-type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates having the same finishes as that of other electrical plates in the room.
2. Electrical metallic tubing fittings:
   a. Fittings and conduit bodies shall meet the requirements of UL 514B, ANSI C80.3, and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Compression couplings and connectors: Concrete-tight and rain-tight, with connectors having insulated throats.
   d. Indent-type connectors or couplings are prohibited.
   e. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
3. Flexible steel conduit fittings:
   a. Conform to UL 514B. Only steel or malleable iron materials are acceptable.
   b. Clamp-type, with insulated throat.
4. Liquid-tight flexible metal conduit fittings:
   a. Fittings shall meet the requirements of UL 514B and NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
5. Direct burial plastic conduit fittings:
   a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
6. 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.
7. Expansion and deflection couplings:
   a. Conform to UL 467 and UL 514B.

b. Accommodate a 0.75 in [19 mm] deflection, expansion, or contraction in any direction, and allow 30 degree angular deflections.
c. Include internal flexible metal braid, sized to guarantee conduit ground continuity and a low-impedance path for fault currents, in accordance with UL 467 and the NEC tables for equipment grounding conductors.
d. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat-resistant molded rubber material with stainless steel jacket clamps.

D. Conduit Supports:
1. Parts and hardware: Zinc-coat or provide equivalent corrosion protection.
2. Individual Conduit Hangers: Designed for the purpose, having a pre-assembled closure bolt and nut, and provisions for receiving a hanger rod.
3. Multiple conduit (trapeze) hangers: Not less than 1.5 x 1.5 in [38 mm x 38 mm], 12-gauge steel, cold-formed, lipped channels; with not less than 0.375 in [9 mm] diameter steel hanger rods.
4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.

E. Outlet, Junction, and Pull Boxes:
1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush-mounted wall or ceiling boxes shall be installed with raised covers so that the front face of raised cover is flush with the wall. Surface-mounted wall or ceiling boxes shall be installed with surface-style flat or raised covers.

F. Wireways: Equip with hinged covers, except where removable covers are shown. 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 COTR prior to drilling through structural elements.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammers, impact electric, hand, or manual hammer-type drills are not allowed, except where permitted by the COTR as required by limited working space.

B. Firestop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight, as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. In accordance with UL, NEC, as shown, and as specified herein.

B. Essential (Emergency) raceway systems shall be entirely independent of other raceway systems, except where shown on drawings.

C. Install conduit as follows:
   1. In complete mechanically and electrically continuous runs before pulling in cables or wires.
   2. Unless otherwise indicated on the drawings or specified herein, installation of all conduits shall be concealed within finished walls, floors, and ceilings.
   3. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
   4. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
   5. Cut square, ream, remove burrs, and draw up tight.
   6. Independently support conduit at 8 ft [2.4 M] on centers. Do not use other supports, i.e., suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts.
   7. Support within 12 in [300 mm] of changes of direction, and within 12 in [300 mm] of each enclosure to which connected.
   8. Close ends of empty conduit with plugs or caps at the rough-in stage until wires are pulled in, to prevent entry of debris.
   9. Conduit installations under fume and vent hoods are prohibited.
   10. Secure conduits to cabinets, junction boxes, pull-boxes, and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
   11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
   12. Conduit bodies shall only be used for changes in direction, and shall not contain splices.

D. Conduit Bends:
   1. Make bends with standard conduit bending machines.
   2. Conduit hickey may be used for slight offsets and for straightening stubbed out conduits.
   3. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:
   1. Install conduit with wiring, including homeruns, as shown on drawings.
   2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COTR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
   1. Conduit: Rigid steel, IMC, or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
   2. Align and run conduit in direct lines.
   3. Install conduit through concrete beams only:
      a. Where shown on the structural drawings.
      b. As approved by the COTR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
   4. Installation of conduit in concrete that is less than 3 in [75 mm] thick is prohibited.
      a. Conduit outside diameter larger than one-third of the slab thickness is prohibited.
      b. Space between conduits in slabs: Approximately six conduit diameters apart, and one conduit diameter at conduit crossings.
      c. Install conduits approximately in the center of the slab so that there will be a minimum of 0.75 in [19 mm] of concrete around the conduits.
   5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to ensure low resistance ground continuity through the conduits. Tightening setscrews with pliers is prohibited.

B. Above Furred or Suspended Ceilings and in Walls:
   1. Conduit for conductors 600 V and below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the same system is prohibited.
   2. Align and run conduit parallel or perpendicular to the building lines.
   3. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
   4. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT. Mixing different types of conduits indiscriminately in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.

F. Surface metal raceways: Use only where shown.

G. Painting:
   1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.

3.5 DIRECT BURIAL INSTALLATION

A. Refer to Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

3.6 WET OR DAMP LOCATIONS

A. Unless otherwise shown, use conduits of rigid steel or IMC.

B. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant-temperature rooms, air-conditioned spaces, building exterior walls, roofs, or similar spaces.

C. Unless otherwise shown, use rigid steel or IMC conduit within 5 ft [1.5 M] of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall be half-lapped with 10 mil PVC tape before installation. After installation, completely recoat or retape any damaged areas of coating.

3.7 MOTORS AND VIBRATING EQUIPMENT

A. Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission.

B. Use liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside airstream of HVAC units, and locations subject to seepage or dripping of oil, grease, or water. Provide a green equipment grounding conductor with flexible metal conduit.

3.8 EXPANSION JOINTS

A. Conduits 3 in [75 mm] and larger that are secured to the building structure on opposite sides of a building expansion joint require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 3 in [75 mm] with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5 in [125 mm] vertical drop midway between the ends. Flexible conduit shall have a bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for conduits 15 in [375 mm] and larger are acceptable.

C. Install expansion and deflection couplings where shown.

D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 15 in [375 mm] of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.9 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed one-quarter of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 lbs [90 kg]. Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:
   1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
   2. Existing Construction:
      a. Steel expansion anchors not less than 0.25 in [6 mm] bolt size and not less than 1.125 in [28 mm] embedment.
      b. Power set fasteners not less than 0.25 in [6 mm] diameter with depth of penetration not less than 3 in [75 mm].
      c. Use vibration and shock-resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for all uses except horizontal and vertical supports/fasteners within walls.

L. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.10 BOX INSTALLATION

A. Boxes for Concealed Conduits:

1. Flush-mounted.
2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

D. Outlet boxes mounted back-to-back in the same wall are prohibited. A minimum 24 in [600 mm] center-to-center lateral spacing shall be maintained between boxes.

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 in [100 mm] square x 2.125 in [55 mm] deep, with device covers for the wall material and thickness involved.

F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG-FA JB No. 1."

G. On all branch circuit junction box covers, identify the circuits with black marker.

END OF SECTION

SECTION 26 05 41
UNDERGROUND ELECTRICAL CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of precast manholes and pullboxes with ducts to form a complete underground raceway system.

B. "Duct" and "conduit," and "rigid metal conduit" and "rigid steel conduit" are used interchangeably in this specification.

1.2 RELATED WORK

A. Section 07 92 00, JOINT SEALANTS: Sealing of conduit penetrations.

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.

D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits, fittings and boxes for raceway systems.

E. Section 31 20 00, EARTH MOVING: Trenching, backfill and compaction.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Coordinate layout and installation of ducts, manholes, pullboxes, and pull-boxes with final arrangement of other utilities, site grading, and surface features, as determined in the field.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include manholes, pullboxes, duct materials, and hardware. Submit plan and elevation drawings, showing openings, pulling irons, cable supports, cover, ladder, sump, and other accessories and details.
   3. Proposed deviations from details on the drawings shall be clearly marked on the submittals. If it is necessary to locate manholes or pullboxes at locations other than shown on the drawings, show the proposed locations accurately on scaled site drawings, and submit four copies to the COTR for approval prior to construction.

C. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. American Concrete Institute (ACI):

C. Building Code Requirements for Structural Concrete

318/318M-05	Building Code Requirements for Structural Concrete & Commentary
SP-66-04	ACI Detailing Manual

D. American National Standards Institute (ANSI):

77-07	Underground Enclosure Integrity

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

C478-09	Standard Specification for Precast Reinforced Concrete Manhole Sections
C858-09	Underground Precast Concrete Utility Structures
C990-09	Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

F. Institute of Electrical and Electronic Engineers (IEEE):

C2-07	National Electrical Safety Code

G. National Electrical Manufacturers Association (NEMA):

TC 2-03	Electrical Polyvinyl Chloride (PVC) Tubing And Conduit
TC 3-2004	PVC Fittings for Use With Rigid PVC Conduit And Tubing
TC 6 & 8 2003	PVC Plastic Utilities Duct For Underground Installations
TC 9-2004	Fittings For PVC Plastic Utilities Duct For Underground Installation

H. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)

I. Underwriters Laboratories, Inc. (UL):

6-07	Electrical Rigid Metal Conduit-Steel
467-07	Grounding and Bonding Equipment
651-05	Schedule 40 and 80 Rigid PVC Conduit and Fittings
651A-00	Type EB and A Rigid PVC Conduit and HDPE Conduit
651B-07	Continuous Length HDPE Conduit

J. U.S. General Services Administration (GSA):

A-A-60005-1998	Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole

1.6 STORAGE

A. Lift and support pre-cast concrete structures only at designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 PULLBOXES

A. General: Size as indicated on drawings. Provide pullboxes with weatherproof, non-skid covers with recessed hook eyes, secured with corrosion- and tamper-resistant hardware. Cover material shall be identical to pullbox material. Covers shall have molded lettering, ELECTRIC or SIGNAL as applicable. Pullboxes shall comply with the requirements of ANSI/SCTE 77 Tier 5 loading. Provide pulling irons, 0.875 in [22 mm] diameter galvanized steel bar with exposed triangular-shaped opening.

B. Polymer Concrete Pullboxes: Shall be molded of sand, aggregate, and polymer resin, and reinforced with steel, fiberglass, or both. Pullbox shall have open bottom.

C. Fiberglass Pullboxes: Shall be sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

D. Concrete Pullboxes: Shall be monolithically-poured reinforced concrete.

2.2 DUCTS

A. Number and sizes shall be as shown on drawings.

B. Ducts (direct-burial):
   1. Plastic duct:
      a. NEMA TC2 and TC3
      b. Schedule 40 PVC or HDPE.
      c. Duct shall be suitable for use with 167˚ F [75˚ C] rated conductors.
   2. Rigid metal conduit: UL6 and NEMA RN1 galvanized rigid steel, threaded type, half-lapped with 10 mil PVC tape.

2.3 GROUNDING

A. Rods: Per Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

B. Ground Wire: Stranded bare copper 6 AWG [16 mm²] minimum.

2.4 WARNING TAPE

A. Standard 4-mil polyethylene 3 in [76 mm] wide detectable tape, red with black letters, imprinted with “CAUTION - BURIED ELECTRIC CABLE BELOW” or similar.

2.5 PULL ROPE FOR SPARE DUCTS

A. Plastic with 200 lb [890 N] minimum tensile strength.

PART 3 - EXECUTION

3.1 MANHOLE AND PULLBOX INSTALLATION

A. Assembly and installation shall follow the printed instructions and recommendations of the manufacturer. Install manholes and pullboxes level and plumb.
   1. Units shall be installed on a 12 in [300 mm] level bed of 90% compacted granular fill, well-graded from the 1 in [25 mm] sieve to the No. 4 sieve. Granular fill shall be compacted with a minimum of four passes with a plate compactor.
   2. Seal duct terminations so they are watertight.

B. Access: Ensure the top of frames and covers are flush with finished grade.

3.2 TRENCHING

A. Refer to Section 31 20 00, EARTH MOVING for trenching, backfilling, and compaction.

B. Before performing trenching work at existing facilities, the Ground Penetrating Radar Survey shall be carefully performed by certified technician to reveal all existing underground ducts, conduits, cables, and other utility systems.

C. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

D. Cut the trenches neatly and uniformly.

E. Conduits to be installed under existing paved areas and roads that cannot be disturbed shall be jacked into place. Conduits shall be heavy wall rigid steel.

3.3 DUCT INSTALLATION

A. General Requirements:
   1. Ducts shall be in accordance with the NEC and IEEE C2, as shown on the drawings, and as specified.
   2. Slope ducts to drain towards manholes and pullboxes, and away from building and equipment entrances. Pitch not less than 4 in [100 mm] in 100 ft [30 M].
   3. Underground conduit stub-ups and sweeps to equipment inside of buildings shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft [1.5 M] outside the building foundation. Tops of conduits below building slab shall be minimum 24 in [610 mm] below bottom of slab.
   4. Stub-ups, sweeps, and risers to equipment mounted on outdoor concrete slabs shall be taped galvanized rigid steel, and shall extend a minimum of 5 ft [1.5 M] away from the edge of slab.
   5. Install insulated grounding bushings on the terminations.
   6. Radius for turns of direction shall be sufficient to accomplish pulls without damage. Minimum radius shall be six times conduit diameter. Use manufactured long sweep bends.
   7. Additional burial depth shall be required in order to accomplish NEC-required minimum bend radius of ducts.
   8. All multiple conduit runs shall have conduit spacers. Spacers shall securely support and maintain uniform spacing of the duct assembly a minimum of 3 in [75 mm] above the bottom of the trench during the concrete pour. Spacer spacing shall not exceed 5 ft [1.5 M]. Secure spacers to ducts and earth to prevent floating during concrete pour. Provide nonferrous tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitute for spacers.
   9. Duct lines shall be installed no less than 12 in [300 mm] from other utility systems, such as water, sewer, and chilled water.
   10. Clearances between individual ducts:
      a. For like services, not less than 3 in [75 mm].
      b. For power and signal services, not less than 6 in [150 mm].
   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. Seal conduits, including spare conduits, at building entrances and at outdoor equipment terminations with a suitable compound to prevent entrance of moisture and gases.

B. Direct-Burial Duct and Conduits:
   1. Install direct-burial ducts and conduits only where shown on the drawings. Provide direct-burial ducts only for low-voltage systems.
   2. Join and terminate ducts and conduits with fittings recommended by the conduit manufacturer.
   3. Tops of ducts and conduits shall be:
      a. Not less than 24 in [600 mm] and not less than shown on the drawings, below finished grade.
      b. Not less than 30 in [750 mm] and not less than shown on the drawings, below roads and other paved surfaces.
   4. Do not kink the ducts or conduits. Compaction shall not deform the ducts.

C. Concrete-Encased and Direct-Burial Duct and Conduit Identification: Place continuous strip of warning tape approximately 12 in [300 mm] above ducts or conduits before backfilling trenches. Warning tape shall be preprinted with proper identification.

D. Spare Ducts and Conduits: 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.

E. Duct and Conduit 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. The mandrel shall be not less than 12 in [3600 mm] long, and shall have a diameter not less than 0.5 in [13 mm] 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 diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.
   2. Mandrel pulls shall be witnessed by the COTR.

F. Duct and Conduit Sealing: Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

G. Connections to Existing Manholes: For duct connections to existing manholes, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut steel and extend into the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

H. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate around the duct banks as necessary. Cut off the ducts and remove loose concrete from inside before installing new ducts. Provide a reinforced-concrete collar, poured monolithically with the new ducts, to take the shear at the joint of the duct banks.

I. Partially-Completed Duct Banks: During construction, wherever a construction joint is necessary in a duct bank, prevent debris such as mud and dirt from entering ducts by providing suitable conduit plugs. Fit concrete envelope of a partially completed duct bank with reinforcing steel extending a minimum of 2 ft [0.6 M] back into the envelope and a minimum of 2 ft [0.6 M] beyond the end of the envelope. Provide one No. 4 bar in each corner, 3 in [75 mm] from the edge of the envelope. Secure corner bars with two No. 3 ties, spaced approximately 12 in [300 mm] apart. Restrain reinforcing assembly from moving during pouring of concrete.

END OF SECTION

SECTION 26 05 71
ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the requirements of the Electrical System Protective Device Study (herein, “the study”).

B. A short-circuit and selective coordination study shall be prepared for the electrical overcurrent devices to be installed under this project.

C. The study shall present an organized time-current analysis of each protective device in series from the individual device back to the Main Distribution Switchboard for Normal and Emergency power systems The study shall reflect the operation of each device during normal and abnormal current conditions.

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 23 00, LOW-VOLTAGE SWITCHGEAR: Low voltage switchgear.

C. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: Low-voltage distribution switchboards.

D. Section 26 24 16, PANEL BOARDS: Low-voltage panelboards.

E. Section 26 24 19, MOTOR CONTROL CENTERS: Low-voltage motor control centers.

F. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Automatic transfer switches.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. The protective device study shall be prepared by the equipment manufacturer's qualified engineers or an approved consultant. The contractor is responsible for providing all pertinent information required by the preparers to complete the study.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Product data on the software program to be used for the study. Software shall be in mainstream use in the industry, shall provide device settings and ratings, and shall show selective coordination by time-current drawings.

C. Complete short-circuit and coordination study as described in paragraph 1.6.

D. Protective equipment shop drawings shall be submitted simultaneously with or after the protective device study. Protective equipment shop drawings will not be accepted prior to protective device study.

E. Certification: Two weeks prior to final inspection, submit four copies of the following to the COTR.

F. Certification by the contractor that the protective devices have been adjusted and set in accordance with the approved protective device 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):

242-01	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
399-97	Recommended Practice for Power Systems Analysis
1584a-04	Guide for Performing Arc-Flash Hazard Calculations

1.6 REQUIREMENTS

A. The complete study shall include a system one line diagram, short-circuit and ground fault analysis, and protective coordination plots for all overcurrent protective devices.

B. One Line Diagram:
   1. On the one line diagram, show all electrical equipment and wiring to be protected by the overcurrent devices installed under this project.
   2. On the one line diagram, also show the following specific information:
      a. Calculated fault impedance, X/R ratios, and short-circuit values at each feeder and branch circuit bus.
      b. Breaker and fuse ratings.
      c. Voltage at each bus.
      d. Identification of each bus, matching the identification on the construction drawings.
      e. Conduit, cable, and busway material and sizes, length, and X/R ratios.

C. Short-Circuit Study:
   1. Systematically calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices.
   2. The study shall be calculated by means of a computer program. Pertinent data and the rationale employed in developing the calculations shall be incorporated in the introductory remarks of the study.
   3. Present the data conclusions of the short-circuit study in a table format. Include the following:
      a. Device identification.
      b. Operating voltage.
      c. Protective device.
      d. Device rating.
      e. Calculated short-circuit current.

D. Coordination Curves:
   1. Prepare the coordination curves to determine the required settings of protective devices to ensure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that all upstream devices are clearly depicted on one sheet.
   2. The following specific information shall also be shown on the coordination curves:

a. Device identification.
b. Voltage and current ratio for curves.
c. 3-phase and 1-phase ANSI damage points for each transformer.
d. No-damage, melting, and clearing curves for fuses.
e. Cable damage curves.
f. Transformer in-rush points.
g. Maximum short-circuit cutoff point.

3. Develop a table to summarize the settings selected for the protective devices. Include the following in the table:
   a. Device identification.
   b. Relay CT ratios, tap, time dial, and instantaneous pickup.
   c. Circuit breaker sensor rating, long-time, short-time, and instantaneous settings, and time bands.
   d. Fuse rating and type.
   e. Ground fault pickup and time delay.

1.7 ANALYSIS

A. Analyze the short-circuit calculations, and highlight any equipment determined to be underrated as specified. Propose approaches to effectively protect the underrated equipment. Provide minor modifications to conform with the study (examples of minor modifications are trip sizes within the same frame, the time-current curve characteristics of induction relays, CT ranges, etc.).

B. After developing the coordination curves, highlight areas lacking coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

1.8 ADJUSTMENTS, SETTINGS AND MODIFICATIONS

A. Necessary final field adjustments, settings, and minor modifications shall be made to conform with the study without additional cost to the Government.

B. All final circuit breaker and relay settings and fuse sizes shall be made in accordance with the recommendations of the study.

END OF SECTION

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 26.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the electrical systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Electrical systems will be commissioned:
   1. Utility Service Entrance Switchgear (Fuses and circuit breaker settings, metering, mimic diagram, gages, and controls).
   2. Standby Generator Systems (Automatic transfer switches).
   3. Automatic Transfer Switches (Test with associated generator).

4. Normal Power Distribution Systems (Grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
5. Life Safety Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
6. Essential Equipment Power Distribution Systems (Automatic transfer on loss of normal power, grounding tests, coordination study review, major circuit breaker settings, meters and gages, and controls).
7. Lighting Controls (Control system hardware and software, scene settings, zone settings, occupancy sensor interface, and unoccupied cycle control).
8. Uninterruptible Power Supply Systems and UPS Power Distribution Systems (Battery chargers, static and dynamic power generators – i.e. inverters, MG sets, metering and controls, system power displays, and distribution panel circuit breakers).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Resident Engineer prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 26 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 TRAINING OF VA PERSONNEL

A. Training of the VA's 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. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 26 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation and connection of the lighting controls.

1.2 RELATED WORK

A. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Interface of lighting controls with HVAC control systems.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

E. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Product Data: For each type of lighting control, submit the following information.
   1. Manufacturer's catalog data.
   2. Wiring schematic and connection diagram.
   3. Installation details.

C. Manuals:
   1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
   2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.

D. Certifications:
   1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
      a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Green Seal (GS):

GC-12	Occupancy Sensors

C. Illuminating Engineering Society of North America (IESNA):

IESNA LM-48	Guide for Calibration of Photoelectric Control Devices

D. National Electrical Manufacturer's Association (NEMA)

C136.10	American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
ICS-1	Standard for Industrial Control and Systems General Requirements
ICS-2	Standard for Industrial Control and Systems: Controllers, Contractors, and Overload Relays Rated Not More than 2000 Volts AC or 750 Volts DC: Part 8 - Disconnect Devices for Use in Industrial Control Equipment
ICS-6	Standard for Industrial Controls and Systems Enclosures

E. Underwriters Laboratories, Inc. (UL):

20	Standard for General-Use Snap Switches
773	Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
773A	Nonindustrial Photoelectric Switches for Lighting Control
98	Enclosed and Dead-Front Switches
917	Clock Operated Switches

PART 2 - PRODUCTS

2.1 TIMER SWITCHES

A. Digital switches with backlit LCD display, 120/277 volt rated, fitting as a replacement for standard wall switches.
   1. Compatibility: Compatible with all ballasts.
   2. Warning: Audible warning to sound during the last minute of “on” operation.
   3. Time-out: Adjustable from 5 minutes to 12 hours.
   4. Faceplate: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

2.2 SMARTWIRED DATALINE SWITCHES

A. Description
   1. To allow individual overrides, dataline switches shall be terminated to each panel’s 4-wire Local Dataline. Switches shall be available in single, dual, quad, or octal (1-button, 2-button, 4-button, or 8-button) designs. The single, dual, and quad devices shall mount in a standard single gang box: the octal version in a two-gang box.
   2. Each button in a switch module can be individually programmed. Programming is done by smartwiring rather than with a handheld keypad or computer. Each button can control any one of the following options:

a. Any individual relay in any single panel.
b. Any group of relays in any single panel.
c. Any of the eight channels (A-H) in a single panel.
d. The same channel letter (A-H) in multiple panels in the system (requires Network Clock or BMS Interface Module).

3. For applications that require pattern switching, any button can perform its function using a ON/OFF/Not Controlled pattern of relays instead of the normal All ON/ALL OFF.

B. Features
1. Switches shall be constructed of non-breakable Lexan on all exposed parts and shall include a matching screwless Lexan wallplate.
2. Individual buttons shall have a removable clear cover to allow standard 9 mm (3/8 inch) labeling tape to be used to identify the controlled loads. The contractor shall label all switches per the direction of the Architect.
3. Each switch module shall use a bi-color LED pilot light for the individual buttons to indicate status of the controlled relay or group of relays. LED indications are Red for All ON, Green for Mixed State (some relays in the group ON and others OFF), and No LED for All OFF.
4. Switch LED pilot lights shall flash green to indicate impending off sweep during the five-minute grace period following blink warning of the lights. Once the button is pressed, the LED will change to Red to acknowledge the occupant's override command to keep lights ON.
5. Multiple dataline switches smartwired to control the same relay or relay group shall indicate the same status automatically.
6. Each switch unit shall also include a locator light.
7. The dual, quad, and octal switches shall all include a single master button that will override all relays controlled by the individual buttons OFF, or Restore them to their original state. Each switch's master button configuration can be altered to perform a Master On/Off, OFF Only, or Disabled function if desired.
8. Switch modules can be configured to follow a "Cleaning" scenario. This specific scenario shall prevent the cleaners from overriding OFF any relays turned ON by the occupant.
9. Each switch module is available in a Keylock Override version. Once a key is inserted, the individual buttons will function for five minutes.

C. Dataline Switches: Wattstopper Cat. No.'s HDLS1SS, HDLS2SS, HDLS4SS, HDLS8SS, or approved equal.

2.3 INDOOR OCCUPANCY SENSORS

A. Wall- or ceiling-mounting, solid-state units with a power supply and relay unit, suitable for the environmental conditions in which installed.
1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a 1 to 15 minute adjustable time delay for turning lights off.
2. Sensor Output: Contacts rated to operate the connected relay. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
4. Mounting:
a. Sensor: Suitable for mounting in any position on a standard outlet box.
b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Manual/automatic selector switch.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc [21.5 to 2152 lx]; keep lighting off when selected lighting level is present.
9. Faceplate for Wall-Switch Replacement Type: Refer to wall plate material and color requirements for toggle switches, as specified in Section 26 27 26, WIRING DEVICES.

B. Dual-technology Type: Ceiling mounting; combination PIR and ultrasonic detection methods, field-selectable.
1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch [150mm] minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. [232 sq. cm], and detect a person of average size and weight moving not less than 12 inches [305 mm] in either a horizontal or a vertical manner at an approximate speed of 12 inches/s [305 mm/s].
3. Detection Coverage: as scheduled on drawings.

2.4 LIGHTING CONTROL PANEL – RELAY TYPE

A. Controller: Comply with UL 508; programmable, solid-state, astronomic 365-day control unit with non-volatile memory, mounted in preassembled relay panel with low-voltage-controlled, latching-type, single-pole lighting circuit relays. Controller shall be capable of receiving inputs from sensors and other sources, and capable of timed overrides and/or blink-warning on a per-circuit basis. Controller communication protocol shall be compatible with the building automation system specified in SECTION 23 09 23 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Where indicated, a limited number of digital or analog, low-voltage control-circuit outputs shall be supported by control unit and circuit boards associated with relays.

B. The Controller shall be capable of interfacing with a pc control station, and supporting software for Vivarium, diurnal cycle applications. The pc station will provide programming, control, and monitoring of the holding rooms with a graphic plan and icons for light status, override, and alarms. Wattstopper, Complete LIC System with WIN control software or equal.

C. Cabinet: Steel with hinged, locking door. Barriers separate low-voltage and line-voltage components.

D. Directory: Identifies each relay as to load controlled.

E. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

F. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-V ac for tungsten filaments and 20 A, 277-V ac for ballasts, 50,000 cycles at rated capacity.

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. Aim outdoor photocell switch according to manufacturer's recommendations. Set adjustable window slide for 1 footcandle photocell turn-on.

C. Aiming for wall-mounted and ceiling-mounted motion sensor switches shall be per manufacturer's recommendations.

D. Set occupancy sensor "on" duration to 15 minutes.

E. Locate light level sensors as indicated and in accordance with the manufacturer's recommendations. Adjust sensor for the scheduled light level at the typical work plane for that area.

F. Label time switches and contactors with a unique designation.

G. Lights in the animal holding rooms shall be capable of providing three separately controllable lighting levels by using multiple lamp and ballast combinations. The first level will be used for animal diurnal cycles. It will be controlled with programmable on/off times to simulate a sunrise to sunset. A switch (black) will override off the diurnal cycle, and after a programmable time period, will return to a scheduled diurnal cycle. A second switch (white) will activate the inspection level, and after a programmable time period will turn off. Red light level will be provided with colored lamps sleeves and will be activated by an override switch (red), and after a programmable time period will turn off.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations.

B. Upon completion of installation, conduct an operating test to show that equipment operates in accordance with requirements of this section.

C. Test for full range of dimming ballast and dimming controls capability. Observe for visually detectable flicker over full dimming range.

D. Test occupancy sensors for proper operation. Observe for light control over entire area being covered.

E. Program lighting control panels per schedule on drawings.

F. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placements.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks and tests, the Contractor shall show by demonstration in service that the lighting control devices are in good operating condition and properly performing the intended function.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of dry-type general-purpose transformers.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of nonstructural components.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include electrical ratings, impedance, dimensions, weight, mounting details, decibel rating, terminations, temperature rise, no load and full load losses, and connection diagrams.
   3. Complete nameplate data, including manufacturer's name and catalog number.

C. Manuals:
   1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets and wiring diagrams.
   2. If changes have been made to the maintenance and operating manuals originally submitted, then submit four copies of the updated maintenance and operating manuals to the COTR two weeks prior to final inspection.

D. Certifications: Two weeks prior to the final inspection, submit four copies of the following to the COTR:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the 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. National Fire Protection Association (NFPA):
   70-08 National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):
   ST20-92 Dry-Type Transformers for General Applications
   TP1-02 Guide for Determining Energy Efficiency for Distribution Transformers
   TR1-00 Transformers, Regulators, and Reactors

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Unless otherwise specified, dry-type transformers shall be in accordance with NEMA, NEC, and as shown on the drawings. Transformers shall be UL-listed and labeled.

B. Dry-type transformers shall have the following features:
   1. Transformers shall be self-cooled by natural convection, isolating windings, indoor dry-type. Autotransformers will not be accepted.
   2. Rating and winding connections shall be as shown on the drawings.
   3. Transformers shall have copper windings.
   4. Ratings shown on the drawings are for continuous duty without the use of cooling fans.
   5. Insulation systems:
      a. Transformers 30 kVA and larger: UL rated 220˚ C system with an average maximum rise by resistance of 150 ˚ C in a maximum ambient of 40 ˚ C.
      b. Transformers below 30 kVA: Same as for 30 kVA and larger or UL rated 185 ˚ C system with an average maximum rise by resistance of 115 ˚ C in a maximum ambient of 40 ˚ C.
   6. Core and coil assemblies:
      a. Rigidly braced to withstand the stresses caused by short-circuit currents and rough handling during shipment.
      b. Cores shall be grain-oriented, non-aging, and silicon steel.
      c. Coils shall be continuous windings without splices except for taps.
      d. Coil loss and core loss shall be minimized for efficient operation.
      e. Primary and secondary tap connections shall be brazed or pressure type.
      f. Coil windings shall have end filters or tie-downs for maximum strength.
   7. Certified sound levels determined in accordance with NEMA, shall not exceed the following:

Transformer Rating	Sound Level Rating
0 - 9 KVA	40 dB
10 - 50 KVA	45 dB
51 - 150 KVA	50 dB

151 - 300 KVA	55 dB
301 - 500 KVA	60 dB

8. If not shown on drawings, nominal impedance shall be as permitted by NEMA.
9. Single phase transformers rated 15 kVA through 25 kVA shall have two 5% full capacity taps below normal rated primary voltage. All transformers rated 30 kVA and larger shall have two 2.5% full capacity taps above, and four 2.5% full capacity taps below normal rated primary voltage.
10. Core assemblies shall be grounded to their enclosures with adequate flexible ground straps.
11. Enclosures:
    a. Comprised of not less than code gauge steel.
    b. Outdoor enclosures shall be NEMA 3R.
    c. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
    d. Ventilation openings shall prevent accidental access to live components.
    e. The enclosure at the factory shall be thoroughly cleaned and painted with manufacturer's prime coat and standard finish.
12. Standard NEMA features and accessories, including ground pad, lifting provisions, and nameplate with the wiring diagram and sound level indicated on it.
13. Dimensions and configurations shall conform to the spaces designated for their installations.
14. Transformers shall meet the minimum energy efficiency values per NEMA TP1 as listed below:

kVA Rating	Output efficiency (%)
15	97
30	97.5
45	97.7
75	98
112.5	98.2
150	98.3
225	98.5
300	98.6
500	98.7
750	98.8

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of transformers shall be in accordance with the NEC, as recommended by the equipment manufacturer and as shown on the drawings.

B. Install transformers with manufacturer's recommended clearance from wall and adjacent equipment for air circulation. Minimum clearance shall be 6 in [150 mm].

C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.

D. Use flexible metal conduit to enclose the conductors from the transformer to the raceway systems.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections.
   1. Compare equipment nameplate data with specifications and approved shop drawings.
   2. Inspect physical and mechanical condition.
   3. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections.
   4. Perform specific inspections and mechanical tests as recommended by manufacturer.
   5. Verify correct equipment grounding.
   6. Verify proper secondary phase-to-phase and phase-to-neutral voltage after energization and prior to connection to loads.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the transformers are in good operating condition and properly performing the intended function.

END OF SECTION

SECTION 26 24 11
DISTRIBUTION SWITCHBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the distribution switchboards.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for Seismic Restraint for Nonstructural Components.

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 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for Personnel Safety and to provide a low impedance path for possible fault currents.

E. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit and outlet boxes.

F. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Coordination study of overcurrent protection devices.

G. Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION: TVSS equipment for distribution switchboards.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

A. Distribution switchboards shall be thoroughly tested at the factory to assure that there are no electrical or mechanical defects. Tests shall be conducted as per NEMA PB 2 and UL 891. Factory tests shall be certified.

B. The following additional tests shall be performed:
   1. Verify that circuit breaker sizes and types correspond to drawings and coordination study.
   2. Verify tightness of bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.
   3. Confirm correct operation and sequencing of electrical and mechanical interlock systems by attempting closure on locked-open devices, and attempting to open locked-closed devices, and making key exchange with devices operated in off-normal positions.
   4. Exercise all active components.
   5. Perform a dielectric withstand voltage test on each bus section, each phase-to-ground with phases not under test grounded, in accordance with manufacturer's published data.

6. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 volts dc for 300-volt rated cable and 1000 volts dc for 600-volt rated cable, or as required if solid-state components or control devices cannot tolerate the applied voltage.
7. If applicable, verify correct function of control transfer relays located in the switchboard with multiple control power sources.
8. Perform phasing checks on double-ended or dual-source switchboards to insure correct bus phasing from each source.

C. Furnish four (4) copies of certified manufacturer's factory test reports to the Resident Engineer prior to shipment of the switchboards to ensure that the switchboards have been successfully tested as specified.

D. // The Government shall have an option to witness the factory tests. All expenses of the Government Representative's trips to witness the testing will be paid by the Government. Notify the Resident Engineer not less than 30 days prior to making tests at the factory.//

1.5 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

B. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, temperature rise, wiring and connection diagrams, plan, front, side, and rear elevations, sectional views, bus work, circuit breaker frame sizes, trip and short-circuit rating, long-time, short-time, instantaneous and ground fault settings, coordinated breaker and fuse curves, accessories, and device nameplate data.
3. Show the size, ampere-rating, number of bars per phase and neutral in each bus run (horizontal and vertical), bus spacing, equipment ground bus, and bus material.

C. Manuals:
1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
   a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance, and operation.
   b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnection between the items of equipment.
   c. Provide a clear and concise description of operation, which gives, in detail, the information required to properly operate the equipment.
   d. Approvals will be based on complete submissions of manuals together with shop drawings.
2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manuals to the Resident Engineer.
   a. The manuals shall be updated to include any information necessitated by shop drawing approval.
   b. Complete "As Installed" wiring and schematic diagrams shall be included which show all items of equipment and their interconnecting wiring.
   c. Show all terminal identification.
   d. Include information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.

e. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
f. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

D. Certifications:
1. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested, including circuit breakers settings.
b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. Institute of Engineering and Electronic Engineers (IEEE):

C37.13	Low Voltage AC Power Circuit Breakers Used in Enclosures
C57.13	Instrument Transformers
C62.41	Surge Voltage in Low Voltage AC Power Circuits
C62.45	Surge Testing for Equipment connected to Low-Voltage AC Power Circuits

C. National Electrical Manufacturer's Association (NEMA):

PB-2	Dead-Front Distribution Switchboards.
PB-2.1	Instructions for Proper Handling, Installation, Operation, and Maintenance of Switchboards
AB-1	Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures

D. National Fire Protection Association (NFPA):

70	National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):

67	Panelboards
489	Molded Case Circuit Breakers and Circuit Breakers Enclosures
891	Dead-Front Switchboards
1283	Electromagnetic Interference Filters
1449	Transient Voltage Surge Suppressors

PART 2 - PRODUCTS

2.1 GENERAL

A. Switchboards shall be in accordance with UL, NEMA, NEC, IEEE, and as shown on the drawings.

B. Switchboards shall be provided complete, ready for operation including, but not limited to housing, buses, circuit breakers, instruments and related transformers, fuses, and wiring.

C. Switchboard dimensions shall not exceed the dimensions shown on the drawings.

D. Manufacturer’s nameplate shall include complete ratings of switchboard in addition to the date of manufacture.

2.2 BASIC ARRANGEMENT

A. Type I: Switchboard shall be front accessible with the following features:
   1. Device mounting:
      a. Main breaker: Individually mounted and compartmented or group mounted with feeder breakers.
      b. Feeder breakers: Group mounted.
   2. Section alignment: As shown on the drawings.
   3. Accessibility:
      a. Main section line and load terminals: Front and side.
      b. Distribution section line and load terminals: Front.
      c. Through bus connections: Front and end.
   4. Bolted line and load connections.
   5. Full height wiring gutter covers for access to wiring terminals.
   6. Short Circuit Current Rating: 42k amperes rms symmetrical, minimum, or as shown on the drawings, whichever is higher.

2.3 HOUSING

A. Provide a completely enclosed, free standing, steel enclosure not less than the gage required by the ANSI and UL standards. The enclosure is to consist of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard. The sides, top and rear shall be covered with removable screw on sheet steel plates.

B. Provide ventilating louvers where required to limit the temperature rise of current carrying parts. All openings shall be protected against entrance of falling dirt, water, or foreign matter.

C. Enclosure shall be thoroughly cleaned, phosphate treated, and primed with rust-inhibiting paint. Final finish coat to be the manufacturers standard gray. Provide a quart of finish paint for touch-up purposes.

2.4 BUSES

A. General: Buses shall be arranged for 3 phase, 4 wire distribution. Main phase buses (through bus), full size neutral bus, and ground bus shall be full capacity the entire length of the switchboard. Provide for future extensions by means of bolt holes or other approved method. Brace the bus to withstand the available short circuit current at the particular location and as shown on the drawings. No magnetic material shall be used between buses to form a magnetic loop.

B. Material and Size: Buses and connections shall be hard drawn copper of 98 percent conductivity. Bus temperature rise shall not exceed 65 degrees C (149 degrees F). Section busing shall be sized based on UL and NEMA Switchboard Standards.

C. Bus Connections: All contact surfaces shall be copper. Provide a minimum of two plated bolts per splice. Where physical bus size permits only one bolt, provide a means other than friction to prevent turning, twisting or bending. Torque bolts to the manufacturer's recommended values.

D. Neutral Bus: Provide bare or plated bus and mount on insulated bus supports. Provide neutral disconnect link to permit isolation of neutral bus from the common ground bus and service entrance conductors.

E. Ground Bus: Provide an uninsulated 6 mm by 50 mm (1/4 inch by 2 inch) copper equipment ground bus bar sized per UL 891 the length of the switchboard and secure at each section.

F. Main Bonding Jumper: Connect an uninsulated 1/4 inch by 2 inch (6mm by 50 mm) copper bus between the neutral and ground buses to establish the system common ground point.

2.5 TRANSIENT VOLTAGE SURGE SUPPRESSION

A. Refer to Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION.

2.6 METERING

A. Refer to Section 26 09 13, ELECTRICAL POWER MONITORING AND CONTOL.

2.7 NAMEPLATES AND MIMIC BUS

A. Nameplates: For Normal Power system, provide laminated black phenolic resin with white core with 1/2 inch [12mm] engraved lettered nameplates next to each circuit breaker. For Essential Electrical System, provide laminated red phenolic resin with white core with 1/2 inch [12mm] engraved lettered nameplates next to each circuit breaker. Nameplates shall indicate equipment served, spaces, or spares in accordance with one line diagram shown on drawings. Nameplates shall be mounted with plated screws on front of breakers or on equipment enclosure next to breakers. Mounting nameplates only with adhesive is not acceptable.

B. Mimic Bus: Provide an approved mimic bus on front of each switchboard assembly. Color shall be black for the Normal Power system and red for the Essential Electrical System, either factory-painted plastic or metal strips. Plastic tape shall not be used. Use symbols similar to one line diagram shown on drawings. Plastic or metal strips shall be mounted with plated screws.

2.8 PROVISION FOR FUTURE

A. Where "provision for", "future", or "space" is noted on drawings, the space shall be equipped with bus connections to the future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and physical clearance. Provide buses for the ampere rating as shown for the future device.

2.9 BREAKER REMOVAL EQUIPMENT

A. Where draw out circuit breakers are provided, furnish a portable elevating carriage or switchboard permanent top mounted device for installation and removal of the breakers.

2.10 CONTROL WIRING

A. Control wiring shall be 600 volt class B stranded SIS. Install all control wiring complete at the factory adequately bundled and protected. Wiring across hinges and between shipping units shall be Class C stranded. Size in accordance with NEC. Provide control circuit fuses.

2.11 MAIN CIRCUIT BREAKERS

A. Type I Switchboard: Provide UL listed and labeled molded case circuit breakers in accordance with NEC and as shown on the drawings. Circuit breakers shall be the solid state adjustable trip type.
   1. Trip units shall have field adjustable tripping characteristics as follows:
      a. Ampere setting (continuous).
      b. Long time band.
      c. Short time trip point.
      d. Short time delay.
      e. Instantaneous trip point.
      f. Ground fault trip point.
      g. Ground fault trip delay.
   2. Trip settings shall be as indicated on the drawings. Final settings shall be as shown on the electrical system protective device study.
   3. Breakers, which have same rating, shall be interchangeable with each other.

2.12 FEEDER CIRCUIT BREAKERS

A. Provide UL listed and labeled molded case circuit breakers, in accordance with the NEC, as shown on the drawings, and as herein specified.

B. Adjustable Trip Molded Case Circuit Breakers:
   1. Provide molded case, solid state adjustable trip type circuit breakers.
   2. Trip units shall have field adjustable tripping characteristics as follows:
      a. Ampere setting (continuous).
      b. Long time band.
      c. Short time trip point.
      d. Short time delay.
      e. Instantaneous trip point.
      f. Ground fault trip point.
      g. Ground fault trip delay.
   3. Trip settings shall be as indicated on the drawings. Final settings shall be shown on the electrical system protective device study.
   4. Breakers, which have same rating, shall be interchangeable with each other.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the switchboard in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.

B. Anchor switchboard to the slab with plated 1/2 inch [12.5mm] minimum anchor bolts, or as recommended by the manufacturer.

C. In seismic areas, switchboard shall be adequately anchored and braced per details on structural contract drawings to withstand the seismic forces at the location where installed.

D. Interior Location. Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches [100mm] thick. The top of the concrete slab shall be approximately 4 inches [100mm] above finished floor. Edges above floor shall have 1/2 inch [12.5mm] chamfer. The slab shall be of adequate size to project at least 8 inches [200mm] beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches [75mm] above slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
   1. Visual and Mechanical Inspection
      a. Compare equipment nameplate data with specifications and approved shop drawings.
      b. Inspect physical, electrical, and mechanical condition.
      c. Confirm correct application of manufacturer's recommended lubricants.
      d. Verify appropriate anchorage, required area clearances, and correct alignment.
      e. Verify that circuit breaker sizes and types correspond to approved shop drawings.
      f. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.

g. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
h. Clean switchboard.
i. Inspect insulators for evidence of physical damage or contaminated surfaces.
j. Verify correct shutter installation and operation.
k. Exercise all active components.
l. Verify the correct operation of all sensing devices, alarms, and indicating devices.
m. If applicable, verify that vents are clear.
n. If applicable, inspect control power transformers.

2. Electrical Tests
   a. Perform insulation-resistance tests on each bus section.
   b. Perform overpotential tests.
   c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.
   d. Perform phasing check on double-ended switchboard to ensure correct bus phasing from each source.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the switchboard is in good operating condition and properly performing the intended function. Circuit breakers shall be tripped by operation of each protective device.

3.4 INSTRUCTION

A. Furnish the services of a factory certified instructor for one 4 hour period for instructing personnel in the operation and maintenance of the switchboard and related equipment on the date requested by the Resident Engineer.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of panelboards.

1.2 RELATED WORK

A. Section 09 91 00, PAINTING: Identification and painting of panelboards.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint of non-structural components.

C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.

D. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

E. 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.

F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

G. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for installing the over-current protective devices to ensure proper equipment and personnel protection.

H. Section 26 09 23, LIGHTING CONTROLS: Lighting controls integral to panelboards.

I. Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION: Surge suppressors installed in panelboards.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Sufficient information, shall be clearly presented to determine compliance with drawings and specifications.
   2. Include electrical ratings, dimensions, mounting details, materials, wiring diagrams, accessories, and weights of equipment. Complete nameplate data, including manufacturer's name and catalog number.

C. Manuals:

1. When submitting the shop drawings, submit companion copies of complete maintenance and operating manuals, including technical data sheets and wiring diagrams.
2. If changes have been made to the maintenance and operating manuals that were originally submitted, then submit four copies of updated maintenance and operating manuals to the COTR two weeks prior to final inspection.

D. Certification: Two weeks prior to final inspection, submit four copies of the following to the COTR:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):

PB-1-06	Panelboards
250-08	Enclosures for Electrical Equipment (1000V Maximum)

C. National Fire Protection Association (NFPA):

70-2005	National Electrical Code (NEC)
70E-2004	Standard for Electrical Life Safety in the Workplace

D. Underwriters Laboratories, Inc. (UL):

50-95	Enclosures for Electrical Equipment
67-09	Panelboards
489-09	Molded Case Circuit Breakers and Circuit Breaker Enclosures

PART 2 - PRODUCTS

2.1 PANELBOARDS

A. Panelboards shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.

B. Panelboards shall be standard manufactured products.

C. All panelboards shall be hinged “door in door” type with:
1. Interior hinged door with hand-operated latch or latches, as required to provide access only to circuit breaker operating handles, not to energized parts.
2. Outer hinged door shall be securely mounted to the panelboard box with factory bolts, screws, clips, or other fasteners, requiring a tool for entry. Hand-operated latches are not acceptable.
3. Push inner and outer doors shall open left to right.

D. All panelboards shall be completely factory-assembled with molded case circuit breakers and integral accessories, such as surge protective devices per Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION, metering devices per Section 25 10 10, ADVANCED UTILITY METERING, lighting controls per Section 26 09 23, LIGHTING CONTROLS, and as scheduled on the drawings or specified herein. Include one-piece removable, inner dead front cover, independent of the panelboard cover.

E. Panelboards shall have main breaker or main lugs, bus size, voltage, phase, top or bottom feed, and flush or surface mounting as scheduled on the drawings.

F. Panelboards shall conform to NEMA PB-1, NEMA AB-1, and UL 67 and have the following features:
   1. Non-reduced size copper bus bars with current ratings as shown on the panel schedules, rigidly supported on molded insulators.
   2. Bus bar connections to the branch circuit breakers shall be the “distributed phase” or “phase sequence” type.
   3. Mechanical lugs furnished with panelboards shall be cast, stamped, or machined metal alloys of sizes suitable for the conductors to which they will be connected.
   4. Neutral bus shall be 100% rated, mounted on insulated supports.
   5. Grounding bus bar shall be equipped with screws or lugs for the connection of grounding wires.
   6. Buses shall be braced for the available short-circuit current. Bracing shall not be less than 10,000 A symmetrical for 120/208 V and 120/240 V panelboards, and 14,000 A symmetrical for 277/480 V panelboards.
   7. Branch circuit panelboards shall have buses fabricated for bolt-on type circuit breakers.
   8. Protective devices shall be designed so that they can easily be replaced.
   9. Where designated on panel schedule "spaces," include all necessary bussing, device support, and connections. Provide blank cover for each space.
   10. In two section panelboards, the main bus in each section shall be full size. The first section shall be furnished with subfeed lugs on the line side of main lugs only, or through-feed lugs for main breaker type panelboards, and have cable connections to the second section. Panelboard sections with tapped bus or crossover bus are not acceptable.
   11. Series-rated panelboards are not permitted.

2.2 CABINETS AND TRIMS

A. Cabinets:
   1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panelboards shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL 50 and UL 67.
   2. Cabinet enclosure shall not have ventilating openings.
   3. Cabinets for panelboards may be of one-piece formed steel or of formed sheet steel with end and side panels welded, riveted, or bolted as required.

2.3 2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS

A. Circuit breakers shall be per UL 489, in accordance with the NEC, as shown on the drawings, and as specified.

B. Circuit breakers in panelboards shall be bolt-on type.

C. Molded case 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. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 A frame or lower. Magnetic trip shall be adjustable from 3x to 10x for breakers with 600 A frames and higher. //Breaker trip setting shall be set in the field, based on the approved protective device study as specified in Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

E. 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 ON, TRIPPED, and OFF positions.
   8. An overload on one pole of a multipole 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 indicated.
   10. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory accordingly.

2.4 SURGE SUPPRESSION

A. Where shown on drawings, furnish panelboard with integral transient voltage surge suppression device. Refer to Section 26 43 13, TRANSIENT-VOLTAGE SURGE SUPPRESSION.

2.5 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.

B. Enclosures are to be of the NEMA types shown on the drawings. Where the types are not shown, they are to be the NEMA type most suitable for the environmental conditions where the circuit breakers are being installed.

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. Locate panelboards so that the present and future conduits can be conveniently connected.

C. Install a printed schedule of circuits in each panelboard after approval by the //Resident Engineer// //COTR//. Schedules shall be printed on the panelboard directory cards, installed in the appropriate panelboards, and incorporate all applicable contract changes. Information shall indicate outlets, lights, devices, or other equipment controlled by each circuit, and the final room numbers served by each circuit.

D. Mount the fully-aligned panelboard such that the maximum height of the top circuit breaker above the finished floor shall not exceed 78 in [1980 mm]. Mount panelboards that are too high such that the bottom of the cabinets will not be less than 6 in [150 mm] above the finished floor.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection
    a. Compare equipment nameplate data with specifications and approved shop drawings.
    b. Inspect physical, electrical, and mechanical condition.
    c. 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.
    f. Clean panelboard.

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 OF SECTION

SECTION 26 24 19
MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, complete installation, and connection of motor control centers.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.

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 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.

F. Section 26 29 11, MOTOR STARTERS: Control and protection of motors.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Catalog Data: Submit catalog data and information as required to demonstrate that materials conform to the specification requirements. Data shall include features, characteristics, ratings, and settings of all adjustable components.

C. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include electrical ratings, enclosure type, dimensions, weights, mounting details, front view, side view, equipment and device arrangement, running overcurrent protection, branch circuit overcurrent protection, wiring diagrams, materials, connection diagrams for each motor control center, and nameplate schedule.
   3. For starters: a list of overload sizes for each motor and circuit breaker sizes.

D. Manuals: Two weeks prior to the final inspection, submit four copies of the following to the COTR:

1. Complete maintenance, operating and testing manuals, including wiring diagrams, technical data sheets, including load current, overload relay and settings of adjustable relays, and information for ordering replacement parts:
   a. Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
   b. Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
   c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.
   d. Instructions for testing and adjusting overcurrent protective devices.

E. Certification: Two weeks prior to final inspection, submit four copies of the following to the COTR:
   1. Certification from the manufacturer that the motor control center(s) will withstand the design seismic event forces, and that the unit will be fully operational after the design seismic event at the project site.
   2. Certification by the manufacturer that the motor control centers conform to the requirements of the drawings and specifications.
   3. Certification by the contractor that the motor control centers 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 designation only.

B. National Electrical Manufacturers Association (NEMA):

ICS 1-05	Industrial Control and Systems: General Requirements
ICS 2-05	Industrial Control and Systems: Controllers, Contactors, and Overhead Relays, Rated 600 volts
ICS 6-06	Industrial Control and Systems: Enclosures
FU 1-02	Low-Voltage Cartridge Fuses
250-03	Enclosures for Electrical Equipment (1000 Volts Maximum)

C. National Fire Protection Association (NFPA):

70-05	National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

845-05	Motor Control Centers

PART 2 - PRODUCTS

2.1 MOTOR CONTROL CENTERS

A. Factory-assembled motor control centers shall comply with NEC, NEMA, and UL, and as shown on the drawings.

B. Motor control centers shall be complete, floor-mounted, dead-front metal-enclosed, free-standing, grounded, indoor type.

C. Wiring: The motor control centers shall be NEMA Standard, Class 1, Type B.

D. Ratings: Ratings shall be not less than shown on the drawings. Interrupting ratings shall be not less than the maximum short circuit currents available at the motor control center location, as shown on the drawings.

E. Motor control centers shall conform to the arrangements and details of the drawings and to the spaces designated for installation.

F. The components and the control wiring shall conform to the approved shop drawings as furnished for the various applicable electrical and mechanical sections of the specifications.

G. All steel parts shall be factory-phosphatized, painted with primer, and baked enamel or lacquer finishes, except for ground connections. The paint and finish shall withstand a minimum of 1000 hours salt spray test.

H. Vertical Sections:
   1. Approximately 90 in [2.25 M] high, front, and rear line-up, dead-front assembly. Unit shall be designed to permit future additions or rearrangement of units.
   2. The structure shall be NEMA-Type rated (Type 1, Type 3R, or Type 12) as indicated on the drawings or as required per the environment.
   3. Spaces within the sections shall be suitable and adequately sized for starters and accessories as indicated on the drawings.
   4. Mount the sections on adequate structural steel supports at the factory, front, and rear, for the full length of each center.
   5. Each space shall have an individual door with hinges and latches for present and future starters.
   6. End panels shall be removable to facilitate future additions.
   7. All section parts shall be accessible from the front for maintenance rearrangement.
   8. Screws in the removable panels shall remain in the panels when the panels are removed. Self-aligning, self-retaining nuts, which are parts of the screw assembly, shall remain intact.
   9. The structure shall have a minimum 12 in [300 mm] high wireway at the top of each section and a minimum 6 in [150 mm] high wireway at the bottom of each section. The wireway shall run the full length of the structure.
   10. Each section in the motor control center shall have isolated vertical full height wireways. Vertical wireways shall connect with both the top and bottom horizontal wireways.
   11. Each vertical section for starters shall be equipped with all necessary hardware and busing for modular plug-in units to be added or relocated. All unused space shall be covered by hinged doors and equipped to accept future units.

2.2 BUS BARS AND INTERCONNECTIONS

A. Horizontal and vertical bus ratings as shown on drawings; bus bars shall be fully rated.

B. Bus shall be tin-plated copper.

C. Bus bar joints and interconnection joints shall be plated, constant high-pressure type, with high strength copper-silicon bolts and nuts.

D. Vertical bus shall have insulation as follows:
   1. High strength polyester glass or the equivalent.
   2. High track-resistance.
   3. High impulse and dielectric strength, suitable for withstanding the maximum short-circuit currents.
   4. High flame-retardant, self-extinguishing.
   5. Comply with NEMA Standard for 122˚ F [50˚ C] temperature rise above the ambient temperature.

E. A ground bus shall extend across the entire length of the motor control center.

F. Bus bars and interconnections shall include provisions to extend the motor control center horizontal bus into additional future vertical sections.

G. Provide shutter mechanism to isolate vertical bus when plug-in device is withdrawn.

H. Equip future spaces for motor controllers, circuit breakers, and switches with all hardware necessary for the future equipment.

2.3 STARTERS

A. Product of the same manufacturer as the motor control centers.

B. Factory tested, stab-on, draw-out type up through size 4. Size 5 and above require bolted connections.

C. Shall conform to the requirements in Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

D. Interchangeable with starter of the same ratings in all of the motor control centers being installed for this contract. Each motor starter shall be provided with a label indicating all of its ratings.

E. Disconnecting devices shall be circuit breaker type with external operating handle with lock-open padlocking positions and on-off position indicator.
   1. Circuit Breakers:
      a. UL listed and labeled, in accordance with the NEC, as shown on the drawings and as specified.
      b. Bolt-on thermal-magnetic type with a minimum interrupting rating as indicated on the drawings.
      c. Equipped with automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100A or less. The magnetic trips shall be adjustable from 3x to 10x for breakers greater than 100A frames. Factory setting shall be HI, unless otherwise noted.
      d. 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, 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 overload on one pole of a multi-pole breaker shall automatically cause all breaker poles to open.

F. 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.

G. Identify each motor controller, circuit breaker, and switch with a separate nameplate of laminated black phenolic resin with white core and engraved lettering not less than 0.25 in [6 mm] high. Identify each motor by its number or other designation, which indicates function fulfilled by the motor. Identify pilot light with ON and OFF designation.

2.4 FEEDER UNITS

A. Circuit breaker: shall conform to the applicable portions of Section 26 24 16, PANELBOARDS.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with NEC, written instructions of the manufacturer, and as shown on the drawings.

B. Install motor control center on concrete pad as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Bolt the motor control center to the concrete pad.

C. Comply with mounting and anchoring requirements specified in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
   1. Visual and Mechanical Inspection
      a. Compare equipment nameplate data with specifications and approved shop drawings.
      b. Inspect physical, electrical, and mechanical condition.
      c. Verify appropriate anchorage and required area clearances.
      d. Verify that fuse and circuit breaker sizes and types correspond to approved shop drawings.
      e. Use calibrated torque-wrench method to verify the tightness of accessible bolted electrical connections, or perform a thermographic survey after energization.
      f. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
      g. Clean motor control center.
      h. Inspect insulators for evidence of physical damage or contaminated surfaces.
      i. Exercise all active components.
      j. Verify the correct operation of all sensing devices, alarms, and indicating devices.
      k. If applicable, inspect control power transformers.
   2. Electrical Tests
      a. Perform insulation-resistance tests on each bus section.
      b. Perform overpotential tests.
      c. Perform insulation-resistance test on control wiring; do not perform this test on wiring connected to solid-state components.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the motor control center is in good operating condition and properly performing the intended function.

3.4 TRAINING

A. Furnish the services of a competent, factory-trained engineer or technician for a 2-hour period to instruct VA personnel in operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the COTR.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation and connection of wiring devices.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.

B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.

C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the Resident Engineer: Technical data sheets and information for ordering replacement units.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer: Certification by the Contractor that the devices comply with the drawings and specifications, and have been properly installed, aligned, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. National Fire Protection Association (NFPA):
   70 National Electrical Code (NEC)

C. National Electrical Manufacturers Association (NEMA):

WD 1	General Color Requirements for Wiring Devices
WD 6	Wiring Devices – Dimensional Requirements

D. Underwriter's Laboratories, Inc. (UL):

5	Surface Metal Raceways and Fittings
20	General-Use Snap Switches
231	Power Outlets
467	Grounding and Bonding Equipment
498	Attachment Plugs and Receptacles
943	Ground-Fault Circuit-Interrupters

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., and conform to NEMA WD 6.
   1. Mounting straps shall be plated steel, with break-off plaster ears and shall include a self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
   2. Receptacles shall have provisions for back wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.

B. Duplex Receptacles: Hospital-grade, single phase, 20 ampere, 120 volts, 2-pole, 3-wire, and conform to the NEMA 5-20R configuration in NEMA WD 6. The duplex type shall have break-off feature for two-circuit operation. The ungrounded pole of each receptacle shall be provided with a separate terminal.
   1. Bodies shall be ivory in color.
   2. Switched duplex receptacles shall be wired so that only the top receptacle is switched. The remaining receptacle shall be unswitched.
   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 Interrupter Duplex Receptacles: Shall be an integral unit, hospital-grade, suitable for mounting in a standard outlet box.
      a. Ground fault interrupter shall be consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. Device shall have nominal sensitivity to ground leakage current of five milliamperes and shall function to interrupt the current supply for any value of ground leakage current above five milliamperes (+ or – 1 milliamp) on the load side of the device. Device shall have a minimum nominal tripping time of 1/30th of a second.
      b. Ground Fault Interrupter Duplex Receptacles (not hospital-grade) shall be the same as ground fault interrupter hospital-grade receptacles except for the "hospital-grade" listing.
   5. Duplex Receptacles (not hospital grade): Shall be the same as hospital grade duplex receptacles except for the "hospital grade" listing

C. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.

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.

2.2 TOGGLE SWITCHES

A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless otherwise specified. The rocker type switch is not acceptable and will not be approved.
   1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.
   2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plasters ears and provisions for back wiring with separate metal wiring clamps and side wiring with captively held binding screws.
   3. Ratings:
      a. 120 volt circuits: 20 amperes at 120-277 volts AC.
      b. 277 volt circuits: 20 amperes at 120-277 volts AC.

2.3 WALL PLATES

A. Wall plates for switches and receptacles shall be type 302 stainless steel. Oversize plates are not acceptable.

B. Standard NEMA design, so that products of different manufacturers will be interchangeable. Dimensions for openings in wall plates shall be accordance with NEMA WD 6.

C. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.

D. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.

E. Duplex Receptacles on Emergency Circuit:
   1. Bodies shall be red in color. Wall plates shall be red with the word "EMERGENCY" engraved in 6 mm, (1/4 inch) white letters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC and as shown as on the drawings.

B. Ground terminal of each receptacle shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor.

C. Outlet boxes for light and dimmer switches shall be mounted on the strike side of doors.

D. Provide barriers in multigang outlet boxes to separate systems of different voltages, Normal Power and Emergency Power systems, and in compliance with the NEC.

E. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work. Coordinate the electrical work with the work of other trades to ensure that wiring device flush outlets are positioned with box openings aligned with the face of the surrounding finish material. Pay special attention to installations in cabinet work, and in connection with laboratory equipment.

F. Exact field locations of floors, walls, partitions, doors, windows, and equipment may vary from locations shown on the drawings. Prior to locating sleeves, boxes and chases for roughing-in of conduit and equipment, the Contractor shall coordinate exact field location of the above items with other trades. In addition, check for exact direction of door swings so that local switches are properly located on the strike side.

G. Install wall switches 48 inches [1200mm] above floor, OFF position down.

H. Install wall dimmers 48 inches [1200mm] above floor; derate ganged dimmers as instructed by manufacturer; do not use common neutral.

I. Install convenience receptacles 18 inches [450mm] above floor, and 6 inches [152mm] above counter backsplash or workbenches. Install specific-use receptacles at heights shown on the drawings.

J. Label device plates with a permanent adhesive label listing panel and circuit feeding the wiring device.

K. 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.

L. Test GFCI devices for tripping values specified in UL 1436 and UL 943.

END OF SECTION

SECTION 26 29 11
MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. All motor starters and variable speed motor controllers, including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise), shall meet these specifications.

1.2 RELATED WORK

A. Other sections which specify motor driven equipment, except elevator motor controllers.

B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirements for seismic restraint for nonstructural components.

C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one Section of Division 26.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 24 19, MOTOR-CONTROL CENTERS and Section 26 24 21, MOTOR-CONTROL PANELBOARDS: For multiple motor control assemblies, which include motor starters.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS:

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include electrical ratings, dimensions, weights, mounting details, materials, running over current protection, size of enclosure, over current protection, wiring diagrams, starting characteristics, interlocking and accessories.

C. Manuals:
   1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets, wiring diagrams and information for ordering replacement parts.
      a. Wiring diagrams shall have their terminals identified to facilitate installation, maintenance and operation.
      b. Wiring diagrams shall indicate internal wiring for each item of equipment and interconnections between the items of equipment.
      c. Elementary schematic diagrams shall be provided for clarity of operation.

2. Two weeks prior to the project final inspection, submit four copies of the final updated maintenance and operating manual to the Resident Engineer.

D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the Resident Engineer:
   1. Certification that the equipment has been properly installed, adjusted, and tested.
   2. Certification by the manufacturer that medium voltage motor controller(s) conforms to the requirements of the drawings and specifications. This certification must be furnished to the Resident Engineer prior to shipping the controller(s) to the job site.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by basic designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):

519	Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
C37.90.1	Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

C. National Electrical Manufacturers Association (NEMA):

ICS 1	Industrial Control and Systems General Requirements
ICS 1.1	Safety Guidelines for the Application, Installation and Maintenance of Solid State Control
ICS 2	Industrial Control and Systems, Controllers, Contactors and Overload Relays Rated 600 Volts DC
ICS 6	Industrial Control and Systems Enclosures
ICS 7	Industrial Control and Systems Adjustable-Speed Drives
ICS 7.1	Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems

D. National Fire Protection Association (NFPA):

70	National Electrical Code (NEC)

E. Underwriters Laboratories Inc. (UL):

508	Industrial Control Equipment

PART 2 - PRODUCTS

2.1 MOTOR STARTERS, GENERAL

A. Shall be in accordance with the requirements of the IEEE, NEC, NEMA (ICS 1, ICS 1.1, ICS 2, ICS 6, ICS 7 and ICS 7.1) and UL.

B. Shall have the following features:
   1. Separately enclosed unless part of another assembly.
   2. Circuit breakers and safety switches within the motor controller enclosures shall have external operating handles with lock-open padlocking provisions and shall indicate the ON and OFF positions.
   3. Motor control circuits:
      a. Shall operate at not more than 120 volts.
      b. Shall be grounded except as follows:
         1) Where isolated control circuits are shown.

2) Where manufacturers of equipment assemblies recommend that the control circuits be isolated.

c. Incorporate a separate, heavy duty, control transformer within each motor controller enclosure to provide the control voltage for each motor operating over 120 volts.

d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.

4. Overload current protective devices:

a. Overload relay (thermal or induction type).

b. One for each pole.

c. Manual reset on the door of each motor controller enclosure.

d. Correctly sized for the associated motor's rated full load current.

e. Check every motor controller after installation and verify that correct sizes of protective devices have been installed.

f. Deliver four copies of a summarized list to the Resident Engineer, which indicates and adequately identifies every motor controller installed. Include the catalog numbers for the correct sizes of protective devices for the motor controllers.

5. Hand-Off-Automatic (H-O-A) switch is required unless specifically stated on the drawings as not required for a particular starter. H-O-A switch is not required for manual motor starters.

6. Incorporate into each control circuit a 120-volt, solid state time delay relay (ON delay), minimum adjustable range from 0.3 to 10 minutes, with transient protection. Time delay relay is not required where H-O-A switch is not required.

7. Unless noted otherwise, equip with not less than two normally open and two normally closed auxiliary contacts. Provide green run pilot lights and H-O-A control devices as indicated, operable at front of enclosure without opening enclosure. Push buttons, selector switches, pilot lights, etc., shall be interchangeable.

8. Enclosures:

a. Shall be the NEMA types shown on the drawings for the motor controllers and shall be the NEMA types which are the most suitable for the environmental conditions where the motor controllers are being installed.

b. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open. Provision for padlock must be provided.

c. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.

C. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.

D. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.

E. Provide a disconnecting means or safety switch near and within sight of each motor. Provide all wiring and conduit required to facilitate a complete installation.

2.2 MANUAL MOTOR STARTERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Manual motor starters.

1. Starters shall be general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.

2. Units shall include overload protection and toggle operator.

C. Fractional horsepower manual motor starters.

1. Starters shall be general-purpose Class A, manually operated with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload protection, red pilot light and toggle operator.

D. Motor starting switches.
1. Switches shall be general-purpose Class A, manually operated type with full voltage controller for fractional horsepower induction motors.
2. Units shall include thermal overload protection, red pilot light // low voltage protection //, // NO // NC // auxiliary contact // and toggle operator.

2.3 MAGNETIC MOTOR STARTERS

A. Shall be in accordance with applicable requirements of 2.1 above.

B. Starters shall be general-purpose, Class A magnetic controllers for induction motors rated in horsepower. Minimum size 0.

C. Where combination motor starters are used, combine starter with protective or disconnect device in a common enclosure.

D. Provide phase loss protection for each starter, with contacts to de-energize the starter upon loss of any phase.

E. Unless otherwise indicated, provide full voltage non-reversing across-the-line mechanisms for motors less than 75 HP, closed by coil action and opened by gravity. For motors 75 HP and larger, provide reduced voltage starters. Equip starters with 120V AC coils and individual control transformer unless otherwise noted. Locate "reset" button to be accessible without opening the enclosure.

2.4 VARIABLE SPEED MOTOR CONTROLLERS

A. Shall be in accordance with applicable portions of 2.1 above.

B. Shall be solid state, micro processor-based with adjustable frequency and voltage, three phase output capable of driving standard NEMA B design, three phase alternating current induction motors at full rated speed. The drives shall utilize a full wave bridge design incorporating diode rectifier circuitry with pulse width modulation (PWM). Other control techniques are not acceptable. Silicon controlled rectifiers (SCR) shall not be used in the rectifying circuitry. The drives shall be designed to be used on variable torque loads and shall be capable of providing sufficient torque to allow the motor to break away from rest upon first application of power.

C. Unit shall be capable of operating within voltage parameters of plus 10 to minus 10 percent of line voltage, and be suitably rated for the full load amps of the maximum watts (HP) within its class.

D. Operating and Design Conditions:
1. Elevation: 50 feet AMSL
2. Temperatures: Maximum +90°F, Minimum -10°F
3. Relative Humidity: 95%
4. Drive Location: Air conditioned Building

E. Controllers shall have the following features:
1. Isolated power for control circuits.
2. Manually re-settable motor overload protection for each phase.
3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.

4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacturer's recommended time in the above range.)
5. Provide 4 to 20 ma current follower circuitry for interface with mechanical sensor devices.
6. Automatic frequency adjustment from 20 Hz to 60 Hz.
7. Provide circuitry to initiate an orderly shutdown when any of the conditions listed below occur. The controller shall not be damaged by any of these electrical disturbances and shall automatically restart when the conditions are corrected. The drive shall be able to restart into a rotating motor operating in either the forward or reverse direction and matching that frequency.
   a. Incorrect phase sequence.
   b. Single phasing.
   c. Over voltage in excess of 10 percent.
   d. Under voltage in excess of 10 percent.
   e. Running over current above 110 percent (shall not automatically reset for this condition.)
   f. Instantaneous overcurrent above 150 percent (shall not automatically reset for this condition).
   g. Surge voltage in excess of 1000 volts.
   h. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, and automatic transfer switch operations.)
8. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
9. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.

G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.

H. Controllers shall include a door interlocked fused safety disconnect switch or door interlocked circuit breaker switch which will disconnect all input power.

I. Controller shall include a 3% line reactor, and RFI/EMI filter.

J. The following accessories are to be door mounted:
   1. AC Power on light.
   2. Ammeter (RMS motor current).
   3. HAND-OFF-AUTOMATIC switch.
   4. Manual speed control in HAND mode.
   5. System protection lights indicating that the system has shutdown and will not automatically restart.
   6. System protection light indicating that the system has shutdown but will restart when conditions return to normal.
   7. Manual variable speed controller by-pass switch.
   8. Diagnostic shutdown indicator lights for each shutdown condition.
   9. Provide two N.O. and two N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
      a. System shutdown with auto restart.
      b. System shutdown without auto restart.
      c. System running.

10. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide transformer/s for the control circuit/s.
11. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall transients from other devices on the AC power distribution system affect the controller. Controllers shall be protected to comply with IEEE C37.90.1 and UL-508. Line noise and harmonic voltage distortion shall not exceed the values allowed by IEEE 519.

K. Hardware and software to enable the BAS to monitor, control, and display controller status and alarms.

L. Network Communications Ports: Ethernet and RS-422/485.

M. Embedded BAS Protocols for Network Communications: As specified in Division 22.

2.5 MOTOR CONTROL STATIONS

A. Shall have the following features:
1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
   a. Red while the motor is running.
   b. Green while the motor is stopped.
4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the motor by its number or other designation and indicate the function fulfilled by the motor.

B. Components of Motor Control Circuits:
1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.

B. In seismic areas, equipment shall be adequately anchored and braced per details on structural contract drawing to withstand the seismic forces at the location where installed.

C. Furnish and install heater elements in motor starters and to match the installed motor characteristics. Submit a list of all motors listing motor nameplate rating and heater element installed.

D. Motor Data: Provide neatly-typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, voltage/phase rating and heater element installed.

E. Connect hand-off auto selector switches so that automatic control only is by-passed in "manual" position and any safety controls are not by-passed.

F. Install manual motor starters in flush enclosures in finished areas.

G. Examine control diagrams indicated before ordering motor controllers. Should conflicting data exist in specifications, drawings and diagrams, request corrected data prior to placing orders.

3.2 ADJUSTING

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

C. Adjust trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust at six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Resident Engineer before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers at //50// //65 //80// percent.

E. In reduced-voltage solid-state controllers, set field-adjustable switches and program microprocessors for required start and stop sequences.

3.3 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
   1. Visual and Mechanical Inspection
      a. Compare equipment nameplate data with specifications and approved shop drawings.
      b. Inspect physical, electrical, and mechanical condition.
      c. Inspect contactors.
      d. Clean motor starters and variable speed motor controllers.
      e. Verify overload element ratings are correct for their applications.
      f. If motor-running protection is provided by fuses, verify correct fuse rating.
      g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer’s published data.
   2. Variable speed motor controllers:
      a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
      b. Test all control and safety features of the variable frequency drive.

3.4 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

3.5 SPARE PARTS

A. Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

END OF SECTION

SECTION 26 29 21
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of low voltage disconnect switches.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.

B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLTS AND BELOW: Cables and wiring.

C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.

D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.

E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Motor rated toggle switches.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
   3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.

C. Manuals:
   1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the COTR two weeks prior to final inspection.
   2. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.
   3. Wiring diagrams shall indicate internal wiring and any interlocking.

D. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the COTR:
   1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.

2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. National Electrical Manufacturers Association (NEMA):

FU l-07	Low Voltage Cartridge Fuses
KS l-06	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

C. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):

98-04	Enclosed and Dead-Front Switches
248-00	Low Voltage Fuses
977-94	Fused Power-Circuit Devices

PART 2 - PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

A. In accordance with UL 98, NEMA KS1, and NEC.

B. Shall have NEMA classification General Duty (GD) for 240 V switches and NEMA classification Heavy Duty (HD) for 480 V switches.

C. Shall be HP rated.

D. Shall have the following features:
1. Switch mechanism shall be the quick-make, quick-break type.
2. Copper blades, visible in the OFF position.
3. An arc chute for each pole.
4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
6. Fuse holders for the sizes and types of fuses specified.
7. //Electrically operated switches shall only be installed where shown on the drawings. //
8. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
9. Ground lugs for each ground conductor.
10. Enclosures:
    a. Shall be the NEMA types shown on the drawings for the switches.
    b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
    c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS

A. Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but without provisions for fuses.

2.3 MOTOR RATED TOGGLE SWITCHES

A. Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

2.4 LOW VOLTAGE CARTRIDGE FUSES

A. In accordance with NEMA FU1.

B. Motor Branch Circuits: Class RK5, time delay.

C. Other Branch Circuits: Class RK5, time delay

D. Control Circuits: Class CC,fast acting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches in accordance with the NEC and as shown on the drawings.

B. Fusible disconnect switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuse.

3.2 SPARE PARTS

A. Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fusible disconnect switch installed on the project. Deliver the spare fuses to the COTR.

END OF SECTION

SECTION 26 36 23
AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, and testing of open-transition automatic transfer switches with bypass isolation.

B. The automatic transfer switch shall be compatible with the existing San Francisco VA Medical Center, SFVAMC, Emergency Power Supply System and generator paralleling system controls.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section in Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personal safety and to provide a low impedance path for possible ground fault currents.

E. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Raceways for power and control wiring.

F. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for a coordinated electrical system.

G. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General communications requirements that are common to more than one section in Division 27.

H. Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATION SYSTEMS: Raceways for communications cabling.

I. SECTION 27 15 00, COMMUNICATIONS HORIZONTAL CABLING: Communications media for interconnecting automatic transfer switches and remote control and annunciation components.

1.3 QUALITY ASSURANCE

A. QUALITY ASSURANCE
   1. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. A factory-authorized representative shall maintain a service center capable of providing emergency maintenance and repair services at the project site within a 8 hour maximum response time.

C. Automatic transfer switch, bypass/isolation switch, and annunciation control panels shall be products of same manufacturer.

D. Comply with OSHA – 29 CFR 1910.7 for the qualifications of the testing agency.

1.4 FACTORY TESTS

A. Automatic transfer switches shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted per UL standards. Factory tests shall be certified. The following factory tests shall be performed:
   1. Visual inspection to verify that each ATS is as specified.
   2. Mechanical test to verify that ATS sections are free of mechanical hindrances.
   3. Insulation resistance test to ensure integrity and continuity of entire system.
   4. Main switch contact resistance test.
   5. Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.

1.5 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include electrical ratings (including withstand), dimensions, weights, mounting details, conduit entry provisions front view, side view, equipment and device arrangement, elementary and interconnection wiring diagrams, factory relay settings, and accessories.
   3. For automatic transfer switches that are networked together to a common means of annunciation and/or control, submit interconnection diagrams and site and building plans, showing connections for normal and emergency sources of power, load, control and annunciation components, and interconnecting communications paths. Equipment locations on the diagrams and plans shall match the site, building, and room designations on the construction drawings.
   4. Complete nameplate data, including manufacturer's name and catalog number.
   5. A copy of the markings that are to appear on the transfer switches when installed.

C. Manuals:
   1. When submitting the shop drawings, submit companion copies of complete maintenance and operating and maintenance manuals, including technical data sheets, wiring diagrams and information, such as telephone number, fax number and web sites, for ordering replacement parts.
   2. Two weeks prior to final inspection, submit four copies of a final updated maintenance and operating manual to the COTR.
      a. Include complete "As Installed" diagrams that indicate all pieces of equipment and their interconnecting wiring.
      b. Include complete diagrams of the internal wiring for each piece of equipment, including "As Installed" revisions of the diagrams.
      c. The wiring diagrams shall identify the terminals to facilitate installation, maintenance, operation, and testing.

D. Certifications:
   1. When submitting the shop drawings, submit a certified test report from a recognized independent testing laboratory that a representative sample has passed UL 1008 prototype testing.
   2. Two weeks prior to final inspection, submit four copies of the following to the COTR:
      a. Certification that no design changes have been made to the switch or its components since last certified by UL or tested by an independent laboratory.

b. Certification by the manufacturer that the equipment conforms to the requirements of the drawings and specifications.
c. Certification that the withstand current rating has been coordinated with upstream protective devices.
d. Certification by the contractor that the equipment has been properly installed, adjusted, and tested.
e. A certified test report from an independent laboratory that a representative sample has passed the ANSI surges withstand test for transfer switches which incorporate solid-state components.
f. Certification from the manufacturer that the automatic transfer switch(s), accessories, and components will withstand the seismic forces and that the unit will be fully operational after the zone seismic event at the project site. Certification shall be based upon simulated seismic forces, not by calculation.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only:

B. Institute of Electrical and Electronic Engineers (IEEE):

446-95	Recommended Practice for Design and Maintenance of Emergency and Standby Power Systems
C37.90.1-02	Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
C62.41.1-02	Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits
C62.41.2	Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

C. National Electrical Manufacturers Association (NEMA):

250-03	Enclosure for Electrical Equipment (1000 Volts Maximum)
ICS 6-06	Enclosures
IC3 4-05	Industrial Control and Systems: Terminal Blocks
MG 1-07	Motors and Generators

D. National Fire Protection Association (NFPA):

70–08	National Electrical Code (NEC)
99-05	Health Care Facilities
110-10	Emergency and Standby Power Systems

E. Underwriters Laboratories, Inc. (UL):

50-95	Enclosures for Electrical Equipment
508-99	Industrial Control Equipment
891-05	Dead-Front Switchboards
1008-96	Transfer Switch Equipment

PART 2 - PRODUCTS

2.1 OPEN-TRANSITION AUTOMATIC TRANSFER SWITCH

A. Automatic transfer & bypass-isolation switch shall be ASCO 7000 Series, or approved equal.

B. General:

1. Comply with UL, NEMA, NEC, ANSI, IEEE, and NFPA.
2. Automatic transfer switches are to be 4- pole draw-out construction, electrically operated, mechanically held open contact type, without integral overcurrent protection. Automatic transfer switches utilizing automatic or non-automatic molded case circuit breakers, insulated case circuit breakers, or power circuit breakers as switching mechanisms are not acceptable.
3. Automatic transfer switches shall be completely factory-assembled and wired such that only external circuit connections are required in the field.
4. Each automatic transfer switch shall be equipped with an integral bypass/isolation switch.
5. Ratings:
   a. Phases, voltage, ampere rating, poles, and withstand current rating shall be as shown on the drawings.
   b. Transfer switches are to be rated for continuous duty at specified continuous current rating on 60Hz systems.
   c. Maximum automatic transfer switch rating: 800 A.
6. Markings:
   a. Markings shall be in accordance with UL 1008.
   b. Markings for the additional withstand test specified below shall be included in the nameplate data.
7. Tests:
   a. Automatic transfer switches shall be tested in accordance with UL 1008. The contacts of the transfer switch shall not weld during the performance of withstand and closing tests when used with the upstream overcurrent device and available fault current specified.
8. Surge Withstand Test:
   a. Transfer switches utilizing solid-state devices in sensing, relaying, operating, or communication equipment or circuits shall comply with IEEE C37.90.1.
9. Housing:
   a. Enclose automatic transfer switches in wall- or floor-mounted steel cabinets, with metal gauge not less than No. 14, in accordance with UL 508, or in a switchboard assembly in accordance with UL 891, as shown on the drawings.
   b. Enclosure shall be constructed so that personnel are protected from energized bypass-isolation components during automatic transfer switch maintenance.
   c. Automatic transfer switch components shall be removable without disconnecting external source or load power conductors.
   d. Finish: Cabinets shall be given a phosphate treatment, painted with rust-inhibiting primer, and finish-painted with the manufacturer's standard enamel or lacquer finish.
   e. Viewing Ports: Provide viewing ports so that contacts may be inspected without disassembly.

C. Automatic transfer switches shall include the following features:
1. Operating Mechanism:
   a. Actuated by an electrical operator.
   b. Electrically and mechanically interlocked so that the main contact cannot be closed simultaneously in either normal and emergency position.
   c. Normal and emergency main contacts shall be mechanically locked in position by the operating linkage upon completion of transfer. Release of the locking mechanism shall be possible only by normal operating action.
   d. Contact transfer time shall not exceed six cycles.
   e. Operating mechanism components and mechanical interlocks shall be insulated or grounded.
2. Contacts:

a. Main contacts: Silver alloy.
b. Neutral contacts: Silver alloy, with same current rating as phase contacts.
c. Current carrying capacity of arcing contacts shall not be used in the determination of the automatic transfer switch rating, and shall be separate from the main contacts.
d. Main and arcing contacts shall be visible for inspection with cabinet door open and barrier covers removed.

3. Manual Operator:
   a. Capable of operation by one person in either direction under no load.
4. Replaceable Parts:
   a. Include the main and arcing contact individually or as units, relays, and control devices.
   b. Switch contacts and accessories shall be replaceable from the front without removing the switch from the cabinet and without removing main conductors.
5. Sensing Relays:
   a. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100% of nominal, and dropout voltage is adjustable from 75 to 98% of pickup value. Factory set for pickup at 90% and dropout at 85%.
   b. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   c. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100% of nominal. Factory set for pickup at 90%. Pickup frequency shall be adjustable from 90 to 100% of nominal. Factory set for pickup at 95%.
   d. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
   e. Test Switch: Simulate normal-source failure.
   f. Switch-Position Pilot Lights: Indicate source to which load is connected.
   g. g. Source-Available Indicating Lights: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
   h. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
   i. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
   j. Transfer Override Switch: Overrides automatic retransfer control so that automatic transfer switch shall remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
   k. Engine Starting Contacts: One isolated and normally closed and one isolated and normally open; rated 10 A at 32-V dc minimum.
   l. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
   m. Engine-Generator Exerciser: Programmable exerciser starts engine-generator(s) and transfers load to them from normal source for a preset time, then retransfers and shuts down engine-generator(s) after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period.
6. Controls:
   a. Control module shall provide indication of switch status and be equipped with alarm diagnostics.

b. Control module shall control operation of the automatic transfer switches.

7. Factory Wiring: Train and bundle factory wiring and label either by color-code or by numbered/lettered wire markers. Labels shall match those on the shop drawings.
8. Annunciation, Control, and Programming Interface Components: Devices for communicating with remote programming devices, annunciators, or control panels and paralleling switchgear shall have open-protocol communication capability matched with remote device.
9. Auxiliary Contacts:
   a. Provide contacts as necessary to accomplish the functions shown on the drawings, as specified herein, and as designated in other sections of these specifications, as well as one spare normally open contact and one normally closed contact.
   b. Provide remote contact to bypass retransfer time delay to normal source.
10. In-Phase Monitor: Factory-wired, internal relay controls transfer, so that it occurs only when the two sources are synchronized in phase. The relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70% or more of nominal voltage.
11. Programmed Neutral Switch Position: Switch operator has a programmed neutral position, arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Pause is adjustable from 0.5 to 30 seconds minimum and factory set for 0.5 seconds, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

2.2 SEQUENCE OF OPERATION

A. The specified voltage decrease in one or more phases of the normal power source shall initiate the transfer sequence. The automatic transfer switch shall start the engine-generator(s) after a specified time delay to permit override of momentary dips in the normal power source.

B. The automatic transfer switch shall transfer the load from normal to emergency source when the frequency and voltage of the engine-generator(s) have attained the specified percent of rated value.

C. Engine Start: A voltage decrease, at any automatic transfer switch, in one or more phases of the normal power source to less than the specified value of normal shall start the engine-generator(s) after a specified time delay.

D. Transfer to Emergency System Loads: Automatic transfer switches for Emergency System loads shall transfer their loads from normal to emergency source when frequency and voltage of the engine-generator(s) have attained the specified percent of rated value. Only those switches with deficient normal source voltage shall transfer.

E. Transfer to Equipment Branch Loads: Automatic transfer switches for Equipment Branch loads shall transfer their loads to the generator on a time-delayed, staggered basis, after the Emergency System switches have transferred. Only those switches with deficient normal source voltage shall transfer.

F. Retransfer to Normal (All Loads): Automatic transfer switches shall retransfer the load from emergency to normal source upon restoration of normal supply in all phases to the specified percent or more of normal voltage, and after a specified time delay. Should the emergency source fail during this time, the automatic transfer switches shall immediately transfer to the normal source whenever it becomes available. After restoring to normal source, the engine-generator(s) shall continue to run unloaded for a specified interval before shut-down.

G. Exercise Mode: Transfer to emergency power source shall be accomplished by remote manual test switches on a selective basis.

2.3 BYPASS/ISOLATION SWITCH

A. Provide each automatic transfer switch with two-way bypass/isolation manual type switch. The bypass-isolation switch shall permit load by-pass to either normal or emergency power source and complete isolation of the automatic transfer switch, independent of transfer switch position. Bypass and isolation shall be possible under all conditions including when the automatic transfer switch is removed from service.

B. Operation: The bypass/isolation switch shall have provisions for operation by one person through the movement of a maximum of two handles at a common dead front panel in no more than 15 seconds. Provide a lock, which must energize to unlock the bypass switch, to prevent bypassing to a dead source. Provide means to prevent simultaneous connection between normal and emergency sources.
   1. Bypass to normal (or emergency): Operation of bypass handle shall allow direct connection of the load to the normal (or emergency) source, without load interruption or by using a break-before-make design, or provide separate load interrupter contacts to momentarily interrupt the load.
      a. Ensure continuity of auxiliary circuits necessary for proper operation of the system.
      b. A red indicating lamp shall light when the automatic transfer switch is bypassed.
      c. Bypassing source to source: If the power source is lost while in the bypass position, bypass to the alternate source shall be achievable without re-energization of the automatic transfer switch service and load connections.
   2. Isolation: Operation of the isolating handle shall isolate all live power conductors to the automatic transfer switch without interruption of the load.
      a. Interlocking: Provide interlocking as part of the bypass/ isolation switch to eliminate personnel-controlled sequence of operation, and to prevent operation to the isolation position until the bypass function has been completed.
      b. Padlocking: Include provisions to padlock the isolating handle in the isolated position.
      c. Visual verification: The isolation blades shall be visible in the isolated position.
   3. Testing: It shall be possible to test (normal electrical operation) the automatic transfer switch and engine–generator(s) with the isolation contacts closed and the load bypassed without interruption of power to the load.

C. Ratings: The electrical capabilities and ratings of the bypass/isolation switch shall be compatible with those of the associated automatic transfer switch, including any required additional withstand tests.

2.4 REMOTE ANNUNCIATOR SYSTEM

A. Remote annunciator panel shall annunciate conditions for indicated automatic transfer switches. Annunciation shall include the following:
   1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
   2. Switch position.
   3. Switch in test mode.
   4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.
   1. Indicating Lights: Grouped for each automatic transfer switch monitored.
   2. Label each group, indicating the automatic transfer switch it monitors, the location of switch, and the identity of load it serves.
   3. Mounting: Flush, modular steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.5 SPARE PARTS

A. Provide six control fuses for each automatic transfer switch with a different rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install the automatic transfer switch in accordance with the NEC, as shown on the drawings, and as recommended by the manufacturer.

B. Anchor control and annunciator panel to wall.

C. Anchor automatic transfer switch to the slab with plated 0.5 in [12.5 mm] minimum anchor bolts, or as recommended by the manufacturer.

D. In seismic areas, automatic transfer switch shall be properly anchored and braced to withstand the seismic forces at the location where installed per details on structural contract drawings.

E. Mount automatic transfer switch on concrete slab. Unless otherwise indicated, the slab shall be at least 4 in [100 mm] thick. The top of the concrete slab shall be approximately 4 in [100 mm] above finished floor. Edges above floor shall have 0.5 in [12.5 mm] chamfer. The slab shall be of adequate size to project at least 8 in [200 mm] beyond the equipment. Provide conduit turnups and adequate cable entrance space required for the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 in [75 mm] above the slab surface. Concrete work shall be as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

F. Set field-adjustable intervals and delays, relays, and engine exerciser.

3.2 ACCEPTANCE CHECKS AND TESTS

A. A factory-authorized service representative is required to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   1. Following completion of automatic transfer switch installation and after making proper adjustments and settings, site tests shall be performed by the manufacturer’s representative in accordance with manufacturer's written instructions to demonstrate that each automatic transfer switch functions satisfactorily and as specified. Advise COTR of the site testing within five days prior to its scheduled date, and provide certified field test reports within 14 days following successful completion of the site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:
      a. Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
      c. Verify that manual transfer warnings are properly placed.
      d. Perform manual transfer operation.
   2. After energizing circuits, demonstrate the interlocking sequence and operational function for each automatic transfer switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.

d. Verify pickup and dropout voltages by data readout or inspection of control settings.
e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, re-transfer time delay on restoration of normal power, and engine cool-down and shut-down.

3.3 DEMONSTRATION

A. At the final inspection in the presence of COTR, demonstrate that the complete auxiliary electrical power system operates properly in every respect. Coordinate this demonstration with the demonstration of the engine-generator(s) and paralleling switchgear.

3.4 TRAINING

A. Furnish the services of a competent, factory-trained engineer or technician for one 4-hour period to instruct VA personnel in the operation and maintenance of the equipment, including review of the operation and maintenance manual, on a date requested by the COTR. Coordinate this training with that of the generator training.

END OF SECTION

SECTION 26 43 13
TRANSIENT-VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Section includes transient voltage surge suppression equipment for low-voltage power distribution and control equipment.

1.2 RELATED WORK

A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

B. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: For factory-installed TVSS.

C. Section 26 24 16, PANELBOARDS: For factory-installed TVSS.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.

B. Operation and Maintenance Data: For TVSS devices to include in emergency, operation, and maintenance manuals.

C. Warranties: Sample of special warranties.

D. Certifications:
   1. Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
      a. Certification by the Contractor that the assemblies have been properly installed, adjusted and tested.3.
      b. Certified copies of all of the factory design and production tests, field test data sheets and reports for the assemblies.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplement and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. Institute of Engineering and Electronic Engineers (IEEE):
   IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
   IEEE C62.45 Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

C. National Electrical Manufacturers Association (NEMA):

NEMA LS 1 Low Voltage Surge Protective Devices

D. Underwriters Laboratories, Inc. (UL):
UL 1283 Electromagnetic Interference Filters
UL 1449.....Surge Protective Devices

E. National Fire Protection Association (NFPA):
NFPA 70 National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 SWITCHGEAR/SWITCHBOARD SUPPRESSORS

A. Surge Protection Devices:
1. Comply with UL 1449.
2. Modular design with field-replaceable modules.
3. Fuses, rated at 200-kA interrupting capacity.
4. Fabrication using bolted compression lugs for internal wiring.
5. Integral disconnect switch.
6. Redundant suppression circuits.
7. Redundant replaceable modules.
8. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
9. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
10. LED indicator lights for power and protection status.
11. Audible alarm, with silencing switch, to indicate when protection has failed.
12. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
13. Four-digit transient-event counter set to totalize transient surges.

B. Peak Single-Impulse Surge Current Rating: 160 kA per mode/320 kA per phase.

C. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2
1. Line to Neutral: 70,000A.
2. Line to Ground: 70,000A.
3. Neutral to Ground: 50,000A.

D. Protection modes and UL 1449 SVR for grounded wye circuits shall be as follows:
1. Line to Neutral: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
2. Line to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
3. Neutral to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.

E. Protection modes and UL 1449 SVR for 240/120 V, single-phase, 3-wire circuits shall be as follows:
1. Line to Neutral: 400 V.
2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

F. Protection modes and UL 1449 SVR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:
1. Line to Neutral: 400 V, 800 V from high leg.

2. Line to Ground: 400 V.
3. Neutral to Ground: 400 V.

G. Protection modes and UL 1449 SVR for 240 V or 480 V, 3-phase, 3-wire, delta circuits shall be as follows:
1. Line to Line: 2000 V for 480 V, 1000 V for 240 V.
2. Line to Ground: 2000 V for 480 V, 1000 V for 240 V.

2.2 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install TVSS devices at switchboard, switchgear, or panelboard on load side, with ground lead bonded to service entrance ground.

3.2 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:
1. Visual and Mechanical Inspection
a. Compare equipment nameplate data with specifications and approved shop drawings.
b. Inspect physical, electrical, and mechanical condition.
c. Verify that disconnecting means and feeder size and maximum to TVSS unit correspond to approved shop drawings.
d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.
e. Clean TVSS unit.
f. Complete startup checks according to manufacturer's written instructions.
g. Verify the correct operation of all sensing devices, alarms, and indicating devices.

3.3 STARTUP

A. Do not energize or connect switchgear, switchboards, or panelboards to their sources until TVSS devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 SPARE PARTS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Replaceable Protection Modules: One of each size and type installed.

3.5 INSTRUCTION

A. Provide factory certified technician to train Government maintenance personnel to maintain TVSS devices. Training shall be provided for a total period of 4 hours of normal working time and shall start after the system is functionally complete but prior to final acceptance test. Training shall cover all essential items contained in the operation and maintenance manual.

END OF SECTION

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.

1.2 RELATED WORK

A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural Components.

B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements that are common to more than one section of Division 26.

C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.

D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

E. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:

B. Product Data: For each type of lighting fixture (luminaire) designated on the LIGHTING FIXTURE SCHEDULE, arranged in order of fixture designation, submit the following information.
   1. Material and construction details include information on housing, optics system and lens/diffuser.
   2. Physical dimensions and description.
   3. Wiring schematic and connection diagram.
   4. Installation details.
   5. Energy efficiency data.
   6. Photometric data based on laboratory tests complying with IESNA Lighting Measurements, testing and calculation guides.
   7. Lamp data including lumen output (initial and mean), color rendition index (CRI), rated life (hours) and color temperature (degrees Kelvin).
   8. Ballast data including ballast type, starting method, ambient temperature, ballast factor, sound rating, system watts and total harmonic distortion (THD).

C. Manuals:

1. Submit, simultaneously with the shop drawings companion copies of complete maintenance and operating manuals including technical data sheets, and information for ordering replacement parts.
2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, including any changes, to the Resident Engineer.

D. Certifications:
1. Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:
   a. Certification by the Contractor that the equipment has been properly installed, adjusted, and tested.

1.5 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.

B. Institute of Electrical and Electronic Engineers (IEEE):
C62.41-91 Guide on the Surge Environment in Low Voltage (1000V and less) AC Power Circuits

C. National Fire Protection Association (NFPA):
70 National Electrical Code (NEC)
101 Life Safety Code

D. National Electrical Manufacturer's Association (NEMA):
C82.1-97 Ballasts for Fluorescent Lamps - Specifications
C82.2-02 Method of Measurement of Fluorescent Lamp Ballasts
C82.4-02 Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps
C82.11-02 High Frequency Fluorescent Lamp Ballasts

E. Underwriters Laboratories, Inc. (UL):
496-96 Edison-Base Lampholders
542-99 Lampholders, Starters, and Starter Holders for Fluorescent Lamps
844-95 Electric Lighting Fixtures for Use in Hazardous (Classified) Locations
924-95 Emergency Lighting and Power Equipment
935-01 Fluorescent-Lamp Ballasts
1029-94 High-Intensity-Discharge Lamp Ballasts
1029A-06 Ignitors and Related Auxiliaries for HID Lamp Ballasts
1598-00 Luminaires
1574-04 Standard for Track Lighting Systems
2108-04 Standard for Low-Voltage Lighting Systems
8750-08 Light Emitting Diode (LED) Light Sources for Use in Lighting Products

F. Federal Communications Commission (FCC):
Code of Federal Regulations (CFR), Title 47, Part 18

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES (LUMINAIRES)

A. Shall be in accordance with NFPA 70 and UL 1598, as shown on drawings, and as specified.

B. Sheet Metal:

1. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved) and parallel to each other as designed.
2. Wireways and fittings shall be free of burrs and sharp edges and shall accommodate internal and branch circuit wiring without damage to the wiring.
3. When installed, any exposed fixture housing surface, trim frame, door frame and lens frame shall be free of light leaks; lens doors shall close in a light tight manner.
4. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, latches shall function easily by finger action without the use of tools.

C. Ballasts shall be serviceable while the fixture is in its normally installed position, and shall not be mounted to removable reflectors or wireway covers unless so specified.

D. Lamp Sockets:
1. Fluorescent: Lampholder contacts shall be the biting edge type or phosphorous-bronze with silver flash contact surface type and shall conform to the applicable requirements of UL 542. Lamp holders for bi-pin lamps shall be of the telescoping compression type, or of the single slot entry type requiring a one-quarter turn of the lamp after insertion.
2. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.

E. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

F. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, captive hinges or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.

G. Metal Finishes:
1. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
2. Interior light reflecting finishes shall be white with not less than 85 percent reflectances, except where otherwise shown on the drawing.
3. Exterior finishes shall be as shown on the drawings.

H. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.

I. Light Transmitting Components for Fluorescent Fixtures:
1. Shall be 100 percent virgin acrylic.
2. Flat lens panels shall have not less than 1/8 inch [3.2mm] of average thickness. The average thickness shall be determined by adding the maximum thickness to the minimum unpenetrated thickness and dividing the sum by 2.
3. Unless otherwise specified, lenses, diffusers and louvers shall be retained firmly in a metal frame by clips or clamping ring in such a manner as to allow expansion and contraction of the lens without distortion or cracking.

J. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Group areas as defined in NFPA 70, and shall comply with UL 844.

K. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballast integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures (not the lamp). Fixtures shall be designed for lamps as specified.

2.2 BALLASTS

A. Linear Fluorescent Lamp Ballasts: Multi-voltage (120 – 277V) electronic programmed-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
   1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: 10 percent or less.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. Ballast Factor: 0.87 or higher unless otherwise indicated.
   9. Power Factor: 0.98 or higher.
   10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.
   12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.

B. Low-Frequency Linear T8 Fluorescent Lamp Ballasts (allowed for Surgery Suites, Critical Care Units and Animal Labs): 277V hybrid electronic-electromagnetic rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output; including the following features:
   1. Automatic lamp starting after lamp replacement.
   2. Sound Rating: Class A.
   3. Total Harmonic Distortion Rating: 20 percent or less.
   4. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   5. Operating Frequency: 60 Hz.
   6. Lamp Current Crest Factor: 1.7 or less.
   7. Ballast Factor: 0.85 or higher unless otherwise indicated.
   8. Power Factor: 0.90 or higher.
   9. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   10. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.

11. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.

C. Compact Fluorescent Lamp Ballasts: Multi-voltage (120 – 277V), electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:
   1. Lamp end-of-life detection and shutdown circuit.
   2. Automatic lamp starting after lamp replacement.
   3. Sound Rating: Class A.
   4. Total Harmonic Distortion Rating: 10 percent or less.
   5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   6. Operating Frequency: 20 kHz or higher.
   7. Lamp Current Crest Factor: 1.7 or less.
   8. Ballast Factor: 0.95 or higher unless otherwise indicated.
   9. Power Factor: 0.98 or higher.
   10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   11. Dimming ballasts shall be as per above, except dimmable from 100% to 5% of rated lamp lumens.

D. Electronic ballast for high intensity discharge metal-halide lamps shall include the following features unless otherwise indicated:
   1. Minimum Starting Temperature: Minus 20 deg F (Minus 29 deg C) for single-lamp ballasts.
   2. Rated Ambient Operating Temperature: 130 deg F (54 deg C).
   3. Lamp end-of-life detection and shutdown circuit.
   4. Sound Rating: Class A.
   5. Total Harmonic Distortion Rating: 20 percent or less.
   6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
   7. Lamp Current Crest Factor: 1.5 or less.
   8. Power Factor: 0.90 or higher.
   9. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
   10. Protection: Class P thermal cut.

2.3 FLUORESCENT EMERGENCY BALLAST

A. Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.
   1. Emergency Connection: Operate one or two fluorescent lamp(s) continuously at an output of 1100 lumens. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   2. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.
      a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
   3. Battery: Sealed, maintenance-free, nickel-cadmium type.

4. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
5. Integral Self-Test: Automatically initiates test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing LED.

2.4 LAMPS

A. Linear and U-shaped T5 and T8 Fluorescent Lamps:
   1. Rapid start fluorescent lamps shall comply with ANSI C78.1; and instant-start lamps shall comply with ANSI C78.3.
   2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
   3. Except as indicated below, lamps shall be low-mercury energy saving type, have a color temperature between 3500° and 4100°K, a Color Rendering Index (CRI) of greater than 70, average rated life of 20,000 hours, and be suitable for use with dimming ballasts, unless otherwise indicated. Low mercury lamps shall have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in NEMA LL 1.
      a. Other areas as indicated on the drawings.

B. Compact Fluorescent Lamps:
   1. T4, CRI 80 (minimum), color temperature 3500 K, and suitable for use with dimming ballasts, unless otherwise indicated.

C. Long Twin-Tube Fluorescent Lamps:
   1. T5, CRI 80 (minimum), color temperature between 3500° and 4100°K, 20,000 hours average rated life.

2.5 EXIT LIGHT FIXTURES

A. Exit light fixtures shall meet applicable requirements of NFPA 101 and UL 924.

B. Housing and Canopy:
   1. Shall be made of die-cast aluminum.
   2. Optional steel housing shall be a minimum 20 gauge thick or equivalent strength aluminum.
   3. Steel housing shall have baked enamel over corrosion resistant, matte black or ivory white primer.

C. Door frame shall be cast or extruded aluminum, and hinged with latch.

D. Finish shall be satin or fine-grain brushed aluminum.

E. There shall be no radioactive material used in the fixtures.

F. Fixtures:
   1. Maximum fixture wattage shall be 1 watt or less.
   2. Inscription panels shall be cast or stamped aluminum a minimum of 0.090 inch [2.25mm] thick, stenciled with 6 inch [150mm] high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass. The LED shall be rated minimum 25 years life.
   3. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
   4. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.

G. Voltages: Refer to 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. Lighting Fixture Supports:
   1. Shall provide support for all of the fixtures. Supports may be anchored to channels of the ceiling construction, to the structural slab or to structural members within a partition, or above a suspended ceiling.
   2. Shall maintain the fixture positions after cleaning and relamping.
   3. Shall support the lighting fixtures without causing the ceiling or partition to deflect.
   4. Hardware for recessed lighting fixtures:
      a. All fixture mounting devices connecting fixtures to the ceiling system or building structure shall have a capacity for a horizontal force of 100 percent of the fixture weight and a vertical force of 400 percent of the fixture weight.
      b. Mounting devices shall clamp the fixture to the ceiling system structure (main grid runners or fixture framing cross runners) at four points in such a manner as to resist spreading of these supporting members. Each support point device shall utilize a screw or approved hardware to "lock" the fixture housing to the ceiling system, restraining the fixture from movement in any direction relative to the ceiling. The screw (size No. 10 minimum) or approved hardware shall pass through the ceiling member (T-bar, channel or spline), or it may extend over the inside of the flange of the channel (or spline) that faces away from the fixture, in a manner that prevents any fixture movement.
      c. In addition to the above, the following is required for fixtures exceeding 20 pounds [9kg] in weight.
         1) Where fixtures mounted in ASTM Standard C635-69 "Intermediate" and "Heavy Duty" ceilings and weigh between 20 pounds and 56 pounds [9kg and 25kg] provide two 12 gauge safety hangers hung slack between diagonal corners of the fixture and the building structure.
         2) Where fixtures weigh over 56 pounds [25kg] they shall be independently supported from the building structure by approved hangers. Two-way angular bracing of hangers shall be provided to prevent lateral motion.
      d. Where ceiling cross runners are installed for support of lighting fixtures, they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.
   5. Surface mounted lighting fixtures:
      a. Fixtures 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 1/4-20 [6mm] 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 56 pounds [25kg] shall be supported directly from the building structure.
      b. Where ceiling cross runners are installed for support of lighting fixtures they must have a carrying capacity equal to that of the main ceiling runners and be rigidly secured to the main runners.

c. Fixtures less than 15 pounds [6.8kg] in weight and occupying less than two square feet [600mm x 600mm] of ceiling area may, (when designed for the purpose) be supported directly from the outlet box when all the following conditions are met.
   1) Screws attaching the fixture to the outlet box pass through round holes (not key-hole slots) in the fixture body.
   2) The outlet box is attached to a main ceiling runner (or cross runner) with approved hardware.
   3) The outlet box is supported vertically from the building structure.
d. Fixtures mounted in open construction shall be secured directly to the building structure with approved bolting and clamping devices.

6. Single or double pendant-mounted lighting fixtures:
   a. Each stem shall be supported by an approved outlet box, mounted swivel joint and canopy which holds the stem captive and provides spring load (or approved equivalent) dampening of fixture oscillations. Outlet box shall be supported vertically from the building structure.
7. Outlet boxes for support of lighting fixtures (where permitted) shall be secured directly to the building structure with approved devices or supported vertically in a hung ceiling from the building structure with a nine gauge wire hanger, and be secured by an approved device to a main ceiling runner or cross runner to prevent any horizontal movement relative to the ceiling.

D. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled under this project.

E. Coordinate between the electrical and ceiling trades to ascertain that approved lighting fixtures are furnished in the proper sizes and installed with the proper devices (hangers, clips, trim frames, flanges), to match the ceiling system being installed.

F. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

G. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.

H. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.

I. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of exterior luminaires, poles, and supports.

1.2 RELATED WORK

A. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for exterior light poles and luminaires.

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 21, 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 09 23, LIGHTING CONTROLS: Controls for exterior lighting.

1.3 QUALITY ASSURANCE

A. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Shop Drawings:
   1. Clearly present sufficient information to determine compliance with drawings and specifications.
   2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaires, lamps, and accessories.

C. Manuals: Two weeks prior to final inspection, submit four copies of operating and maintenance manuals to the COTR. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement lamps, ballasts, and parts.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the COTR:
   1. Certification by the manufacturer that the materials are in accordance with the drawings and specifications.

2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

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. Aluminum Association Inc. (AA):

AAH35.1-06	Alloy and Temper Designation Systems for Aluminum

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

LTS-5-09	Structural Supports for Highway Signs, Luminaires and Traffic Signals

D. American Concrete Institute (ACI):

318-05	Building Code Requirements for Structural Concrete

E. American National Standards Institute (ANSI):

C81.61-09	Electrical Lamp Bases – Specifications for Bases (Caps) for Electric Lamps

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

A123/A123M-09	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A153/A153M-09	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
B108-03a-08	Aluminum-Alloy Permanent Mold Castings
C1089-06	Spun Cast Prestressed Concrete Poles

G. Federal Aviation Administration (FAA):

AC 70/7460-IK-07	Obstruction Lighting and Marking
AC 150/5345-43F-06	Obstruction Lighting Equipment

H. Illuminating Engineering Society of North America (IESNA)

HB-9-00	Lighting Handbook
RP-8-05	Roadway Lighting
RP-20-98	Lighting for Parking Facilities
RP-33-99	Lighting for Exterior Environments
LM-5-96	Photometric Measurements of Area and Sports Lighting Installations
LM-50-99	Photometric Measurements of Roadway Lighting Installations
LM-52-99	Photometric Measurements of Roadway Sign Installations
LM-64-01	Photometric Measurements of Parking Areas
LM-72-97	Directional Positioning of Photometric Data
LM-79-08	Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products
LM-80-08	Approved Method for Measuring Lumen Maintenance of LED Light Sources

I. National Electrical Manufacturers Association (NEMA):

C78.41-06	Electric Lamps – Guidelines for Low-Pressure Sodium Lamps
C78.42-07	Electric Lamps – Guidelines for High-Pressure Sodium Lamps
C78.43-07	Electric Lamps – Single-Ended Metal-Halide Lamps
C78.1381-98	Electric Lamps – 70-Watt M85 Double-Ended Metal-Halide Lamps
C82.4-02	Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (Multiple-Supply Type)
C136.3-05	For Roadway and Area Lighting Equipment – Luminaire Attachments

C136.17-05	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 (R2006)	Enclosures

J. National Fire Protection Association (NFPA):

70-08	National Electrical Code (NEC)

K. Underwriters Laboratories, Inc. (UL):

496-08	Lampholders
773-95	Plug-In, Locking Type Photocontrols for Use with Area Lighting
773A-06	Nonindustrial Photoelectric Switches for Lighting Control
1029-94	High-Intensity-Discharge Lamp Ballasts
1598-08	Luminaires
8750-08	Light Emitting Diode (LED) Light Sources 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 12 in [305 mm] above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the drawings and specified.

2.2 LUMINAIRES

A. Per UL 1598 and NEMA C136.17. 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. Incorporate ballasts in the luminaire housing, except where otherwise shown on the drawings.

C. 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.

D. Lamp sockets for high intensity discharge (H.I.D) fixture shall have locking-type porcelain enclosures in conformance to the applicable requirements of ANSI C81.61 and UL 496.

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, as scheduled on the drawings. Where indicated on drawings, match finish process and color of pole or support materials. Where indicated on drawings, provide finishes as indicated in Section 09 06 00, SCHEDULE FOR FINISHES.

I. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

2.3 LAMPS

A. Install the proper lamps in every luminaire installed

B. Lamps shall be general-service, outdoor lighting types.

C. Mercury vapor lamps shall not be used.

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. Install lamps in each luminaire.

C. 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.

END OF SECTION

SECTION 27 05 11
REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section, Requirements for Communications Installations, applies to all sections of Division 27.

B. Furnish and install communications cabling, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of transformers, cable, and other items and arrangements for the specified items are shown on drawings.

1.2 MINIMUM REQUIREMENTS

A. References to industry and trade association standards and codes are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:
   1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
   2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.4 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:
   1. Components of an assembled unit need not be products of the same manufacturer.
   2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
   3. Components shall be compatible with each other and with the total assembly for the intended service.
   4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:
   1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
   2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
   3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.5 EQUIPMENT REQUIREMENTS

A. Where variations from the contract requirements are requested in accordance with the GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.6 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
   1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
   2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
   3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
   4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.7 WORK PERFORMANCE

A. Job site safety and worker safety is the responsibility of the contractor.

B. For work on existing stations, arrange, phase and perform work to assure communications service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

D. Coordinate location of equipment and pathways with other trades to minimize interferences. See the GENERAL CONDITIONS.

1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS

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

B. Inaccessible Equipment:
   1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
   2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.9 EQUIPMENT IDENTIFICATION

A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.

B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

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

B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage, or installation of equipment or material which has not had prior approval will not be permitted at the job site.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings, and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
   2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
   3. Submit each section separately.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
   2. Submittals are required for all equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed.
   3. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
   4. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
   1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.

2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.
4. The manuals shall include:
   a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
   b. A control sequence describing start-up, operation, and shutdown.
   c. Description of the function of each principal item of equipment.
   d. Installation and maintenance instructions.
   e. Safety precautions.
   f. Diagrams and illustrations.
   g. Testing methods.
   h. Performance data.
   i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
   j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
   1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
   2. Each type of conduit and pathway coupling, bushing and termination fitting.
   3. Raceway and pathway hangers, clamps and supports.
   4. Duct sealing compound.

I. In addition to the requirement of SUBMITTALS, the VA reserves the right to request the manufacturer to arrange for a VA representative to see typical active systems in operation, when there has been no prior experience with the manufacturer or the type of equipment being submitted.

1.11 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.

1.12 TRAINING

A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

B. Training shall be provided for the particular equipment or system as required in each associated specification.

C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies general grounding and bonding requirements of telecommunication installations for equipment operations.

B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, telecommunications system grounding electrodes.

C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

A. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 27.

B. Section 27 10 00, STRUCTURED CABLING: Low Voltage power and lighting wiring.

1.3 SUBMITTALS

A. Submit in accordance with Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
   1. Certification that the materials and installation is in accordance with the drawings and specifications.
   2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. 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

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

D. National Fire Protection Association (NFPA):
70 2005 National Electrical Code (NEC)

E. Telecommunications Industry Association, (TIA)
J-STO-607-A-2002 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

F. Underwriters Laboratories, Inc. (UL):
44 2005 Thermoset Insulated Wires and Cables
83 2003 Thermoplastic Insulated Wires and Cables
467 2004 Grounding and Bonding Equipment
486A-486B-2003 Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.

D. Telecom System Grounding Riser Conductor: Telecommunications Grounding Riser shall be in accordance with J STO-607A. Use a minimum 50mm² (1/0 AWG) insulated stranded copper grounding conductor unless indicated otherwise.

2.2 GROUND RODS

A. Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.

B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.3 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.4 TELECOMMUNICATION SYSTEM GROUND BUSBARS

A. Provide solid copper busbar, pre-drilled from two-hole lug connections with a minimum thickness of 6 mm (1/4 inch) for wall and backboard mounting using standard insulators sized as follows:
1. Room Signal Grounding: 300 mm x 100 mm (12 inches x 4 inch).
2. Master Signal Ground: 600 mm x 100 mm (24 inches x 4 inch).

2.5 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
   1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
   2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
   3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.6 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 with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

2.7 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 screw lug-type terminal blocks.

2.8 SPLICE CASE GROUND ACCESSORIES

A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. System Grounding:
   1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
   2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
   3. Isolation transformers and isolated power systems shall not be system grounded.

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.3 SECONDARY EQUIPMENT AND CIRCUITS

A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.

B. Metallic Piping, Building Steel, and Supplemental Electrode(s):

1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
2. Provide a supplemental ground electrode and bond to the grounding electrode system.

C. Conduit Systems:
1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. Non metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
3. Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.

D. Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.

E. 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. 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. 3. Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

F. Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

G. Raised Floors: Provide bonding of all raised floor components.

3.4 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.5 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the building 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 gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.6 TELECOMMUNICATIONS SYSTEM

A. Bond telecommunications system grounding equipment to the electrical grounding electrode system.

B. Furnish and install all wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to a ground source.

C. Ground bonding jumpers shall be continuous with no splices. Use the shortest length of bonding jumper possible.

D. Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milli ohms or less.

E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file the point of contact to a bare metal surface. Use exothermic welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly cleaned the joint area. Notify the Resident Engineer prior to backfilling any ground connections.

F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.

G. Bonding Jumpers:
   1. Use insulated ground wire of the size and type shown on the Drawings or use a minimum of 16 mm² (6 AWG) insulated copper wire.
   2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
   3. Use compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

H. Bonding Jumper Fasteners:
   1. Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
   2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
   3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
   4. Unistrut and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.7 COMMUNICATION ROOM GROUNDING

A. Telecommunications Ground Busbars:
   1. Provide communications room telecommunications ground busbar hardware at 950 mm (18 inches) at locations indicated on the Drawings.
   2. Connect the telecommunications room ground busbars to other room grounding busbars as indicated on the Grounding Riser diagram.

B. Telephone-Type Cable Rack Systems: aluminum pan installed on telephone-type cable rack serves as the primary ground conductor within the communications room. Make ground connections by installing the following bonding jumpers:
   1. Install a 16 mm² (6 AWG) bonding between the telecommunications ground busbar and the nearest access to the aluminum pan installed on the cable rack.
   2. Use 16 mm² (6 AWG) bonding jumpers across aluminum pan junctions.

C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:

1. When ground bars are provided at the rear of lineup of bolted together equipment racks, bond the copper ground bars together using solid copper splice plates supplied by the ground bar manufacturer.
2. Bond together nonadjacent ground bars on equipment racks and cabinets with 16 mm² (6 AWG) insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
3. Provide a 16 mm² (6 AWG) bonding jumper between the rack and/or cabinet ground busbar and the aluminum pan of an overhead cable tray or the raised floor stringer as appropriate.

D. Backboards: Provide a screw lug-type terminal block or drilled and tapped copper strip near the top of backboards used for communications cross-connect systems. Connect backboard ground terminals to the aluminum pan in the telephone-type cable tray using an insulated 16 mm² (16 AWG) bonding jumper.

E. E. Other Communication Room Ground Systems: Ground all metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to the cable tray pan or the telecommunications ground busbar, whichever is closer, using insulated 16 mm² (6 AWG) ground wire bonding jumpers.

3.8 COMMUNICATIONS CABLE GROUNDING

A. Bond all metallic cable sheaths in multipair communications cables together at each splicing and/or terminating location to provide 100 percent metallic sheath continuity throughout the communications distribution system.
1. At terminal points, install a cable shield bonding connector provide a screw stud connection for ground wire. Use a bonding jumper to connect the cable shield connector to an appropriate ground source like the rack or cabinet ground bar.
2. Bond all metallic cable shields together within splice closures using cable shield bonding connectors or the splice case grounding and bonding accessories provided by the splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to an approved ground source and all other metallic components and equipment at that location.

3.9 COMMUNICATIONS CABLE TRAY SYSTEMS:

A. Bond the metallic structures of one cable tray in each tray run following the same path to provide 100 percent electrical continuity throughout this cable tray systems as follows:
1. Splice plates provided by the cable tray manufacturer can be used for providing a ground bonding connection between cable tray sections when the resistance across a bolted connection is 10 milliohms or less. The Subcontractor shall verify this loss by testing across one slice plate connection in the presence of the Contractor.
2. Install a 16 mm² (6 AWG) bonding jumper across each cable tray splice or junction where splice plates cannot be used.
3. When cable tray terminations to cable rack, install 16 mm² (6 AWG) bonding jumper between cable tray and cable rank pan.

3.10 COMMUNCIATIONS RACEWAY GROUNDING

A. Conduit: Use insulated 16 mm² (6 AWG) bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.

B. Wireway: use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and across all section junctions.

C. Cable Tray Systems: Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 16 meters (50 feet).

3.11 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

D. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

3.12 GROUND ROD INSTALLATION

A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

SECTION 27 05 33
RACEWAYS AND BOXES FOR COMMUNICATIONS 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, raceway systems. Raceways are required for all communications cabling 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. Bedding of conduits: Section 31 20 00, EARTH MOVING.

B. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.

C. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.

D. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07 92 00, JOINT SEALANTS.

E. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

F. General electrical requirements and items that is common to more than one section of Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

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

B. Shop Drawings:
   1. Size and location of panels and pull boxes
   2. Layout of required conduit penetrations through structural elements.
   3. The specific item proposed and its area of application shall be identified on the catalog cuts.

C. Certification: Prior to final inspection, deliver to the COTR four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. National Fire Protection Association (NFPA):

70-05	National Electrical Code (NEC)

C. Underwriters Laboratories, Inc. (UL):

1-03	Flexible Metal Conduit
5-01	Surface Metal Raceway and Fittings
6-03	Rigid Metal Conduit
50-03	Enclosures for Electrical Equipment
360-03	Liquid-Tight Flexible Steel Conduit
467-01	Grounding and Bonding Equipment
514A-01	Metallic Outlet Boxes
514B-02	Fittings for Cable and Conduit
514C-05	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-02	Schedule 40 and 80 Rigid PVC Conduit
651A-03	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-03	Electrical Metallic Tubing
1242-00	Intermediate Metal Conduit

D. National Electrical Manufacturers Association (NEMA):

TC-3-04	PVC Fittings for Use with Rigid PVC Conduit and Tubing
FB1-03	Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown. Where permitted by the NEC, 13 mm (1/2 inch) flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:
1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
5. Flexible galvanized steel 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 IMC conduit fittings:
   a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   b. Standard threaded couplings, locknuts, bushings, 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:
   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 prohibited.
   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. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
   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 steel 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 ANSI/ 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:
   a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
   b. As recommended by the conduit manufacturer.
7. Surface metal raceway fittings: As recommended by the raceway manufacturer.
8. Expansion and deflection couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate, 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 fault currents in accordance with UL 467, and the NEC code tables for ground 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 by 38 mm (1 1/2 by 1 1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 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, Junction, and Pull Boxes:
1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that 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.

F. Wireways: Equip with hinged covers, except where removable covers are shown.

G. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with "CAUTION BURIED COMMUNICATIONS CABLE BELOW".

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:
1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural sections.
2. Cut 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 allowed, except where permitted by the COTR as required by limited working space.

B. 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 the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. Install conduit as follows:
1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 8'0" on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).

7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
12. Do not use aluminum conduits in wet locations.
13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. 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.

C. Layout and Homeruns:
1. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COTR.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
   a. Where shown on the structural drawings.
   b. As approved by the COTR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
   a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
   b. Space between conduits in slabs: Approximately six conduit diameters apart, except 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 (3/4 inch) of concrete around the conduits.
5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.

B. Furred or Suspended Ceilings and in Walls:
1. Conduit for conductors above 600 volts:
   a. Rigid steel or rigid aluminum.
   b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
2. Conduit for conductors 600 volts and below:
   a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.

5. Tightening set screws with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for conductors above 600 volts:
   1. Rigid steel or rigid aluminum.
   2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.

C. Conduit for Conductors 600 volts and below:
   1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.

D. Align and run conduit parallel or perpendicular to the building lines.

E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

F. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.

G. Surface metal raceways: Use only where shown.

H. Painting:
   1. Paint exposed conduit as specified in Section09 91 00, PAINTING.
   2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

3.5 EXPANSION JOINTS

A. Conduits 75 mm (3 inches) 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 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

C. Install expansion and deflection couplings where shown.

D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.6 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.

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 90 kg (200 pounds). 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 (1/4 inch) bolt size and not less than 28 mm (1 1/8 inch) embedment.
      b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
      c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted.

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.

3.7 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.

D. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG FA JB No. 1".

3.8 COMMUNICATION SYSTEM CONDUIT

A. Install the communication raceway system as shown on drawings.

B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.

C. All conduit ends shall be equipped with insulated bushings.

D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.

E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.

F. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.

G. Were drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

H. All empty conduits located in communication closets or on backboards shall be sealed with a standard non hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

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)

J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in Section 06 10 00, ROUGH CARPENTRY on the wall of communication closets where shown on drawings. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.

K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

END OF SECTION

SECTION 27 08 00
COMMISSIONING OF COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 27.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the communications systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.
   1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
   2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.
   3. Activities and documentation for the LEED™ section on “Measurement and Verification” requirements for the Measurement and Verification credit.

D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Communications systems will be commissioned:
   1. Facility Telecommunications and Data Distribution Systems.
   2. Nurse Call / Code Blue systems (Local stations, system hardware and software, reset functions, response time per activation, and notification signals.
   3. Public Address and Mass Notification Systems (Amplifiers and head-end hardware, speaker volume, and background noise – i.e. hiss or similar interference).
   4. Healthcare Intercommunications and Program Systems (Local stations, system hardware and software, and notification signals).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Resident Engineer prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 27 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 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. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 27 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 27 10 00
STRUCTURED CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

A. Excavation and backfill for cables that are installed in conduit: Section 31 20 00, EARTH MOVING.

B. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

C. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

D. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

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

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.

B. American Society of Testing Material (ASTM):
   D2301-04 Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape

C. Federal Specifications (Fed. Spec.):
   A-A-59544-00 Cable and Wire, Electrical (Power, Fixed Installation)

D. National Fire Protection Association (NFPA):
   70-05 National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):
   44-02 Thermoset-Insulated Wires and Cables
   83-03 Thermoplastic-Insulated Wires and Cables

467-01	Electrical Grounding and Bonding Equipment
486A-01	Wire Connectors and Soldering Lugs for Use with Copper Conductors
486C-02	Splicing Wire Connectors
486D-02	Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
486E-00	Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
493-01	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
514B-02	Fittings for Cable and Conduit
1479-03	Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.

B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.2 COMMUNICATION AND SIGNAL WIRING

A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.

B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.

C. Multi conductor cables shall have the conductors color coded.

2.3 WIRE LUBRICATING COMPOUND

A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.

B. Shall not be used on wire for isolated type electrical power systems.

2.4 FIREPROOFING TAPE

A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame retardant elastomer.

B. The tape shall be self extinguishing and shall not support combustion. It shall be arc-proof and fireproof.

C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.

D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.

E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install all wiring in raceway systems.

B. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

C. Wire Pulling:
   1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
   2. Use ropes made of nonmetallic material for pulling feeders.
   3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Resident Engineer.
   4. Pull in multiple cables together in a single conduit.

3.2 INSTALLATION IN MANHOLES

A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 CONTROL, COMMUNICATION AND SIGNAL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.

B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

C. Where separate power supply circuits are not shown, connect the systems to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de energizing of the systems.

E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

3.4 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION

A. Install a permanent wire marker on each wire at each termination.

B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

C. Wire markers shall retain their markings after cleaning.

D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.5 EXISITNG WIRING

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

END OF SECTION

SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "the System"), and associated equipment and hardware to be installed in the VA Vivarium here-in-after referred to as "the Facility". The System shall include, but not be limited to: equipment cabinets, interface enclosures, and relay racks; necessary combiners, traps, and filters; and necessary passive devices such as: splitters, couplers, cable "patch", "punch down", and cross-connector blocks or devices, voice and data distribution sub-systems, and associated hardware. The System shall additionally include, but not be limited to: telecommunication closets (TC); telecommunications outlets (TCO); copper and fiber optic distribution cables, connectors, "patch" cables, and/or "break out" devices.

B. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.

C. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, and tested, by the Contractor.

D. The Voice and Digital Telecommunication Distribution Cable Equipment and System provides the media which voice and data information travels over and connects to the Telephone System which is defined as an Emergency Critical Care Communication System by the National Fire Protection Association (NFPA). Therefore, since the System connects to or extends the telephone system, the System's installation and operation shall adhere to all appropriate National, Government, and/or Local Life Safety and/or Support Codes, which ever are the more stringent for this Facility. At a minimum , the System shall be installed according to NFPA, Section 70, National Electrical Code (NEC), Article 517 and Chapter 7; NFPA, Section 99, Health Care Facilities, Chapter 3-4; NFPA, Section 101, Life Safety Code, Chapters 7, 12, and/or 13;this specification; and the original equipment manufacturer's (OEM) suggested installation design, recommendations, and instructions. The OEM and Contractor shall ensure that all management, sales, engineering, and installation personnel have read and understand the requirements of this specification before the System is designed, engineered, delivered, and provided.

E. The VA Project Manager (PM) and/or if delegated, COTR, are the approving authorities for all contractual and mechanical changes to the System. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the RE before proceeding with the change.

F. System Performance:
   1. At a minimum the System shall support the following operating parameters:
      a. Telecommunications Outlet (TCO):
         1) Voice:
            a) Isolation (outlet-outlet): 24 dB.
            b) Impedance: 600 Ohms, balanced (BAL).
            c) Signal Level: 0 deciBel per mili-Volt (dBmV) + 0.1 dBmV.
            d) System speed: 100 mBps, minimum.

e) System data error: 10 to the -6 Bps, minimum.

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

3) Fiber optic:
   a) Isolation (outlet-outlet): 36 dB.
   b) Signal Level: 0 dBmV + 0.1 dBmV.
   c) System speed: 540 mBps, minimum.
   d) System data error: 10 to the -6 bps, minimum.

1.2 RELATED WORK

A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Specification Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

D. Specification Section 27 10 00, STRUCTURED CABLING.

E. Specification Section 26 27 26, WIRING DEVICES.

F. Specification Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

G. Specification Section 26 41 00, FACILITY LIGHTNING PROTECTION.

H. Specification Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.

I. H-088-C3, VA HANDBOOK DESIGN FOR TELEPHONE 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 text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.

B. National Fire Protection Association (NFPA):

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

C. Underwriters Laboratories, Inc. (UL):

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

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

D. ANSI/EIA/TIA Publications:

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

E. Lucent Technologies: Document 900-200-318 “Outside Plant Engineering Handbook”.

F. International Telecommunication Union – Telecommunication Standardization Sector (ITU-T).

G. Federal Information Processing Standards (FIPS) Publications.

H. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.

I. United States Air Force: Technical Order 33K-l-lOO Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.

J. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.

K. National and/or Government Life Safety Code(s): The more stringent of each listed code.

1.4 QUALITY ASSURANCE

A. The authorized representative of the OEM, shall be responsible for the design, satisfactory total operation of the System, and its certification.

B. The OEM shall meet the minimum requirements identified in Paragraph 2.1.A. Additionally, the Contractor shall have had experience with three or more installations of systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identification of these installations shall be provided as a part of the submittal as identified in Paragraph 1.5.

C. The System Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The System Contractor shall be authorized by the OEM to certify and warranty the installed equipment. In addition, the OEM and System Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certification must be provided in writing as part of the Contractor’s Technical Submittal.

D. All equipment, cabling, terminating hardware, TCOs, and patch cords shall be sourced from the certifying OEM or at the OEM’s direction, and support the System design, the OEM’s quality control and validity of the OEM’s warranty.

E. The Contractor's Telecommunications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the RE before being allowed to commence work on the System.

1.5 SUBMITTALS

A. Provide submittals in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. The RE shall retain one copy for review and approval.
   1. If the submittal is approved the RE shall retain one copy for Official Records and return three (3) copies to the Contractor.
   2. If the submittal is disapproved, three (3) copies will be returned to the Contractor with a written explanation attached that indicates the areas the submittal deviated from the System specifications. The RE shall retain one copy for Official Records.

B. Environmental Requirements: Technical submittals shall confirm the environmental specifications for physical TC areas occupied by the System. These environmental specifications shall identify the requirements for initial and expanded system configurations for:
   1. Floor loading for batteries and cabinets.
   2. Minimum floor space and ceiling heights.
   3. Minimum size of doors for equipment passage.
   4. Power requirements: The Contractor shall provide the specific voltage, amperage, phases, and quantities of circuits required.
   5. Air conditioning, heating, and humidity requirements. The Contractor shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.
   6. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).
   7. Proposed floor plan, based on the expanded system configuration of the bidder's proposed EPBX for this FACILITY.
   8. Conduit size requirement (between main TC, computer, and console rooms).
   9. Main trunk line and riser pathways, cable duct, and conduit requirements between each MTC, TC, and TCO.

C. Documents: The submittal shall be separated into sections for each subsystem and shall contain the following:
   1. Title page to include:
      a. VA Medical Center.
      b. Contractor's name, address, and telephone (including FAX) numbers.
      c. Date of Submittal.
      d. VA Project No.
   2. List containing a minimum of three locations of installations of similar size and complexity as identified herein. These locations shall contain the following:
      a. Installation Location and Name.
      b. Owner's or User's name, address, and telephone (including FAX) numbers.
      c. Date of Project Start and Date of Final Acceptance by Owner.
      d. System Project Number.
      e. Brief (three paragraphs minimum) description of each system's function, operation, and installation.
   3. Narrative Description of the system.

4. A List of the equipment to be furnished. The quantity, make, and model number of each item is required. Delete equipment items that are not required add additional items required, and renumber section as per system design. The following is the minimum equipment required by the system:

QUANTITY	UNIT
As required	Cabinet Assembly(s)
As required	Environmental Cabinet
As required	Distribution/Interface Cabinet
As required	Equipment (Radio Relay) Rack
As required	Cross Connection (CCS) Systems
As required	Audio Alarm Panel
As required	TROUBLE ANNUNCIATOR PANEL
As required	Lightning Protection System
As required	Wire Management System/Equipment
As required	Telecommunications Outlets (TCO)
As required	Distribution Cables
As required	TCO Connection Cables
As required	System Connectors
As required	Terminators
As required	Distribution Frames
As required	Telecommunications Closets (TC)
As required	Environmental Requirements
1 ea.	Installation Kit
As required	Separate List Containing Each Equipment Spare(s)

5. Pictorial layouts of each MTC, IMTC, and RTCs; MCCS, IMCCS, VCCS, and HCCS termination cabinet(s), each distribution cabinet layout drawing, and TCO as each is expected to be installed and configured.
6. Equipment technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
7. Engineering drawings of the System, showing calculated signal levels at the EPBX output, each input and output distribution point, proposed TCO values, and signal level at each TCO multipin, fiberoptic jack.
8. List of test equipment as per paragraph 1.5.D. below.
9. Letter certifying that the Contractor understands the requirements of the SAMPLES Paragraph 1.5.E.
10. Letter certifying that the Contractor understands the requirements of Section 3.2 concerning acceptance tests.

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

c. Volt-Ohm Meter.
d. Time Domain Reflectometer (TDR) with strip chart recorder (Data and Optical Measuring).
e. Bit Error Test Set (BERT).
f. Camera with a minimum of 60 pictures to that will develop immediately to include appropriate test equipment adapters. A video camera in VHS format is an acceptable alternate.

E. Samples: A sample of each of the following items shall be furnished to the RE for approval prior to installation.
1. TCO Wall Outlet Box 4" x 4"x 2.5" with:
   a. One each telephone (or voice) rj45 jack installed.
   b. Two each multi pin data rj45 jacks installed.
   c. Cover Plate installed.
   d. Fiber optic ST jack(s) installed.
2. Data CCS patch panel, punch block or connection device with RJ45 connectors installed.
3. Telephone CCS system with IDC and/or RJ45 connectors and cable terminal equipment installed.
4. Fiber optic CCS patch panel or breakout box with cable management equipment and “ST” connectors installed.
5. 610 mm (2 ft.) section of each copper cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
6. 610 mm (2 ft.) section of each fiber optic cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.

F. Certifications:
1. Submit written certification from the OEM indicating that the proposed supervisor of the installation and the proposed provider of the contract maintenance are authorized representatives of the OEM. Include the individual's exact name and address and OEM credentials in the certification.
2. Submit written certification from the OEM that the wiring and connection diagrams meet National and/or Government Life Safety Guidelines, NFPA, NEC, UL, this specification, and JCAHCO requirements and instructions, requirements, recommendations, and guidance set forth by the OEM for the proper performance of the System as described herein. The VA will not approve any submittal without this certification.
3. Preacceptance Certification: This certification shall be made in accordance with the test procedure outlined in paragraph 3.2.B.

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

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

I. Surveys Required As A Part Of The Technical Submittal: The Contractor shall provide the following surveys that depict various system features and capacities are required in addition to the on site survey requirements described herein. Each survey shall be in writing and contain the following information (the formats are suggestions and may be used for the initial Technical Submittal survey requirements), as a minimum:

1. Cable Distribution System Design Plan: A design plan for the entire cable distribution systems requirements shall be provided with this document. A specific cable count shall coincide with the total growth items as described herein. It is the Contractor's responsibility to provide the Systems entire cable requirements and engineer a distribution system requirement plan using the format of the following paragraph(s), at a minimum:
   a. UTP (and/or STP) Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is provided from
BUILDING	Identifies the building by number, title, or location cabling is to be provided in
TO BUILDING IMC	Identifies building main terminal signal closet, by room number or location, to which cabling is provided too, in, and from
FLOOR	Identifies the floor by number (i.e. 1st, 2nd, etc.) cabling and TCOs are to be provided
TC ROOM NUMBER	Identifies the floor signal closet room, by room number, which cabling shall be provided
ROOM NUMBER	Identifies the room, by number, from which cabling and TCOs shall be provided
NUMBER OF CABLE PAIR	Identifies the number of cable pair required to be provided on each floor designated OR the number of cable pair (VA Owned) to be retained
NUMBER OF STRANDS USED/SPARE	Identifies the number of strands provided in each run

   b. Fiber Optic Cabling Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is provided from
TO BUILDING IMC	Identifies building, by number, title, or location, to which cabling is provided
FLOOR	Identifies the floor by number (i.e. 1st, 2nd, etc.)
TC ROOM NUMBER	Identifies the room, by number, from which cabling shall be installed
NUMBER OF STRANDS	Identifies the number of strands in each run of fiber optic cable
INSTALLED METHOD	Identifies the method of installation in accordance with as designated herein
NOTES	Identifies a note number for a special feature or

	equipment
BUILDING MTC	Identifies the building by number or title

2. Telecommunication Outlets: The Contractor shall clearly and fully indicate this category for each outlet location and compare the total count to the locations identified above as a part of the technical submittal. Additionally, the Contractor shall indicate the total number of spares.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. System Requirements:
   1. The System shall provide the following minimum services that are designed in accordance with and supported by an Original Equipment Manufacturer (OEM), and as specified herein. The System shall provide continuous inter and/or intra-Facility voice and data service. The System shall be capacity sized so that loss of connectivity to external telephone systems shall not affect the Facilities operation in specific designated locations. The System shall:
      a. Be capable of inter-connecting and functioning fully with the existing Local Telephone Exchange (LEC) Network(s), Federal Telephone System (FTS) Inter-city Network(s), Inter-exchange Carriers, Integrated Services Digital Network (ISDN), Electronic Private Branch Exchange (EPBX) switches, asynchronous/synchronous data terminals and circuits including Automatic Transfer Mode (ATM), Frame Relay, and local area networks (LAN), at a minimum.
      b. Be a voice and data cable distribution system that is based on a physical “Star” Topology.
      c. Be compatible with and able to provide direct digital connection to trunk level equipment including, but, not limited to: directly accessing trunk level equipment including the telephone system, audio paging, Industry Standard “T” and/or “DS” carrier services and external protocol converters. Additionally, connections to “T” and/or “DS” access/equipment or Customer Service Units (CSU) that are used in FTS and other trunk applications shall be included in the System design. Provide T-1 access/equipment (or CSU), as required for use, in FTS and other trunk applications by system design if this equipment is not provided by the existing telephone system and/or will be deactivated by the installation of the System. The Contractor shall provide all T-1 equipment necessary to terminate and make operational the quantity of circuits designated. The CSU's shall be connected to the System’s emergency battery power supply. The System shall be fully capable of operating in the Industry Standard “DS” protocol and provide that service when required.
      d. Where the System connects to an existing or future telephone system, refer to specification Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT for specific telephone equipment and system operational performance standards.
   2. Specific Subsystem Requirements: The System shall consist, as a minimum, of the following independent sub-systems to comprise a complete and functional voice and digital telecommunications cabling system: “Main” (MTC), “intermediate” (IMTC), and “riser” (RTC) TC’s; “vertical” (or “riser”) trunk cabling system; vertical cross-connection (VCC) cabling systems, and TCO’s with a minimum of three (3) RJ-45 jacks for the appropriate telephone, Data connections, and additional jacks, connectors, drop and patch cords, terminators, and adapters provided.
      a. Telecommunication Closet (TC):

1) There shall be a minimum of one TC for the MTC, each building IMTC, and each RTC per building floor location. However, in large building(s), where the horizontal distance to the farthest voice and digital work area may exceed 90 Meters (M) (or 295 feet [ft]), additional TC's shall be provided as described herein. The maximum DC resistance per cable pair shall be no more than 28.6 Ohms per 305 M (1,000 feet). Each TC shall be centrally located to cover the maximum amount of local floor space. The TC's house in cabinets or enclosures, on relay racks, and/or on backboards, various telecommunication data equipment, controllers, multiplexers, bridges, routers, LAN hub(s), telephone cross-connecting, active and passive equipment.
2) Additionally, the TC's may house fire alarm, nurses call, code one (or blue), video, public address, radio entertainment, intercom, and radio paging equipment. Regardless of the method of installation, mounting, termination, or cross-connecting used, all vertical copper and fiber optic cables shall be terminated on appropriate cross-connection systems (CCS) containing patch panel(s), punch blocks, and/or breakout devices provided in enclosures and tested as described herein. A cable and/or wire management system shall be a part of each CCS.
    a) A minimum of three 110-120 VAC active quad outlets shall be provided, each with "U" grounded receptacles at a minimum of one outlet for each front, side and back wall. These outlets shall be separately protected by an AC circuit breaker provided in the designated Government Emergency Critical Care AC power panel, that is connected to the Facilities Emergency AC Power Distribution System. For larger building TC applications, a minimum of one additional quad AC outlet shall be provided for every 800M² (or 8,000 ft²) of useable floor space. Additional outlets shall be equally spaced along the wall.
    b) Climate control shall be provided in each TC 24 hours a day, seven days per week and 52 week per year to prevent failure of electronic components and for mission critical functional applications. The RE or Facility Chief Engineering Officer are responsible for informing the Contractor regarding the minimum climate control requirements. In identified hostile TC locations where it has been determined (by the RE or Facility Chief Engineer) that proper TC climate or external signal radiation cannot be properly maintained or controlled, the Contractor may, at his/her option, provide a minimum of two individual and properly sized self contained climate controlled equipment cabinet enclosures; one designated for voice, and one designated for data service, in each TC location identified on the drawings, in lieu of providing additional required TC air handling capability.

B. System Performance:
1. At a minimum the System shall support the following operating parameters:
a. Telecommunications Outlet (TCO):
1) Voice:
a) Isolation (outlet-outlet): 24 dB.
b) Impedance: 600 Ohms, balanced (BAL).
c) Signal Level: 0 deciBel per mili-Volt (dBmV) + 0.1 dBmV.
d) System speed: 100 mBps, minimum.
e) System data error: 10 to the -6 Bps, minimum.
2) Data:
a) Isolation (outlet-outlet): 24 dB.
b) Impedance: 600 Ohms, BAL.
c) Signal Level: 0 dBmV + 0.1 dBmV.
d) System speed: 120 mBps, minimum.
e) System data error: 10 to the -8 Bps, minimum.

3) Fiber optic:
   a) Isolation (outlet-outlet): 36 dB.
   b) Signal Level: 0 dBmV + 0.1 dBmV.
   c) System speed: 540 mBps, minimum.
   d) System data error: 10 to the -6 BPS, minimum.

C. General:
1. All equipment to be supplied under this specification shall be new and the current model of a standard product of an OEM or record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
   a. Maintains a stock of replacement parts for the item submitted.
   b. Maintains engineering drawings, specifications, and operating manuals for the items submitted.
   c. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
2. Specifications of equipment as set forth in this document are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity, or performance characteristics of items furnished in the System. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.
3. The Contractor shall provide written verification, in writing to the RE at time of installation, that the type of wire/cable being provided is recommended and approved by the OEM. The Contractor is responsible for providing the proper size and type of cable duct and/or conduit and wiring even though the actual installation may be by another subcontractor.
4. The Telephone Contractor is responsible for providing interfacing cable connections for the telephone, Radio Paging systems with the System.
5. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone equipment, systems, and service.
6. All passive distribution equipment shall meet or exceed -80 dB radiation shielding specifications.
7. All interconnecting twisted pair, fiber-optic cables shall be terminated on equipment terminal boards, punch blocks, breakout boxes, splice blocks, and unused equipment ports/taps shall be terminated according to the OEM's instructions for telephone cable systems without adapters. The Contractor shall not leave unused or spare twisted pair wire, fiber-optic cable unterminated, unconnected, loose or unsecured.
8. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, which ever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING and Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.
9. Connect the System's primary input AC power to the Facility' Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with RE regarding a suitable circuit location prior to bidding.

10. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and interface points. Coaxial cable distribution points and RF transmission lines shall use coaxial cable connections recommended by the cable OEM and approved by the System OEM. Base- band cable systems shall utilize barrier terminal screw type connectors, at a minimum. Crimp type connectors installed with a ratchet type installation tool are and acceptable alternate as long as the cable dress, pairs, shielding, grounding, and connections and labeling are provided the same as the barrier terminal strip connectors. Tape of any type, wire nuts, or solder type connections are unacceptable and will not be approved.
11. All equipment faceplates utilized in the System shall be stainless steel, anodized aluminum, or UL approved cycolac plastic for the areas where provided.
12. Noise filters and surge protectors shall be provided for each equipment interface cabinet, switch equipment cabinet, control console, local, and remote active equipment locations to ensure protection from input primary AC power surges and noise glitches are not induced into low Voltage data circuits.
    a. Underground warning tape shall be standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable, red with black letters imprinted with “CAUTION BURIED ELECTRIC LINE BELOW”, orange with black letters imprinted with “CAUTION BURIED TELEPHONE LINE BELOW” or orange with black letters imprinted with “CAUTION BURIED FIBER OPTIC LINE BELOW”, as applicable.

D. Equipment Functional Characteristics:

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

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

2.2 EQUIPMENT ITEMS

A. Cabinet with Internal Equipment Mounting Rack:
   1. The provided equipment cabinet shall be lockable, fabricated of heavy 16 gauge (ga) steel, and have fully adjustable internal equipment mounting racks or rails that allows front panel equipment mounting and access. It shall have baked-on iron phosphate primer and baked enamel paint finish in a color to be selected by the using Facility Service Chief. It shall be floor or wall mounted with knock-out holes for cable entrance and conduit connection, contain ventilation ports and a quiet fan with non disposable air filter for equipment cooling. Two keys shall be provided to the RE for each lock when the VA accepts the System.
   2. A minimum of one cabinet shall be provided with blank rack space, for additional equipment. Blank panels shall be installed to cover any open or unused rack space. In addition, provide two 120 VAC power strips connected to surge protectors, a ventilation fan with non-disposable air filter, and a conduit or cable duct interfaced to adjacent cabinet(s), as part of this cabinet.
   3. Blank panels shall be color matched to the cabinet, 3.175 mm (1/8in.) aluminum with vertical dimensions in increments of one rack unit 45 mm (or 1.75in.) with mounting holes spaced to correspond to EIA 480 mm (or 19in.) rack dimensions. Single standard size blank panels shall be used to fill unused panel or rack spaces in lieu of numerous 45 mm (1.75in.) types. One blank 45 mm (1.75in.) high blank panel shall be installed between each item of equipment.
   4. Technical Characteristics:

Overall Height	2180 mm (85 7/8in.), maximum
Overall Depth	650 mm (25 1/2in.), maximum
Overall Width	535 mm (21 1/16in.), maximum
Front Panel Opening Width	480 mm (19in.), EIA horizontal
Hole Spacing	per EIA and Industry Standards

   5. Internal Cabinet Components (minimum required):
      a. AC power outlet strip(s):
         1) Power outlet strip(s) shall be provided as directed by the RE or the IRM. The additional equipment cabinet with no installed items in the cabinet, shall contain strip(s) with a minimum of 12 ea. AC power outlets. Each strip shall be mounted inside and at the rear of the cabinet. It shall contain “U” grounded AC outlets for distributing AC power to the installed electronic equipment. The strip shall be self-contained in a metal enclosure and may be provided with a 2 M (6 ft.) long (maximum) connecting cord with three prong plug.
         2) Technical Characteristics:
            a) Power capacity20 Ampere (AMP), 120 VAC continuous duty.
            b) Wire gauge: Three conductor, #12 AWG copper.
      b. Cabinet AC Power Line Surge Protector and Filter:
         1) Each cabinet shall be equipped with a AC Surge Protector and Filter. The Protector and Filter shall be housed in one single enclosure. The Protector and Filter shall perform instantaneous regulation of the AC input voltage and isolate and filter any noise present on the AC input line. The unit shall be equipped with AC voltage and current surge protectors to prevent damage to the electronic equipment from power line induced voltage spikes, surges, lightning, etc. It shall be cabinet mounted and the cabinet AC power strip (maximum of two strips) may be connected to it as long as the system design is met.
         2) Technical Characteristics:

Input Voltage range	120 VAC + 15%
Power capacity	20 AMP, 120 VAC
Voltage output regulation	+3.0%
Circuit breaker	15 AMP, may be self contain
Noise filtering	Greater than -45 dB
AC outlets	Four duplex grounded types, minimum
Response time	5.0 ns
Surge suppression	10,000 AMPS
Noise suppression	
Common	-40 dB
Differential	-45 dB

3) Specific requirements for current and surge protection shall include:
   a) Voltage protection threshold, line to neutral, starts at no more than 220 Volts peak. The transient voltage shall not exceed 300 volts peak. The Contractor shall furnish documentation on peak clamping voltage as a function of transient AMP.
   b) Peak power dissipation minimum 35 Joules per phase, as measured for l.0 mS at sub branch panels, l00 Joules per phase at branch panels and 300 Joules per phase at service entrance panels. The Contractor shall furnish an explanation of how the ratings were measured or empirically derived.
   c) Surge protector must not short circuit the AC power line at any time.
      (1) The primary surge protection components must be silicon semiconductors. Secondary stages, if used, may include other types of devices.
      (2) Surge protectors shall incorporate a visual device which indicates whether the surge suppression component(s) is (are) functioning.
      (3) Surge protection devices shall be UL listed.
      (4) Voltage and current surge protectors shall be provided on all ancillary equipment provided by the Contractor.
   d) Power dissipation 12,000 Watts (W) for l.0 mS (or l2 Joules).
   e) Voltage protection threshold starts at not more than 100 VAC.

B. Environmental Cabinet (if selected):
   1. The Contractor shall provide this enclosure in lieu of a standard equipment cabinet identified in Paragraph 2.3.A to meet system design in hostile TC locations as identified on the drawings. The enclosure shall fully sustain the installed, including electronic, equipment in the same manner as the standard cabinet identified in Paragraph 2.3.A. Additionally, the enclosure shall fully support all installed equipment as if they were in a stand alone air handling area regardless of the local area's air handling capabilities. The enclosure shall be a OEM's fully assembled unit. If more than two enclosures are required in any system location, those enclosures shall be OEM assembled for consolidating or combining two or more enclosures in a single unit to meet system space and equipment handling designs.
   2. Technical Characteristics:

Environmental control	Automatic, heating and/or cooling, as required
Temperature conditions (rated at 1,300 W of install equipment heat generation):	
Internal Range	Maintains 80° to 105° of internal heat conditions, maximum
External Range	100° + 25°, maximum
Forced air unit	Required with non disposable air filter unobstructed and uninterruptible
Air conditioning	As required, fully internal mounted

Heater	As required, fully internal mounted
Uninterruptible power supply	As required, fully internal mounted
Front door	Full length, see through, EMI resistant, and lockable
Rear door	Full length, non-see through, EMI resistant, and lockable
Conduit wiring entrance	TOP AND/OR BOTTOM, FULLY SEALED
Input power	2 ea. minimum 120 VAC @ 20A, maximum, independent circuit, conduit for fixed or armored cable for moveable installations
Dimensions:	
Height	1980 mm (78in.), maximum
Width	635 mm (25in.), maximum
Depth	965 mm (38in.), maximum
Front panel opening	480 mm (19in.), w/ EIA mounting hole spacing

C. Distribution or System Interface Cabinet:
   1. The cabinet shall be constructed of heavy 16 gauge cold rolled steel, have top and side panels and hinged front and rear (front door only if wall mounted) doors. It shall have baked-on iron phosphate primer and baked enamel paint finish in a color to be selected by the using Facility Service Chief or the RE, contain integral and adjustable predrilled rack mounting rails or frame that allows front panel equipment mounting and access. When all equipment, doors and panels are installed, snap-in-place chrome trim strip covers are required to be installed that will cover all front panel screw fasteners. It shall be equipped the same as the equipment cabinet.
   2. Technical Characteristics:

Overall height	2180 mm (85 7/8in.), maximum
Overall depth	650 mm (25 1/2in.), maximum
Overall width	535 mm (21 1/16in.), maximum
Equipment vertical mounting space	1960 mm (77 1/8in.), maximum
Front panel horizontal	484 mm (19 1/16in.), maximum width

D. Stand Alone Equipment (or sometimes called Radio Relay) Rack:
   1. The rack shall be constructed of heavy 16 gauge cold rolled steel and have fully adjustable equipment front mounting rails that allows front panel equipment mounting and access. It shall have baked-on iron phosphate primer and baked enamel paint finish in a color to be selected by the using Facility Service Chief or the RE. It shall be floor or wall mounted or mounted on casters as directed by the RE.
   2. Technical Characteristics:

Overall Height	2180 mm (85 7/8in.), maximum
Overall Depth	650 mm (25 1/2in.), maximum
Overall Width	535 mm (21 1/16in.), maximum
Front Panel Opening	480 mm (19in.), EIA horizontal width
Hole Spacing	per EIA and Industry Standards

E. Cross-Connection System (CCS) Equipment Breakout, Termination Connector (or Bulkhead), and Patch Panels:

1. The connector panel(s) shall be made of flat smooth 3.175 mm (1/8 in.) thick solid aluminum, custom designed, fitted and installed in the cabinet. Bulkhead equipment connectors shall be mounted on the panel to enable all cabinet equipment's signal, control, and coaxial cables to be connected through the panel. Each panel shall be color matched to the cabinet installed.
   a. Voice (or Telephone):
      1) The CSS for voice or telephone service shall be Industry Standard type 110 (minimum) punch blocks for voice or telephone, and control wiring in lieu of patch panels, each being certified for category six service. IDC punch blocks (with internal RJ45 jacks) are acceptable for use in all CCS and shall be specifically designed for category six telecommunications service and the size and type of UTP cable used as described herein. As a minimum, punch block strips shall be secured to an OEM designed physical anchoring unit on a wall location in the MTC, IMTC, RTC, and TC. However, console, cabinet, rail, panel, etc. mounting is allowed at the OEM recommendation and as approved by the RE. Punch blocks shall not be used for Class II or 120 VAC power wiring.
      2) Technical Characteristics:

Number of horizontal rows	100, MINIMUM
Number of terminals per row	4, minimum
Terminal protector	required for each used or unused terminal
Insulation splicing	required between each row of terminals

   b. Digital or High Speed Data:
      1) The CSS for digital or high-speed data service shall be a patch panel with modular female RJ45 jacks installed in rows. Patch panels and RJ45 jacks shall be specifically designed for category six telecommunications service and the size and type of UTP or STP cable used. Each panel shall be 480 mm (19in.) horizontal EIA rack mountable dimensions with EIA standard spaced vertical mounting holes.
      2) Technical Characteristics:

Number of horizontal rows	2, minimum
Number of jacks per row	24, MINIMUM
Type of jacks	RJ45
Terminal protector	required for each used or unused jack
Insulation	required between each row of jacks

   c. Fiber optic:
      1) Product reference of a Government Approved (US State Department) type is Telewire, PUP-17 with pre-punched chassis mounting holes arranged in two horizontal rows. This panel may be used for fiber optic, audio, control cable, and Class II Low Voltage Wiring installations when provided with the proper connectors. This panel is not allowed to be used for 120 VAC power connections.
      2) Technical Characteristics:

Height	Two rack units (RUs), 88 mm (3.5in.) minimum
Width	484 mm (19 1/16in.), EIA minimum
Number of connections	12 pairs, minimum
Connectors	
Audio Service	Use RCA 6.35 mm (1/4in.) Phono, XL or Barrier Strips, surface mounted with spade lugs (punch

	block or wire wrap type strips are acceptable alternates for barrier strips as long as system design is maintained and RE approved)
Control Signal Service	Barrier strips surface mounted with spade lugs (punch block or wire wrap type strips are acceptable alternates for barrier strips as long as system design is maintained and RE approved)
Low voltage power (class II)	Barrier strips with spade lugs and clear full length plastic cover, surfaced mounted
Fiber optic	"ST" Stainless steel, female

d. Mounting Strips and Blocks:
   1) Barrier Strips: Barrier strips are approved for AC power, data, voice, and control cable or wires. Barrier strips shall accommodate the size and type of audio spade (or fork type) lugs used with insulating and separating strips between the terminals for securing separate wires in a neat and orderly fashion. Each cable or wire end shall be provided with an audio spade lug, which is connected to an individual screw terminal on the barrier strip. The barrier strips shall be surface secured to a console, cabinet, rail, panel, etc. 120 VAC power wires shall not be connected to signal barrier strips.
   2) Technical Characteristics:

Terminal size	6-32, minimum
Terminal Count	ANY COMBINATION
Wire size	20 AWG, minimum
Voltage handling	100 V, minimum
Protective connector cover	Required for Class II and 120 VAC power connections

2. Solderless Connectors: The connectors (or fork connectors) shall be crimp-on insulated lug to fit a 6-32 minimum screw terminal. The fork connector shall be installed using a standard lug-crimping tool.
3. Punch Blocks: As a minimum, Industry Standard 110 type punch blocks are approved for data, voice, and control wiring. Punch blocks shall be specifically designed for the size and type of wire used. Punch block strips shall be secured to a console, cabinet, rail, panel, etc. Punch blocks shall not be used for Class II or 120 VAC power wiring.
4. Wire Wrap Strips: Industry Standard wire wrap strips (16.5 mm (0.065in.) wire wrap minimum) are approved for data, voice and control wiring. Wire wrap strips shall be secured to a cabinet, rail, panel, etc. Wire wrap strips shall not be used for Class II or 120 VAC power wiring.

F. Wire Management System and Equipment:
   1. Wire Management System: The system(s) shall be provided as the management center of the respective cable system, CCS, and TC it is incorporated. It shall perform as a platform to house peripheral equipment in a standard relay rack or equipment cabinet. It shall be arranged in a manner as to provide convenient access to all installed management and other equipment. All cables and connections shall be at the rear of each system interface to IDC and/or patch panels, punch blocks, wire wrap strips, and/or barrier strip.

2. Wire Management Equipment: The wire management equipment shall be the focal point of each wire management system. It shall provide an orderly interface between outside and inside wires and cables (where used), distribution and interface wires and cables, interconnection wires and cables and associated equipment, jumper cables, and provide a uniform connection media for all system fire retardant wires and cables and other subsystems. It shall be fully compatible and interface to each cable tray, duct, wireway, or conduit used in the system. All interconnection or distribution wires and cables shall enter the system at the top (or from a wireway in the floor) via a overhead protection system and be uniformly routed down either side (or both at the same time) of the frames side protection system then laterally via a anchoring or routing shelf for termination on the rear of each respective terminating assembly. Each system shall be custom configured to meet the System design and user needs.

2.3 ENVIRONMENTAL REQUIREMENTS

A. Technical submittals shall identify the environmental specifications for housing the system. These environmental specifications shall identify the requirements for initial and expanded system configurations for:

B. Floor loading for batteries and cabinets.

C. Minimum floor space and ceiling heights.

D. Minimum size of doors for equipment passage.

E. Power requirements: The bidders shall provide the specific voltage, amperage, phases, and quantities of circuits required.

F. Air conditioning, heating, and humidity requirements. The bidder shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.

G. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).

H. Proposed floor plan based on the expanded system configuration of the bidder's proposed EPBX for this Facility.

I. Conduit size requirement (between equipment room and console room).

2.4 INSTALLATION KIT

A. The kit shall be provided that, at a minimum, includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. Turn over to the RE all unused and partially opened installation kit boxes, coaxial, fiberoptic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware. The following are the minimum required installation sub-kits:

B. System Grounding:
   1. The grounding kit shall include all cable and installation hardware required. All radio equipment shall be connected to earth ground via internal building wiring, according to the NEC.
   2. This includes, but is not limited to:
      a. Coaxial Cable Shields.
      b. Control Cable Shields.
      c. Data Cable Shields.

d. Equipment Racks.
e. Equipment Cabinets.
f. Conduits.
g. Duct.
h. Cable Trays.
i. Power Panels.
j. Connector Panels.
k. Grounding Blocks.

C. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.

D. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.

E. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.

F. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.

G. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.

H. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. System Installation:
1. After the contract's been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the RE and PM.

2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.
3. The Contractor shall install suitable filters, traps, directional couplers, splitters, TC's, and pads for minimizing interference and for balancing the System. Items used for balancing and minimizing interference shall be able to pass telephone and data signals in the frequency bands selected, in the direction specified, with low loss, and high isolation, and with minimal delay of specified frequencies and signals. The Contractor shall provide all equipment necessary to meet the requirements of Paragraph 2.1.C and the System performance standards.
4. All passive equipment shall be connected according to the OEM's specifications to insure future correct termination, isolation, impedance match, and signal level balance at each telephone/data outlet.
5. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
6. All lines shall be terminated in a suitable manner to facilitate future expansion of the System. There shall be a minimum of one spare 25 pair cable at each distribution point on each floor.
7. All vertical copper and fiber optic cables shall be terminated so any future changes only requires modifications of the EPBX or signal closet equipment only.
8. Terminating resistors or devices shall be used to terminate all unused branches, outlets, equipment ports of the System, and shall be devices designed for the purpose of terminating fiber optic or twisted pair cables carrying telephone and data signals in telephone and data systems.
9. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.
10. Equipment installed indoors shall be installed in metal cabinets with hinged doors and locks with two keys.

C. Conduit and Signal Ducts:
1. Conduit:
   a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 19 mm (3/4 in.).
   b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the RE if requested.) Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.
   c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
   d. When "innerduct" flexible cable protective systems is specifically authorized to be provided for use in the System, it's installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.

e. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.

f. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.

g. Ensure that Critical Care Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.

2. Signal Duct, Cable Duct, or Cable Tray:

a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the RE.

b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.

c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The RE shall approve width and height dimensions.

D. Connectors: Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system.

1. Wires:

a. Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire. Tape of any type is not acceptable.

b. Audio spade lugs shall be installed on each wire (including spare or unused) end and connect to screw terminals of appropriate size barrier strips. AC barrier strips shall be provided with a protective cover to prevent accidental contact with wires carrying live AC current. Punch blocks are approved for signal, not AC wires. Wire Nut or "Scotch Lock" connectors are not acceptable for signal wire installation.

2. Cables: Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, wirewrap, etc.

3. Line or Microphone Audio: Each connector shall be installed according to the cable or connector OEM's instructions and use the OEM's approved installation tool. Install the connector's to provide and maintain the following audio signal polarity:

a. XLR type connectors Signal or positive conductor is pin 3; common or neutral conductor is pin 2; ground conductor is pin 1.

b. Two and 3 conductor 1/4" Signal or positive conductor is tip; neutral or 1/8" phono plugs conductor is ring and ground or shield and jacks conductor is sleeve.

c. RCA Phono Plugs the Signal or positive conductor is tip; and Jacks neutral or shield conductor is sleeve.

4. Speaker Line Audio:

a. Each connector shall be installed according to the cable, transformer or speaker OEM instructions and using the OEM's approved installation tool. The Contractor shall ensure each speaker is properly phased and connected in the same manner throughout the System using two conductor type wires.

b. One of the conductors shall be color coded to aid in establishing speaker signal polarity. Each speaker line shall be permanently soldered or audio spade lug connected to each appropriate speaker or line matching transformer connection terminal. Speaker line connection to each audio amplifier shall use audio spade lugs, as described herein.

E. AC Power: AC power wiring shall be run separately from signal cable.

F. Grounding:
1. General: The Contractor shall ground all Contractor Installed Equipment and identified Government Furnished Equipment to eliminate all shock hazards and to minimize, to the maximum extent possible, all ground loops, common mode returns, noise pickup, crosstalk, etc. The total ground resistance shall be 0.1 Ohm or less.
   a. The Contractor shall install lightning arrestors and grounding in accordance with the NFPA and this specification.
   b. Gas protection devices shall be provided on all circuits and cable pairs serving building distribution frames located in buildings other than the building in which the Vivarium is located or in any area served by an unprotected distribution system (manhole, aerial, etc.). The Contractor shall install the gas protection devices at the nearest point of entrance in buildings where protection is required and on the same circuits on the MDF in the telephone switch room.
   c. Under no conditions shall the AC neutral, either in a power panel or in a receptacle outlet, be used for system control, subcarrier or audio reference ground.
   d. The use of conduit, signal duct or cable trays as system or electrical ground is not acceptable and will not be permitted. These items may be used only for the dissipation of internally generated static charges (not to be confused with externally generated lightning) that may applied or generated outside the mechanical and/or physical confines of the System to earth ground. The discovery of improper system grounding shall be grounds to declare the System unacceptable and the termination of all system acceptance testing.
2. Cabinet Buss: A common ground buss of at least #10 AWG solid copper wire shall extend throughout each equipment cabinet and be connected to the system ground. Provide a separate isolated ground connection from each equipment cabinet ground buss to the system ground. Do not tie equipment ground busses together.
3. Equipment: Equipment shall be bonded to the 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 alternates.
4. Cable Shields: Cable shields shall be bonded to the cabinet ground buss with #12 AWG minimum stranded copper wire at only one end of the cable run. Cable shields shall be insulated from each other, faceplates, equipment racks, consoles, enclosures or cabinets; except, at the system common ground point. Coaxial and audio cables, shall have one ground connection at the source; in all cases, cable shield ground connections shall be kept to a minimum.

G. Equipment Assembly:
1. Cabinets:
   a. Each enclosure shall be: floor or wall mounted with standard knockout holes for conduit connections or cable entrance; provide for ventilation of the equipment; have front and rear locking doors (except wall mounted cabinets that require only a front locking door); power outlet strip(s), and connector or patch panel(s).

b. Rack (including freestanding radio relay) mounted equipment shall be installed in the enclosure's equipment adjustable mounting racks with equipment normally requiring adjustment or observation mounted so operational adjustment(s) can be conveniently made. Heavy equipment shall be mounted with rack slides or rails allowing servicing from the front of the enclosure. Heavy equipment shall not depend only upon front panel mounting screws for support. Equipment shall be provided with sufficient cable slack to permit servicing by removal of the installed equipment from the front of the enclosure. A color matched blank panel (spacer) of 44 mm (1.75 in.) high, shall be installed between each piece of equipment (active or passive) to insure adequate air circulation. The enclosure shall be designed for efficient equipment cooling and air ventilation. Each console or cabinet shall be equipped with a quiet fan and nondisposable air filter.

c. Enclosures and racks shall be installed plumb and square. Each shall be permanently attached to the building structure and held firmly in place. Fifteen inches of front vertical space opening shall be provided for additional equipment.

d. Signal connector, patch, and bulkhead panels (i.e.: audio, data, control, analog video, etc.) shall be connected so that outputs from each source, device or system component shall enter the panel at the top row of jacks, beginning left to right as viewed from the front, which will be called "inputs". Each connection to a load, device or system component shall exit the panel at the bottom row of jacks, beginning left to right as viewed from the front, which will be called "outputs".

1) Equipment located indoors shall be installed in metal racks or enclosures with hinged doors to allow access for maintenance without causing interference to other nearby equipment.

2) Cables shall enter the equipment racks or enclosures in such a manner that allows all doors or access panels to open and close without disturbing or damaging the cables.

3) All distribution hardware shall be securely mounted in a manner that allows access to the connections for testing and provides sufficient room for the doors or access panels to open and close without disturbing the cables.

H. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for voice and data circuits shall be stenciled using laser printers. Handwritten labels are not acceptable.

1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams".

3.2 TESTS

A. Interim Inspection:

1. This inspection shall verify that the equipment provided adheres to the installation requirements of this document. The interim inspection will be conducted by a factory-certified representative and witnessed by a Government Representative. Each item of installed equipment shall be checked to insure appropriate UL certification markings. This inspection shall verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B pin assignments and cabling connections are in compliance with ANSI/EIA/TIA standards. Visually confirm Category 6 marking of outlets, faceplates, outlet/connectors and patch cords.
2. Perform fiber optical field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.
3. The Contractor shall notify the RE, in writing, of the estimated date the Contractor expects to be ready for the interim inspection, at least 20 working days before the requested inspection date.
4. Results of the interim inspection shall be provided to the RE and PM. If major or multiple deficiencies are discovered, a second interim inspection may be required before permitting the Contractor to continue with the system installation.
5. The RE and/or the PM shall determine if an additional inspection is required, or if the Contractor will be allowed to proceed with the installation. In either case, re-inspection of the deficiencies noted during the interim inspection(s), will be part of the proof of performance test. The interim inspection shall not affect the Systems' completion date. The Contracting Officer shall ensure all test documents will become a part of the Systems record documentation.

B. Pretesting:
1. Upon completing the installation of the System, the Contractor shall align and balance the system. The Contractor shall pretest the entire system.
2. Pretesting Procedure:
   a. During the system pretest, the Contractor shall verify (utilizing the approved spectrum analyzer and test equipment) that the System is fully operational and meets all the system performance requirements of this standard.
   b. The Contractor shall pretest and verify that all System functions and specification requirements are met and operational, no unwanted aural effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise, etc. are present. The Contractor shall measure and record the aural carrier levels of each system telephone and data channel, at each of the following points in the system:
      1) Local Telephone Company Interfaces or Inputs.
      2) EPBX interfaces or inputs and outputs.
      3) MDF interfaces or inputs and outputs.
      4) EPBX output S/NR for each telephone and data channel.
      5) Signal Level at each interface point to the distribution system, the last outlet on each trunk line plus all outlets installed as part of this contract.
3. The Contractor shall provide four (4) copies of the recorded system pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the RE.

C. Acceptance Test:

1. After the System has been pretested and the Contractor has submitted the pretest results and certification to the RE, then the Contractor shall schedule an acceptance test date and give the RE 30 days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of a Government Representative and an OEM certified representative. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety compliance. The test shall verify that the total System meets the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

D. Verification Tests:
   1. Test the copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test the operation of shorting bars in connection blocks. Test cables after termination and prior to cross-connection.
   2. Multimode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with ANSI/EIA/TIA-568-B.3 and ANSI/EIA/TIA-526-14A using Method A, Optical Power Meter and Light Source and Method B, OTDR . Perform verification acceptance test.
   3. Single mode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with ANSI/EIA/TIA-568-B.3 and ANSI/EIA/TIA-526-7 using Method A, Optical Power Meter and Light Source and/ Method B, OTDR. Perform verification acceptance test.

E. Performance Testing:
   1. Perform Category 6 tests in accordance with ANSI/EIA/TIA-568-B.1 and ANSI/EIA/TIA-568-B.2. Test shall include the following: wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
   2. Fiber Optic Links: Perform end-to-end fiber optic cable link tests in accordance with ANSI/EIA/TIA-568-B.3.

F. Total System Acceptance Test: The Contractor shall perform verification tests for copper cabling system(s) and the multimode fiber optic cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.
   1. Voice Testing: Connect to the network interface device at the demarcation point. Go off-hook and receive dial tone from the LEC. If a test number is available, place and receive a local, long distance, and FTS telephone call.
   2. Data Testing: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network is achieved.

3.3 TRAINING

A. Furnish the services of a factory-trained engineer or technician for a total of two four hour classes to instruct designated Facility IRM personnel. Instruction shall include cross connection, corrective, and preventive maintenance of the System and equipment.

B. Before the System can be accepted by the VA, this training must be accomplished. Training will be scheduled at the convenience of the Facilities Contracting Officer and Chief of Engineering Service.

3.4 GUARANTEE PERIOD OF SERVICE

A. Contractor's Responsibilities:

1. The Contractor shall guarantee that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the RE (or Facility Contracting Officer if the Facility has taken procession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.
3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
4. Additionally, the Contractor shall accomplish the following minimum requirements during the one year guarantee period:
   a. Response Time:
      1) The RE (or facility Contracting Officer if the facility has taken possession of the building[s]) are the Contractor's reporting and contact officials for the System trouble calls, during the guarantee period.
      2) A standard workweek is considered 8:00 A.M. to 5:00 P.M., Monday through Friday exclusive of Federal Holidays.
      3) The Contractor shall respond and correct on-site trouble calls, during the standard work week to:
         a) A routine trouble call within one working days of its report. A routine trouble is considered a trouble which causes a system outlet, station, or patch cord to be inoperable.
         b) An emergency trouble call within 6 hours of its report. An emergency trouble is considered a trouble which causes a subsystem or distribution point to be inoperable at anytime. Additionally, the loss of a minimum of 50 station or system lines shall be deemed as this type of a trouble call.
      4) The Contractor shall respond on-site to a catastrophic trouble call within 4 hours of its report. A catastrophic trouble call is considered total system failure.
         a) If a system failure cannot be corrected within four hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate system CSS or TCO equipment, or cables. The alternate equipment and/or cables shall be operational within four hours after the four hour trouble shooting time.
         b) Routine or emergency trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) shall also be deemed as a catastrophic trouble call if so determined by the RE or Facility Director. The RE or Facility Contracting Officer shall notify the Contractor of this type of trouble call at the direction of the Facilities Director.
   b. Required on-site visits during the one year guarantee period
      1) The Contractor shall visit, on-site, for a minimum of eight hours, once every 12 weeks, during the guarantee period, to perform system preventive maintenance, equipment cleaning, and operational adjustments to maintain the System according the descriptions identified in this SPEC.
         a) The Contractor shall arrange all Facility visits with the RE or Facility Contracting Officer prior to performing the required maintenance visits.
         b) The Contractor in accordance with the OEM's recommended practice and service intervals shall perform preventive maintenance during a non-busy time agreed to by the RE or Facility Contracting Officer and the Contractor.

c) The preventive maintenance schedule, functions and reports shall be provided to and approved by the RE or Facility Contracting Officer.

2) The Contractor shall provide the RE or Facility Contracting Officer a type written report itemizing each deficiency found and the corrective action performed during each required visit or official reported trouble call. The Contractor shall provide the RE with sample copies of these reports for review and approval at the beginning of the Total System Acceptance Test. The following reports are the minimum required:

a) Monthly Report: The Contractor shall provide a monthly summary all equipment and sub-systems serviced during this guarantee period to RE or Facilities Contracting Officer by the fifth working day after the end of each month. The report shall clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and Systems for preventive and predictive maintenance

b) Contractor Log: The Contractor shall maintain a separate log entry for each item of equipment and each sub-system of the System. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.

3) The RE or Facility Contracting Officer shall provide the Facility Engineering Officer, two (2) copies of actual reports for evaluation.

a) The RE or Facility Contracting Officer shall ensure copies of these reports are entered into the System's official acquisition documents.

b) The Facilities Chief Engineer shall ensure copies of these reports are entered into the System's official technical as-installed documents.

B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use, accidents, other vendor, contractor, owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the RE or Facility Contracting Officer in writing upon the discovery of these incidents. The RE or Facility Contracting Officer will investigate all reported incidents and render findings concerning any Contractor's responsibility.

END OF SECTION

SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "the System"), and associated equipment and hardware to be installed in the VA Vivarium here-in-after referred to as "the Facility". The System shall include, but not be limited to: equipment cabinets, interface enclosures, and relay racks; necessary combiners, traps, and filters; and necessary passive devices such as: splitters, couplers, cable "patch", "punch down", and cross-connector blocks or devices, voice and data distribution sub-systems, and associated hardware. The System shall additionally include, but not be limited to: telecommunication closets (TC); telecommunications outlets (TCO); copper and fiber optic distribution cables, connectors, "patch" cables, and/or "break out" devices.

B. The System shall be delivered free of engineering, manufacturing, installation, and functional defects. It shall be designed, engineered and installed for ease of operation, maintenance, and testing.

C. The term "provide", as used herein, shall be defined as: designed, engineered, furnished, installed, certified, and tested, by the Contractor.

D. The Voice and Digital Telecommunication Distribution Cable Equipment and System provides the media which voice and data information travels over and connects to the Telephone System which is defined as an Emergency Critical Care Communication System by the National Fire Protection Association (NFPA). Therefore, since the System connects to or extends the telephone system, the System's installation and operation shall adhere to all appropriate National, Government, and/or Local Life Safety and/or Support Codes, which ever are the more stringent for this Facility. At a minimum , the System shall be installed according to NFPA, Section 70, National Electrical Code (NEC), Article 517 and Chapter 7; NFPA, Section 99, Health Care Facilities, Chapter 3-4; NFPA, Section 101, Life Safety Code, Chapters 7, 12, and/or 13; Joint Commission on Accreditation of Health Care Organization (JCAHCO), Manual for Health Care Facilities, all necessary Life Safety and/or Support guidelines; this specification; and the original equipment manufacturer's (OEM) suggested installation design, recommendations, and instructions. The OEM and Contractor shall ensure that all management, sales, engineering, and installation personnel have read and understand the requirements of this specification before the System is designed, engineered, delivered, and provided.

E. The VA Project Manager (PM) and/or if delegated, Resident Engineer (RE) are the approving authorities for all contractual and mechanical changes to the System. The Contractor is cautioned to obtain in writing, all approvals for system changes relating to the published contract specifications and drawings, from the PM and/or the RE before proceeding with the change.

F. System Performance:
   1. At a minimum, the System shall be able to support voice and data operations for Category 6 Certified Telecommunication Service.
   2. At a minimum the System shall support the following operating parameters:
      a. Telecommunications Outlet (TCO):
         1) Voice:

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

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

3) Fiber optic:
a) Isolation (outlet-outlet): 36 dB.
b) Signal Level: 0 dBmV + 0.1 dBmV.
c) System speed: 540 mBps, minimum.
d) System data error: 10 to the -6 bps, minimum.

1.2 RELATED WORK

A. Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Specification Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

C. Specification Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.

D. Specification Section 27 10 00, STRUCTURED CABLING.

E. Specification Section 26 27 26, WIRING DEVICES.

F. Specification Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

G. H-088-C3 VA HANDBOOK DESIGN FOR TELEPHONE 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 text by basic designation only. Except for a specific date given the issue in effect (including amendments, addenda, revisions, supplements, and errata) on the date the system's submittal is technically approved by VA, shall be enforced.

B. National Fire Protection Association (NFPA):

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

C. Underwriters Laboratories, Inc. (UL):

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

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

D. ANSI/EIA/TIA Publications:

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

E. Lucent Technologies: Document 900-200-318 “Outside Plant Engineering Handbook”.

F. International Telecommunication Union – Telecommunication Standardization Sector (ITU-T).

G. Federal Information Processing Standards (FIPS) Publications.

H. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.

I. United States Air Force: Technical Order 33K-l-lOO Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.

J. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.

K. National and/or Government Life Safety Code(s): The more stringent of each listed code.

1.4 QUALITY ASSURANCE

A. The authorized representative of the OEM, shall be responsible for the design, satisfactory total operation of the System, and its certification.

B. The OEM shall meet the minimum requirements identified in Paragraph 2.1.A. Additionally, the Contractor shall have had experience with three or more installations of systems of comparable size and complexity with regards to coordinating, engineering, testing, certifying, supervising, training, and documentation. Identification of these installations shall be provided as a part of the submittal as identified in Paragraph 1.5.

C. The System Contractor shall submit certified documentation that they have been an authorized distributor and service organization for the OEM for a minimum of three (3) years. The System Contractor shall be authorized by the OEM to certify and warranty the installed equipment. In addition, the OEM and System Contractor shall accept complete responsibility for the design, installation, certification, operation, and physical support for the System. This documentation, along with the System Contractor and OEM certification must be provided in writing as part of the Contractor’s Technical Submittal.

D. All equipment, cabling, terminating hardware, TCOs, and patch cords shall be sourced from the certifying OEM or at the OEM’s direction, and support the System design, the OEM’s quality control and validity of the OEM’s warranty.

E. The Contractor's Telecommunications Technicians assigned to the System shall be fully trained, qualified, and certified by the OEM on the engineering, installation, and testing of the System. The Contractor shall provide formal written evidence of current OEM certification(s) for the installer(s) as a part of the submittal or to the RE before being allowed to commence work on the System.

1.5 SUBMITTALS

A. Provide submittals in accordance with Specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. The RE shall retain one copy for review and approval.
   1. If the submittal is approved the RE shall retain one copy for Official Records and return three (3) copies to the Contractor.
   2. If the submittal is disapproved, three (3) copies will be returned to the Contractor with a written explanation attached that indicates the areas the submittal deviated from the System specifications. The RE shall retain one copy for Official Records.

B. Environmental Requirements: Technical submittals shall confirm the environmental specifications for physical TC areas occupied by the System. These environmental specifications shall identify the requirements for initial and expanded system configurations for:
   1. Floor loading for batteries and cabinets.
   2. Minimum floor space and ceiling heights.
   3. Minimum size of doors for equipment passage.
   4. Power requirements: The Contractor shall provide the specific voltage, amperage, phases, and quantities of circuits required.
   5. Air conditioning, heating, and humidity requirements. The Contractor shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.
   6. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).
   7. Proposed floor plan, based on the expanded system configuration of the bidder's proposed EPBX for this FACILITY.
   8. Conduit size requirement (between main TC, computer, and console rooms).
   9. Main backbone, trunk line, riser, and horizontal cable pathways, cable duct, and conduit requirements between each MTC, TC, and TCO.

C. Documents: The submittal shall be separated into sections for each subsystem and shall contain the following:
   1. Title page to include:
      a. VA Medical Center.
      b. Contractor's name, address, and telephone (including FAX) numbers.
      c. Date of Submittal.
      d. VA Project No.
   2. List containing a minimum of three locations of installations of similar size and complexity as identified herein. These locations shall contain the following:
      a. Installation Location and Name.
      b. Owner's or User's name, address, and telephone (including FAX) numbers.
      c. Date of Project Start and Date of Final Acceptance by Owner.
      d. System Project Number.
      e. Brief (three paragraphs minimum) description of each system's function, operation, and installation.
   3. Narrative Description of the system.

4. A List of the equipment to be furnished. The quantity, make, and model number of each item is required. Select the required equipment items quantities that will satisfy the needs of the system and edit the list below . Delete equipment items that are not required add additional items required, and renumber section as per system design. The following is the minimum equipment required by the system:

QUANTITY	UNIT
As required	Cabinet Assembly(s)
As required	Environmental Cabinet
As required	Distribution/Interface Cabinet
As required	Equipment (Radio Relay) Rack
As required	Cross Connection (CCS) Systems
As required	Audio Alarm Panel
As required	TROUBLE ANNUNCIATOR PANEL
As required	Lightning Protection System
As required	Wire Management System/Equipment
As required	Telecommunications Outlets (TCO)
As required	Distribution Cables
As required	TCO Connection Cables
As required	System Connectors
As required	Terminators
As required	Distribution Frames
As required	Telecommunications Closets (TC)
As required	Environmental Requirements
1 ea.	Installation Kit
As-required	Separate List Containing Each Equipment Spare(s)

5. Pictorial layouts of each MTC, IMTC, and RTCs; MCCS, IMCCS, VCCS, and HCCS termination cabinet(s), each distribution cabinet layout drawing, and TCO as each is expected to be installed and configured.
6. Equipment technical literature detailing the electrical and technical characteristics of each item of equipment to be furnished.
7. Engineering drawings of the System, showing calculated signal levels at the EPBX output, each input and output distribution point, proposed TCO values, and signal level at each TCO multipin, fiberoptic, jack.
8. List of test equipment as per paragraph 1.5.D. below.
9. Letter certifying that the Contractor understands the requirements of the SAMPLES Paragraph 1.5.E.
10. Letter certifying that the Contractor understands the requirements of Section 3.2 concerning acceptance tests.

D. Test Equipment List:
1. The Contractor is responsible for furnishing all test equipment required to test the system in accordance with the parameters specified. Unless otherwise stated, the test equipment shall not be considered part of the system. The Contractor shall furnish test equipment of accuracy better than the parameters to be tested.

2. The test equipment furnished by the Contractor shall have a calibration tag of an acceptable calibration service dated not more than 12 months prior to the test. As part of the submittal, a test equipment list shall be furnished that includes the make and model number of the following type of equipment as a minimum:
   a. Spectrum Analyzer.
   b. Signal Level Meter.
   c. Volt-Ohm Meter.
   d. Time Domain Reflectometer (TDR) with strip chart recorder (Data and Optical Measuring).
   e. Bit Error Test Set (BERT).
   f. Camera with a minimum of 60 pictures to that will develop immediately to include appropriate test equipment adapters. A video camera in VHS format is an acceptable alternate.
   g. Video Vector Scope.
   h. Color Video Monitor with audio capability.
   i. 100 mHz Oscilloscope with video adapters

E. Samples: A sample of each of the following items shall be furnished to the RE for approval prior to installation.
   1. TCO Wall Outlet Box 4" x 4"x 2.5" with:
      a. One each telephone (or voice) rj45 jack installed.
      b. Two each multi pin data rj45 jacks installed.
      c. Cover Plate installed.
      d. Fiber optic ST jack(s) installed.
   2. Data CCS patch panel, punch block or connection device with RJ45 connectors installed.
   3. Telephone CCS system with IDC and/or RJ45 connectors and cable terminal equipment installed.
   4. Fiber optic CCS patch panel or breakout box with cable management equipment and “ST” connectors installed.
   5. 610 mm (2 ft.) section of each copper cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
   6. 610 mm (2 ft.) section of each fiber optic cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.

F. Certifications:
   1. Submit written certification from the OEM indicating that the proposed supervisor of the installation and the proposed provider of the contract maintenance are authorized representatives of the OEM. Include the individual's exact name and address and OEM credentials in the certification.
   2. Submit written certification from the OEM that the wiring and connection diagrams meet National and/or Government Life Safety Guidelines, NFPA, NEC, UL, this specification, and JCAHCO requirements and instructions, requirements, recommendations, and guidance set forth by the OEM for the proper performance of the System as described herein. The VA will not approve any submittal without this certification.
   3. Preacceptance Certification: This certification shall be made in accordance with the test procedure outlined in paragraph 3.2.B.

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

H. Record Wiring Diagrams:

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

I. Surveys Required As A Part Of The Technical Submittal: The Contractor shall provide the following surveys that depict various system features and capacities are required in addition to the on site survey requirements described herein. Each survey shall be in writing and contain the following information (the formats are suggestions and may be used for the initial Technical Submittal survey requirements), as a minimum:

1. The required EPBX connections (each CSU shall be compatible with) shall be compatible with the following:
   a. Initially connect:

EQUIPPED ITEM	CAPACITY	WIREDCAPACITY
Main Station Lines		
Single Line		
Multi Line (Equipped for direct input dial [DID])		
Central Office (CO) Trunks		
TWO WAY		
DID		
Two-way DRTL		
Foreign Exchange (FX)		
Conference		
Radio Paging Access		
Audio Paging Access		
Off-Premise Extensions		
CO Trunk By-pass		
CRT w/keyboard		
Printers		
Attendant Consoles		
T-1 Access/Equipment		
Maintenance console		

   b. Projected Maximum Growth: The Contractor shall clearly and fully indicate this category for each item identified in Paragraph 1.4.H.1.a. as a part of the technical submittal. For this purpose, the following definitions and sample connections are provided to detail the system's capability:

EQUIPPED ITEM	CAPACITY	WIRED CAPACITY

Servers		
PC's		
Projected Maximum Growth		

c. The Contractor shall clearly and fully indicate this category for each item identified in Paragraph 1.4.H.2.a. as a part of the technical submittal.

2. Cable Distribution System Design Plan: A design plan for the entire cable distribution systems requirements shall be provided with this document. A specific cable count shall coincide with the total growth items as described herein. It is the Contractor's responsibility to provide the Systems entire cable requirements and engineer a distribution system requirement plan using the format of the following paragraph(s), at a minimum:

a. UTP (and/or STP) Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is provided from
BUILDING	Identifies the building by number, title, or location cabling is to be provided in
TO BUILDING IMC	Identifies building main terminal signal closet, by room number or location, to which cabling is provided too, in, and from
FLOOR	Identifies the floor by number (i.e. 1st, 2nd, etc.) cabling and TCOs are to be provided
TC ROOM NUMBER	Identifies the floor signal closet room, by room number, which cabling shall be provided
ROOM NUMBER	Identifies the room, by number, from which cabling and TCOs shall be provided
NUMBER OF CABLE PAIR	Identifies the number of cable pair required to be provided on each floor designated OR the number of cable pair (VA Owned) to be retained
NUMBER OF STRANDS USED/SPARE	Identifies the number of strands provided in each run

b. Fiber Optic Cabling Requirements/Column Explanation:

Column	Explanation
FROM BUILDING	Identifies the building by number, title, or location, and main signal closet or intermediate signal closet cabling is provided from
TO BUILDING IMC	Identifies building, by number, title, or location, to which cabling is provided
FLOOR	Identifies the floor by number (i.e. 1st, 2nd, etc.)
TC ROOM NUMBER	Identifies the room, by number, from which cabling shall be installed
NUMBER OF STRANDS	Identifies the number of strands in each run of fiber optic cable
INSTALLED METHOD	Identifies the method of installation in accordance with as designated herein

NOTES	Identifies a note number for a special feature or equipment
BUILDING MTC	Identifies the building by number or title

3. Telecommunication Outlets: The Contractor shall clearly and fully indicate this category for each outlet location and compare the total count to the locations identified above as a part of the technical submittal. Additionally, the Contractor shall indicate the total number of spares.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. System Requirements:
   1. The System shall provide the following minimum services that are designed in accordance with and supported by an Original Equipment Manufacturer (OEM), and as specified herein. The System shall provide continuous inter and/or intra-Facility voice and data, service. The System shall be capacity sized so that loss of connectivity to external telephone systems shall not affect the Facilities operation in specific designated locations. The System shall:
      a. Be capable of inter-connecting and functioning fully with the existing Local Telephone Exchange (LEC) Network(s), Federal Telephone System (FTS) Inter-city Network(s), Inter-exchange Carriers, Integrated Services Digital Network (ISDN), Electronic Private Branch Exchange (EPBX) switches, asynchronous/synchronous data terminals and circuits including Automatic Transfer Mode (ATM), Frame Relay, and local area networks (LAN), at a minimum.
      b. Be a voice and data cable distribution system that is based on a physical “Star” Topology.
      c. Be compatible with and able to provide direct digital connection to trunk level equipment including, but, not limited to: directly accessing trunk level equipment including the telephone system, audio paging, Industry Standard “T” and/or “DS” carrier services and external protocol converters. Additionally, connections to “T” and/or “DS” access/equipment or Customer Service Units (CSU) that are used in FTS and other trunk applications shall be included in the System design. Provide T-1 access/equipment (or CSU), as required for use, in FTS and other trunk applications by system design if this equipment is not provided by the existing telephone system and/or will be deactivated by the installation of the System. The Contractor shall provide all T-1 equipment necessary to terminate and make operational the quantity of circuits designated. The CSU's shall be connected to the System’s emergency battery power supply. The System shall be fully capable of operating in the Industry Standard “DS” protocol and provide that service when required.
      d. Where the System connects to an existing or future telephone system, refer telephone equipment and system operational performance standards.
   2. Cable Systems - Twisted Pair and Fiber optic
      a. General:
         1) The Contractor shall be responsible for providing a new system conforming to current and accepted telephone and digital industrial/commercial cable distribution standards. The distribution cable installation shall be fully coordinated with the Facility, the PM, the RE and the Contractor prior to the start of installation.

2) The Contractor is responsible for complete knowledge of the space and cable pathways (i.e. equipment rooms, TCs, conduits, wireways, etc.) of the Facility. The Contractor shall at a minimum design and install the System using the Pathway Design Handbook H-088C3, TIA/EIA Telecommunications Building Wiring Standards, and Facility Chief of Information Resource Management's (IRM) instructions, as approved in writing by the PM and/or RE.
3) The System cables shall be fully protected by cable duct, trays, wireways, conduit (rigid, thin wall, or flex), and when specifically approved, flexible innerduct. It is the responsibility of the Contractor to confirm all contract drawings and the Facility's physical layout to determine the necessary cable protective devices to be provided. If flexible innerduct is used, it shall be installed in the same manner as conduit.
4) Cable provided in the system (i.e. backbone, outside plant, inside plant, and station cabling) shall conform to accepted industry and OEM standards with regards to size, color code, and insulation. The pair twists of any pair shall not be exactly the same as any other pair within any unit or sub-unit of cables that are bundled in twenty-five (25) pairs or less. The absence of specifications regarding details shall imply that best general industry practices shall prevail and that first quality material and workmanship shall be provided. Certification Standards, (i.e., EIA, CCITT, FIPPS, and NFPA) shall prevail.
5) Some areas of this Facility may be considered "plenum". All wire and cable used in support of the installation in those areas (if any) shall be in compliance with national and local codes pertaining to plenum environments. It is the responsibility of the Contractor to review the VA's cable and wire requirements with the RE and the IRM prior to installation to confirm the type of environment present at each location.
6) The Contractor shall provide outside and inside plant cables that furnishes the number of cable pairs required in accordance with the System requirements described herein. The Contractor shall fully coordinate and obtain approval of the design with the OEM, RE and the IRM prior to installation.
7) All metallic cable sheaths, etc. shall be grounded by the Contractor (i.e.: risers, underground, station wiring, etc.) as described herein.
8) If temporary cable and wire pairs are used, they shall be installed so as to not present a pedestrian safety hazard and the Contractor shall be responsible for all work associated with the temporary installation and for their removal when no longer necessary. Temporary cable installations are not required to meet Industry Standards; but, must be reviewed and approved by the RE and the IRM prior to installation.
9) Conductors shall be cabled to provide protection against induction in voice and data circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
10) Measures shall be employed by the Contractor to minimize the radiation of RF noise generated by the System equipment so as not to interfere with audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.

11) The System's cables shall be labeled on each end and been fully tested and certified in writing by the Contractor to the RE before proof of performance testing can be conducted. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs. Minimum test requirements are for impedance compliance, inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges specified. The tests required for data cable must be made to guarantee the operation of this cable at not less than 10 mega (m) Hertz (Hz) full bandwidth, fully channel loaded and a Bit Error Rate of a minimum of 10-6 at the maximum rate of speed. All cable installation and test records shall be made available at acceptance testing by the RE or Contractor and thereafter maintained in the Facility's Telephone Switch Room. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.

12) The Contractor shall coordinate with the LEC to install the telephone entrance cable to the nearest point of entry into the Facility and as shown on the drawings. The Contractor shall coordinate with the RE and the LEC to provide all cable pairs/circuits from the Facility point of entry to the Telephone Switch Room all telephone, FTS, DHCP, ATM, Frame Relay, data, pay stations, patient phones, and any low voltage circuits as described herein.

13) The Contractor shall coordinate with the RE and the IRM to install the computer interface cable to the Facility Telephone Switch Room from the Facility's Computer Room for all data, DHCP, FTS, ATM, Frame Relay, and telephone circuits and as shown on the drawings.

14) The Contractor shall coordinate with the RE and the IRM to provide all cable pairs/circuits from the Facility Telephone Switch Room and establish circuits throughout the Facility for all voice, data, computer alarm (except fire alarm), private maintenance line, Radio Paging, PA, LAN, DHCP, and any low voltage circuits as described herein.

15) The Contractor shall provide proper test equipment to guarantee that cable meet each OEM's standard transmission requirements, and guarantee the cable will carry data transmissions at the required speeds, frequencies, and fully loaded bandwidth.

b. Telecommunications Closets (TC): In TC's that are served with both a UTP backbone cable and a fiber optic backbone cable, the UTP cable shall be terminated on separate RJ-45, 8-pin connectors with 110A or equivalent type punch down blocks located on the back or front of a 48-port modular patch panel dedicated to data applications. Only the UTP backbone cable pairs, identified as being connected to the fiber optic backbone, shall be extended to the fiber optic interface device. All connecting cables required to extend these cables (i.e. patch cords, twenty-five pair connectors, etc.), to the fiber optic interface device, in the TC's shall also be provided by the Contractor to insure a complete and operational fiber optic distribution system:

1) In TC's, which are only served by a UTP backbone cable, the cable shall be terminated on separate modular connecting devices (110A or equivalent) that are dedicated to data applications. In order to provide full service to all data cable pairs as identified in each TC/cabinet including spare capacity noted herein, the size of all vertical (riser) cables and/or outside cables serving these TC's shall be increased as required.

c. Backbone and Trunk Cables:

1) The Contractor shall identify, in the technical submittal, the voice and data (analog RF coaxial cable shall not be provided in main trunk or backbone lines) connecting arrangements required by the LEC for interconnection of the System to the commercial telephone and FTS networks. The Contractor shall provide all required voice and data connecting arrangements.

2) The Contractor shall be responsible for compatibility of the proposed TCs (to be compliant with the EPBX and CSU equipment) numbering scheme with the numbering plan for the FTS, DID, local stations, and the North American Numbering Plan. The Contractor shall consult with the VA and the LEC regarding the FTS and North American Numbering plan to be implemented for the Facility to ensure system compatibility.

3) All submitted equipment shall meet or exceed standards, rules, and regulations of the Federal Communications Commission (FCC) and shall be capable of operating without outboard or "extra" devices. The Contractor shall identify the FCC registration number of the System equipment, EPBX, and proposed CSU (if known) in the technical submittal.

4) A minimum of one (1) 400 shielded twisted pair (STP) cable shall be installed from the Telephone Switch Room cross connecting system (CCS) to the Main Computer Room MDF. This cable shall support the transmission of data information over twisted pair cable. The cable shall be tested and terminated on a Contractor provided cable management frame, RJ-45 modular jacks with eight (8) pin connectors, and 48 port modular patch panels located in the Main Computer Room and Telephone Switch Room. The cable shall be labeled, terminated, and separated from the other cables on the MDF and Telephone Switch Room CCS. This requirement shall be fully coordinated and approved by the Facility Chief, IRM and the RE prior to installation. The cabling requirements of this paragraph are in addition to the requirements specified in the System Design Plan identified herein.

d. Riser Cable:

1) All communication riser cables shall be listed as being suitable for the purpose and marked accordingly per Articles 517, 700, and 800 of the NEC.

2) All voice and data communication (analog RF coaxial cable is not to be provided in riser systems) riser cables shall be STP or Unshielded Twisted Pair (UTP), minimum 24 American Wire Gauge (AWG) solid, thermoplastic insulated conductors. They shall be enclosed with a thermoplastic outer jacket.

3) The Contractor shall provide and install inside riser cables to insure full service to all voice cable pairs identified in each TC terminating enclosure plus not less than 50% additional spare capacity.

4) The complete riser cabling system shall be labeled and tested as described herein.

e. Horizontal and Station Cable:

1) A Four (4) UTP 24 AWG station wiring cable shall be installed from the top TCO jack to the TC and shall be of a type designed to support Category 6 communications (250 mega-Hertz [mHz] or above). At the jack location, terminate all four pair on the RJ-45/11 jack. At the signal closet, all four pair shall be terminated on the modular punch down blocks dedicated to telephone applications.

2) A Four (4) UTP 24 AWG (in thermoplastic jacket unless otherwise specified by RE) station wiring cable shall be installed from each of the two (2) bottom TCO RJ-45 jacks (shall conform to EIA/TIA 568 Standard "T568A" and NFPA) to the TC and shall be of a type designed to support Category 6 communications (250 mHz or above).

f. Telecommunication Outlets (TCO), Jacks: All TCO's shall have a minimum of three (3) RJ-45 type jacks. The top jack shall be an eight pin RJ-45/11 compatible jack, labeled, and designated for telephone applications only. The bottom two jacks shall be eight pin RJ-45 type unkeyed (sometimes called center keyed) jacks, labeled, and designated for data.

g. Patient Bedside Prefabricated Units (PBPU): Where PBPU's exist in the Facility, the Contractor shall identify the single gang "box" location on the PBPU designated for installation of the telephone jack. This location shall here-in-after be identified as the PBTCO. The Contractor shall be responsible for obtaining written approval and specific instructions from the PBPU OEM regarding the necessary disassembly and reassembly of each PBPU to the extent necessary to pull wire from above the ceiling junction box to the PBPU box reserved for the PBTCO. A Contractor provided stainless steel cover plate approved for use by the PBPU OEM and Facility IRM Chief shall finish out the jack installation. Under no circumstances shall the Contractor proceed with the PBPU installations without the written approval of the PBPU OEM and the specific instructions regarding the attachment to or modifying of the PBPU. The RE shall be available to assist the Contractor in obtaining these approvals and instructions in a timely manner as related to the project's time constraints. It is the responsibility of the Contractor to maintain the UL integrity of each PBPU. If the Contractor violates that integrity, it shall be the responsibility of the Contractor to obtain on site UL re-certification of the violated PBPU at the direction of the RE and at the Contractor's expense.

h. Fiber Optics:

1) A complete fiber optic cable distribution system shall be provided as a part of the System. The Contractor shall provide a fiber optic cable that meets the minimum bandwidth requirements for FDDI, ATM, and Frame Relay services. This fiber optic cable shall be a 50/125 micron multi-mode, containing a minimum of 18 strands of fiber, unless otherwise specified, and shall not exceed a distance of 2,000 Meters (M), or 6,560 feet (ft.) in a single run. Loose tube cable, which separates the individual fibers from the environment, shall be installed for all outdoor runs or for any area which includes an outdoor run. Tight buffered fiber cable shall be used for indoor runs. The multimode fibers shall be terminated and secured at both ends in "ST" type female stainless steel connectors installed in an appropriate patch or breakout panel with a cable management system. A 610 mm (2 ft.) cable loop (minimum) shall be provided at each end to allow for future movement.

2) In addition, a 12 strand (minimum), 8.3 mm single mode fiber optic cable shall be provided. Single mode fibers shall be terminated and secured at both ends with "ST" type female stainless steel connectors installed in an appropriate patch or breakout panel. The panel shall be provided with a cable management system. A 610 mm (2 ft.) cable loop (minimum) shall be provided at each end to allow for future movement.

3) The fiber optic backbone shall use a conventional hierarchical "star" design where each TC is wired to the primary hub (main cross-connect system) or a secondary hub (intermediate cross-connect system) and then to the primary hub. There shall be no more than two hierarchical levels of cross-connects in the backbone wiring. Each primary hub shall be connected and terminated to a CCS in the Telephone Switch Room. Additionally, a parallel separate fiber optic interconnection shall be provided between the Telephone Switch Room CCS and the MDF in the Main Computer Room.

4) In the TC's, Telephone Switch Room, and Main Computer Room, all fiber optic cables shall be installed in a CCS and/or MDF rack mounted fiber optic cable distribution component/splice case (Contractor provided and installed rack), patch, or breakout panel in accordance with industry standards. Female "ST" connectors shall be provided and installed on the appropriate panel for termination of each strand.

5) The Contractor shall test each fiber optic strand. Cable transmission performance specifications shall be in accordance with EIA/TIA standards. Attenuation shall be measured in accordance with EIA fiber optic test procedures EIA/TIA-455-46, -61, or -53 and NFPA. Information transmission capacity shall be measured in accordance with EIA/TIA-455-51 or -30 and NFPA. The written results shall be provided to the RE for review and approval.

3. Specific Subsystem Requirements: The System shall consist, as a minimum, of the following independent sub-systems to comprise a complete and functional voice and digital telecommunications cabling system: “Main” (MTC), “intermediate” (IMTC), and “riser” (RTC) TC’s; “backbone” cabling (BC) system; “vertical” (or “riser”) trunk cabling system; “horizontal” (or “lateral”) sub-trunk cabling system, vertical and horizontal cross-connection (VCC and HCC respectively) cabling systems, and TCO’s with a minimum of three (3) RJ-45 jacks for the appropriate telephone, Data connections, and additional jacks, connectors, drop and patch cords, terminators, and adapters provided.
   a. Telecommunication Closet (TC):
      1) There shall be a minimum of one TC for the MTC, each building IMTC, and each RTC per building floor location. However, in large building(s), where the horizontal distance to the farthest voice and digital work area may exceed 90 Meters (M) (or 295 feet [ft]), additional TC’s shall be provided as described herein. The maximum DC resistance per cable pair shall be no more than 28.6 Ohms per 305 M (1,000 feet). Each TC shall be centrally located to cover the maximum amount of local floor space. The TC’s house in cabinets or enclosures, on relay racks, and/or on backboards, various telecommunication data equipment, controllers, multiplexers, bridges, routers, LAN hub(s), telephone cross-connecting, active and passive equipment.
      2) Additionally, the TC’s may house fire alarm, nurses call, code one (or blue), video, public address, radio entertainment, intercom, and radio paging equipment. Regardless of the method of installation, mounting, termination, or cross-connecting used, all backbone, vertical, and horizontal copper and fiber optic cables shall be terminated on appropriate cross-connection systems (CCS) containing patch panel(s), punch blocks, and/or breakout devices provided in enclosures and tested as described herein. A cable and/or wire management system shall be a part of each CCS.
         a) A minimum of three 110-120 VAC active quad outlets shall be provided, each with “U” grounded receptacles at a minimum of one outlet for each front, side and back wall. These outlets shall be separately protected by an AC circuit breaker provided in the designated Government Emergency Critical Care AC power panel, that is connected to the Facilities Emergency AC Power Distribution System. For larger building TC applications, a minimum of one additional quad AC outlet shall be provided for every 800M² (or 8,000 ft²) of useable floor space. Additional outlets shall be equally spaced along the wall.
         b) Climate control shall be provided in each TC 24 hours a day, seven days per week and 52 week per year to prevent failure of electronic components and for mission critical functional applications. The Facility Chief Engineering Officer are responsible for informing the Contractor regarding the minimum climate control requirements. In identified hostile TC locations where it has been determined (by the RE or Facility Chief Engineer) that proper TC climate or external signal radiation cannot be properly maintained or controlled, the Contractor may, at his/her option, provide a minimum of two individual and properly sized self contained climate controlled equipment cabinet enclosures; one designated for voice, and one designated for data, service, in each TC location identified on the drawings, in lieu of providing additional required TC air handling capability.
   b. Cross-connect Systems (CCS):

1) The CCS shall be selected based on the following criteria: requires the use of a single tool, has the fewest amount of parts, and requires the least amount of assembly or projected trouble shooting time during the life of the system.
2) 2) The CCS system used at the MTC, each IMTC, and each TC shall force cross-connect cable slack management through adherence to the OEM's installation methods, provided cable management systems, and as described herein, so that moves, adds, and changes can be administered easily and cost effectively.
3) Copper Cables: The MTC, each IMTC, and TC shall contain a copper CCS sized to support the System TCO's and connections served by each individual TC and as shown on the drawings. The System layout shall allow for a minimum of 50% anticipated growth. Additionally, each CCS must provide maximum flexibility, while maintaining performance, in order to meet system-changing requirements that are likely to occur throughout its useful life.
4) Fiber Optic Cables:
    a) The MTC and each TC shall contain a fiber CCS sized to support the System TCO's and connections served by each individual TC and as shown on the drawings. The System layout shall allow for a minimum of 50% anticipated growth.
    b) Each fiber CCS must provide maximum flexibility and cable management while maintaining performance in order to meet changing requirements that are likely to occur throughout the expected life of the system. All fiber optic cable slack shall be stored in protective enclosures.
    c) If it is determined that a fiber optic distribution system is not necessary for the immediate system needs. Each TC shall be provided with fiber optic cable(s) that contain a minimum of 12 strands "dark" multimode fiber and 12 strands "dark" single mode fiber, each fiber properly terminated on its respective female stainless steel connector mounted in an appropriate fiber termination enclosure provided in each TC.
5) The Contractor shall not "cross-connect" the copper or fiber optic cabling systems and subsystems even though appropriate "patch" cords are to be provided for each "patch", "punch", or "breakout" panel. In addition, the Contractor shall not provide active electronic distribution or interface equipment as a part of the System.
6) Grounding: Proper grounding and bonding shall be provided for each TC and all internal equipment. Reference shall be made to proper codes and standards, such that all grounding systems must comply with all applicable National, Regional, and Local Building and Electrical codes. The most stringent code of these governing bodies shall apply.
    a) If local grounding codes do not exist for the System location, then at a minimum, a #6 American Wire Gauge (AWG) stranded copper wire, or equivalent copper braid, shall be connected to a separate earth grounding system for each TC (the looping of TC's in a general location is allowed as long as the specifications contained herein are met). Under no circumstance shall the AC neutral be used for this ground. See PART 3 – EXECUTION for specific grounding instructions.
    b) Each copper UTP or STP cable that enters a TC from the outside of a building (regardless if the cable is installed underground or aerial) shall be provided with a surge protector and grounded an to earth ground at each cable's entry point in and out of the MTC and each IMTC.

c. Main Cross-connection Subsystem (MCCS): The MCCS shall be located in the MTC and it shall be the common point of appearance for inter and intra-building copper and fiber optic "backbone" system cables, and connections to the telephone and data cable systems. The MTC usually houses telephone EPBX, public address, radio paging interface, routers, and main hierarchical data LAN concentrating equipment. Additionally, it shall provide a single administration and management point for the entire System.

d. Voice (or Telephone) Cable Cross-Connection Subsystem:
   1) Due to the usually high number of copper cable termination's required at the MCCS, Insulation Displacement Connection (IDC) hardware shall be used. Termination options shall include the following for a Category 6 Cabling System: IDC termination of cross-connection wire(s), IDC patch cord connector to IDC patch cord connector, and hybrid modular cord to IDC patch cord connector shall be the minimum provided.
   2) Additionally, due to the large or many MCCS (at initial installation and over the life of the System) copper termination points, the CCS that makes the best use of real estate while still following the OEM design and installation guidelines, and meeting the specifications described herein, shall be provided.
   3) For ease of maintenance purposes, all terminations shall be accessible without the need for disassembly of the IDC wafer. IDC wafers shall be removable from their mounts to facilitate testing on either side of the connector. Designation strips or labels shall be removable to allow for inspection of the terminations. The maximum number of terminations on a wall or on a rack frame or panel shall comply with the OEM recommendations and guidelines, and as described herein. A cable management system shall be provided as a part of the IDC.
   4) IDC connectors shall be capable of supporting cable re-terminations without damaging the connector and shall support a minimum of 200 (telephone equipment standard compliant) IDC insertions or withdrawals on either side of the connector panel.
   5) A non-impact termination method using a full-cycle terminating tool having both a tactile and an audible feedback to indicate proper termination is required. For personnel safety and ease of use in day to day administration, high impact installation tools shall not be used.
   6) All system "inputs" from the EPBX, FTS, Local Telephone System, or diverse routed voice distribution systems shall appear on the "left" side of the IDC (110A blocks with RJ45 connections are acceptable alternates to the IDC) of the MCCS.
   7) All system "outputs" from the MCCS to the voice backbone cable distribution system shall appear on the "right" side of the same IDC (or 110A blocks) of the MCCS.
   8) The splitting of pairs within cables between different jacks or connections shall not be allowed. In the case of ISDN and/or ATM and /or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.
   9) UTP or STP cross connecting wires shall be provided for each "pair" of connection terminals plus an additional 50% spare.

e. Data Cross-Connection Subsystems:
   1) The MCCS shall be a Main Distribution Terminating (MDT) data unit and shall be provided in the MTC. The MDT shall consist of a "patch" panel(s) provided with modular RJ45 female connectors for cross-connection of all copper data cable terminations. The panels shall provide for system grounding (where no dielectric cables are used) and be provided with a cable management system.

2) Each panel shall conform to EIA dimensions and be suitable for mounting in standard equipment racks, have the RJ45 jacks aligned in two horizontal rows (up to a maximum of 48 jacks per panel), and shall not exceed the OEM's recommendations. Each RJ45 jack shall be of modular design and capable of accepting and functioning with other modular (i.e. RJ11) plugs without damaging the jack. It is not necessary to provide a jack for unused positions that are not part of the 50% expansion requirement.
   a) All data system inputs from the server(s), data LAN, bridge, or interface distribution systems shall appear on the "top" row of jacks of the appropriate patch panel.
   b) All System outputs or backbone cable connections shall appear on the "bottom" row of jacks of the same patch panel.
   c) The splitting of pairs within cables between different jacks shall not be allowed. In the case of ISDN and/or ATM and/or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.
3) A patch cord shall be provided for each system "pair" of connection jacks. Each patch cord shall have modular RJ45 connectors provided on each end to match the panel's modular RJ45 female jack's being provided.

f. Fiber optic Cross-Connection Subsystems: The MTC shall be provided with a separate fiber MCCS. Each TC shall be provided with a rack mounted patch or distribution panel that is installed inside a lockable cabinet or "breakout enclosure" that accommodates a minimum of 12 strands multimode fiber and 12 strand single mode fiber (these counts shall not be included the 50% spare requirement). Two of the single mode fibers shall be designated for educational analog video applications. A cable management system shall be provided for each panel.
   1) The panel(s) shall contain a minimum of 24 female "ST" connectors, be able to accommodate splices and field mountable connectors and have capacity for additional connectors to be added up to the OEM's maximum standard panel size for this type of use. All patch panel sides, including the front and back, shall be protected by a cabinet or enclosure.
   2) The panel(s) shall conform to EIA dimensions and be suitable for installation in standard racks, cabinets, and enclosures. The panels shall provide for system grounding (where no dielectric cables are used).
   3) The patch panel with the highest OEM approved density of fiber "ST" termination's (maximum of 72 each), while maintaining a high level of manageability, shall be selected. Patch cables, with proper "ST" connectors installed on each end shall be provided for each pair of fiber optic cable "ST" connectors.
      a) All System "inputs" from interface equipment or distribution systems shall appear on the "top" row of connectors of the appropriate patch panel.
      b) All System "outputs" or backbone cable connections shall appear on the "bottom" row of connectors of the same patch panel.
   4) In order to achieve a high level of reliability that approximates that of an OEM connector, field installable connectors shall have an OEM specified physical contact polish. Every fiber cable shall be terminated with the appropriate connector, and tested to ensure compliance to OEM and specifications outlines herein. Where a local fiber optic system connector standard, Industry Standard fiber optic "ST" female connector terminated with a fiber optic cable, shall be used. But, if the fiber optic cable is not used (or "dark"), a "ST" male terminating "cap" shall be provided for each unused "ST" female connector.

g. Intermediate Cross-connection Subsystems (IMCCS): The MTC and each IMTC shall be provided with an IMCCS that shall be the connection point between the MCCS system and the distribution backbone cable and the IMCCS, that is located in one or more buildings on a campus, where each IMCCS is placed by system design. For a technical explanation of internal equipment and system requirements, refer to the above MTC and MCCS paragraphs.

h. Distribution Cable Systems / Backbone Cable System (Common to Inter-buildings): The backbone cable system extends from the MCCS to each IMCCS to establish service between buildings on a campus. The media (copper and fiber optic) used in the BC system shall be designed according to the system requirements, OEM standards and guidelines, and as described herein. A multi-pair copper for voice and data, and separate multiple fiber optic backbone system shall be provided as a part of the BC distribution system.

1) All outside cable shall be minimum of STP or UTP, 22 AWG solid conductors, solid PVC insulation, and filled core (flexgel - waterproof Rural Electric Association (REA) LISTED PE 39 CODE) between the outer armor or jacket and inner conductors protective lining.

2) The copper cable system shall be configured as a “Star” Topology with separate dedicated cables between the MCCS and each IMCCS.

3) UTP and STP copper cables shall consist of thermoplastic insulated conductors formed into binder groups. The groups are to be identified by distinctly colored binders and assembled to form a single compact core covered by a protective sheath. Each cable shall be rated for Category 6 Telecommunications System Service. A minimum of eight pairs per circuit, plus an additional 50% spare for growth shall be provided.

4) Where the distance limitations of UTP or STP may be exceeded, multimode (or single mode) fiber optic cable(s) shall be used to augment the voice and/or data backbone cable system(s). The total loss of each fiber shall not exceed 12 decibel (dB) at 850 nano-Meter (nM), 11 dB at 1,300 nM, or 10 dB at 1,500 nM.

5) All voice system “inputs” from the MCCS via the BC distribution system shall appear on the “left” side of IDC (minimum 110 blocks) punch terminals of the IMCCS.

6) All voice system “outputs” or trunk line connections shall appear on the “right” side of the same IDC (minimum 110 blocks) of the IMCCS.

7) All data system “inputs” from the MCCS via the BC distribution system shall appear on the “top” row of jacks of the appropriate patch panel of the IMCCS.

8) All data system “outputs” or trunk line connections shall appear on the “bottom” row of jacks in the same patch panel of the IMCCS.

9) The splitting of pairs within cables between different jacks shall not be allowed. In the case of ISDN and/or ATM and /or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.

10) A patch cord shall be provided for each system “pair” of connection jacks. Each patch cord shall have modular connectors provided on each end to match the panel’s modular female jack.

11) The fiber optic BC system shall be configured as a “Buss” Topology with separate dedicated fibers between the MCCS and each IMCCS. The System shall be sized to meet the system requirements plus an expansion capability of 50%. Fiber optic cable(s) having a minimum of 12 strands multimode fiber and 12 strands single mode fiber shall be provided. Two of the single mode fibers shall be designated for analog video service.

12) All BC shall be identified with permanent labels at both ends. Labels will indicate system, floor, closet, and zone. The label designations shall match those used for cross-connect terminals and patch panels.

i. Distribution (Common to Intra-Building) Cabling Systems: The intra-building trunk cabling system provides for connection between the IMCCS and each Riser TC's provided vertical cross-connecting system (VCCS) within a building. The media (copper, fiber optic) used in the intra-building backbone cabling system shall be designed according to the system requirements, OEM standards and guidelines, and as described herein. A multi-pair copper for voice and data, and separate multiple fiber optic trunk system shall be provided as a part of the System.

1) Category 6 UTP or STP multi-pair trunk cable(s) shall be used in the voice and data trunk-line-cabling systems. A minimum of eight pairs per circuit, plus an additional 50% spare for growth shall be provided.

2) Where the distance limitations of UTP and/or STP will be exceeded, multimode (or single mode) fiber optic cable shall be used in the voice and/or trunk cabling systems. The total loss of the fiber trunks shall not exceed 12 dB at 850 nM , 11 dB at 1,300 nM, or 10 dB at 1,500 nM.

a) All voice system "outputs" from the IMCCS to the trunk-line distribution system shall appear on the "right" side of IDC (minimum 110A blocks) punch terminals of the IMCCS.

b) All data system "outputs" from the IMCCS to the trunk-line distribution system shall appear on the "bottom" row of jacks of the same IDC (minimum 110A blocks) of the IMCCS.

c) The splitting of pairs within cables between different jacks shall not be allowed. In the case of ISDN and/or ATM and/or Frame Relay applications, terminating resistors shall be provided externally to the patch panel connector or jack.

d) A patch cord shall be provided for each system "pair" of connection jacks. Each patch cord shall have modular connectors provided on each end to match the panel's modular female jack.

3) The fiber optic trunk line system shall be configured as a "Buss" Topology with separate dedicated fibers between the IMCCS and each RCS. The System shall be sized to meet the System requirements with a expansion capability of 50% provided. Separate individual fiber optic cable(s) with a minimum of 18 strands multimode fiber and/or 12 strands single mode fiber shall be provided. Two of the single mode fibers shall be designated for analog video service.

4) All trunk lines shall be identified with permanent labels at both ends. Labels will indicate system, floor, closet, and zone. The label designations shall match those used for cross-connects and patch panels.

a) All System outputs from the IMCCS to the trunk-line distribution system shall appear on the "bottom" row of "ST" connectors in the appropriate patch panel.

b) A patch cord shall be provided for each system "pair" of connection "ST" connectors. As a minimum, each patch cord shall have "ST" male connectors provided on each end to match the panel's female "ST" connector provided.

j. VCCS and Horizontal Cross-connecting (HCCS) Systems: Each TC shall be provided with a separate VCCS and HCCS located within the TC. The VCCS and HCCS shall interconnect and interface the riser (vertical) trunk line cables with the horizontal (or station) sub-trunk line cables. The media (copper, fiber optic) used in the CCS system shall be designed according to the System requirements, OEM standards and guidelines, and as described herein. A multi-pair copper for voice and data, and separate multiple fiber optic CCS system shall be provided as a part of the System.

1) The UTP, STP, and fiber optic trunk-line cabling systems are that connected between the trunk-lines and Riser VCCS, shall be terminated:
   a) On the “left” or “top” IDC (or 110A blocks) for each UTP or STP voice cable.
   b) On the “top” row of RJ45 jacks on the appropriate patch panel for each UTP or STP data cable.
   c) On the “top” row of “ST” connectors on the appropriate patch panel for each fiber .
2) The UTP, STP, and fiber optic sub-trunk (lateral) floor distribution cabling systems that are connected between each RTC and each TCO or secondary system distribution or connection point, shall terminate on an appropriate HCCS, at the:
   a) On the “right” IDC (or 110A block) used as the VCCS input for each UTP or STP voice cable.
   b) On the “bottom row of RJ45 jacks on the appropriate patch panel used as the VCCS input for each UTP or STP data cable.
   c) On the “bottom” row of “ST” connectors on the appropriate patch panel used as the VCCS input for each fiber.
   d) The technical requirements of the VCCS and HCCS “patch”, “terminating”, or “breakout” panels and cable management assemblies for voice, data and fiber optic (and RF coaxial) cables shall be as described in the above MCCS, IMCCS, and TC technical paragraphs.
3) The Contractor shall not “cross-connect” the VCCS or HCCS cabling systems even though appropriate patch cords are provided for each “patch”, “punch”, or “breakout” panel. Also, the Contractor shall not provide active interface or distribution electronic equipment as a part of the System.

k. Horizontal (or Station) Cabling (HC): The HC distribution cabling systems connects the distribution field of the voice and data HCCS, in a “Star” Topology, to each TCO or connector and as shown on the drawings via the sub-trunk system.
   1) Horizontal cables shall consist of insulated, UTP or STP conductors that are rated for Category 6 telecommunications service for voice and data systems.
   2) The number of UTP or STP distribution pairs dedicated to each floor from the HC shall be sufficient to accommodate all the horizontal voice and data circuits served by the distribution cable to each TCO.
      a) A minimum of four pairs for voice shall be connected to the “right” side of the IDC (or 110A block) that the VCCS “input” connections appear in the RTC.
      b) A minimum of two separate sets of four pairs each for data shall be connected to the “bottom” row of RJ45 jacks that the VCCS “input” connections appear in the RTC.
   3) The horizontal cable length to the farthest system outlet shall be limited to a maximum of 90M (or 295 ft). These maximum lengths must be derated, adjusted and reduced to include cross-connection and distribution system losses. Additional TC(s) shall be provided on large floor areas of buildings to limit the horizontal distribution to a maximum of 90M (or 295 ft).
   4) The splitting of pairs within a cable between different jacks shall not be permitted.
   5) The installation of the HC shall conform to appropriate OEM recommendations and standards outlined herein. This requirement will insure adequate protection for Electro-Magnetic Interference (EMI) sources.
   6) A system design where “looping” the HC distribution cables from room to room shall not be permitted.

l. System Telecommunication Outlets (TCO): The System shall be capable of receiving the specified telephone (or voice) and data signals acquired from the LEC, FTS contracted carrier and computer system, and shall process and distribute them to the designated TCO's and as shown on the drawings. At a minimum, one TCO shall be provided on each room wall, associated with an active 120 VAC shall be provided and as shown on the drawings. The only exception to the general rule, of one outlet per wall, shall be those "special" locations (e.g., surgical suites, radiology MRI rooms, labs, patient bed rooms, warehouse, loading docks, storage rooms, etc.) where there is usually only one TCO provided as designated on the drawings.

1) Each TCO shall consist of three multipin modular RJ45 jacks, one designated for telephone and two for data service. Each TCO with appropriate jacks installed shall be provided by the Contractor in each designated location and as shown on the drawings.
2) The Contractor shall connect each telephone multipin modular RJ45 jack to a separate "right side as you look at it" telephone HC distribution system HCCS "punch down" 110A block or approved IDC terminating device in each associated RTC. The modular RJ45 jack shall be able to accept and operate with smaller modular RJ11 plugs while providing proper connection and not damaging the modular jack. he OEM shall warrant all modular RJ45/11 jacks in such a manner to be usable for modular RJ11 plugs.
3) The Contractor shall connect each TCO data multipin modular RJ45 jack to a separate lower row jack on the HCCS "patch panel" in each associated RTC. The Contractor is not to "cross-connect" VCCS and HCCS data distribution cables or provides active electronic data distribution equipment as a part of the System.
4) A non-impact termination method, using either a stuffer cap with installation tool or full-cycle terminating tool having both tactile and audible feedback to indicate proper termination shall be used. High impact installation tools shall not be used.
5) Each terminated conductor end shall be properly trimmed to assure a minimum clearance of 6.35 mm (0.250 in) clearance between the conductors of adjacent modules.
6) The multipin RJ45 jack shall be modular in construction that will accept and operate with a modular UTP and STP RJ45 connector and its pin assignments.
7) The Contractor shall connect each fiber optic TCO "ST" connector to a separate fiber optic "bottom" row "ST" connector HCCS "patch panel" or "breakout" terminating device in each associated TC. The Contractor is not to "interconnect" VCCS and HCCS fiber optic distributions cables or provide active fiber optic electronic distribution equipment as a part of the system.

B. System Performance:

1. At a minimum, the System shall be able to support the voice and data operations for Category 6 Certified Telecommunication Service.
2. At a minimum the System shall support the following operating parameters:
   a. Telecommunications Outlet (TCO):
      1) Voice:
         a) Isolation (outlet-outlet): 24 dB.
         b) Impedance: 600 Ohms, balanced (BAL).
         c) Signal Level: 0 deciBel per mili-Volt (dBmV) + 0.1 dBmV.
         d) System speed: 100 mBps, minimum.
         e) System data error: 10 to the -6 Bps, minimum.
      2) Data:
         a) Isolation (outlet-outlet): 24 dB.
         b) Impedance: 600 Ohms, BAL.

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

3) Fiber optic:
a) Isolation (outlet-outlet): 36 dB.
b) Signal Level: 0 dBmV + 0.1 dBmV.
c) System speed: 540 mBps, minimum.
d) System data error: 10 to the -6 BPS, minimum.

C. General:

1. All equipment to be supplied under this specification shall be new and the current model of a standard product of an OEM or record. An OEM of record shall be defined as a company whose main occupation is the manufacture for sale of the items of equipment supplied and which:
   a. Maintains a stock of replacement parts for the item submitted.
   b. Maintains engineering drawings, specifications, and operating manuals for the items submitted.
   c. Has published and distributed descriptive literature and equipment specifications on the items of equipment submitted at least 30 days prior to the Invitation for Bid.
2. Specifications of equipment as set forth in this document are minimum requirements, unless otherwise stated, and shall not be construed as limiting the overall quality, quantity, or performance characteristics of items furnished in the System. When the Contractor furnishes an item of equipment for which there is a specification contained herein, the item of equipment shall meet or exceed the specification for that item of equipment.
3. The Contractor shall provide written verification, in writing to the RE at time of installation, that the type of wire/cable being provided is recommended and approved by the OEM. The Contractor is responsible for providing the proper size and type of cable duct and/or conduit and wiring even though the actual installation may be by another subcontractor.
4. The Telephone Contractor is responsible for providing interfacing cable connections for the telephone, PA systems with the System.
5. The telephone equipment and PA interface equipment shall be the interface points for connection of the PA interface cabling from the telephone switch via the system telephone interface unit.
6. Active electronic component equipment shall consist of solid state components, be rated for continuous duty service, comply with the requirements of FCC standards for telephone equipment, systems, and service.
7. All passive distribution equipment shall meet or exceed -80 dB radiation shielding specifications.
8. All interconnecting twisted pair, fiber-optic cables shall be terminated on equipment terminal boards, punch blocks, breakout boxes, splice blocks, and unused equipment ports/taps shall be terminated according to the OEM's instructions for telephone cable systems without adapters. The Contractor shall not leave unused or spare twisted pair wire, fiber-optic cable unterminated, unconnected, loose or unsecured.
9. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, which ever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING and Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.

10. Connect the System's primary input AC power to the Facility' Critical Branch of the Emergency AC power distribution system as shown on the plans or if not shown on the plans consult with RE regarding a suitable circuit location prior to bidding.
11. Plug-in connectors shall be provided to connect all equipment, except coaxial cables and interface points. Coaxial cable distribution points and RF transmission lines shall use coaxial cable connections recommended by the cable OEM and approved by the System OEM. Base- band cable systems shall utilize barrier terminal screw type connectors, at a minimum. Crimp type connectors installed with a ratchet type installation tool are and acceptable alternate as long as the cable dress, pairs, shielding, grounding, and connections and labeling are provided the same as the barrier terminal strip connectors. Tape of any type, wire nuts, or solder type connections are unacceptable and will not be approved.
12. All equipment faceplates utilized in the System shall be stainless steel, anodized aluminum, or UL approved cycolac plastic for the areas where provided.
13. Noise filters and surge protectors shall be provided for each equipment interface cabinet, switch equipment cabinet, control console, local, and remote active equipment locations to ensure protection from input primary AC power surges and noise glitches are not induced into low Voltage data circuits.
    a. Underground warning tape shall be standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters imprinted with "CAUTION BURIED ELECTRIC LINE BELOW", orange with black letters imprinted with "CAUTION BURIED TELEPHONE LINE BELOW" or orange with black letters imprinted with "CAUTION BURIED FIBER OPTIC LINE BELOW", as applicable.

D. Equipment Functional Characteristics:

FUNCTIONS	CHARACTERISTICS
Input Voltage	105 to 130 VAC
POWER LINE FREQUENCY	60 HZ ±2.0 HZ
Operating Temperature	O to 50 degrees (*) Centigrade (C)
Humidity	80 percent (%) minimum rating

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

4. Each item of electronic equipment to be provided under this contract must bear the approved UL seal or the seal of the testing laboratory that warrants the equipment has been tested in accordance with, and conforms to the specified standards.

2.2 DISTRIBUTION EQUIPMENT AND SYSTEMS

A. Telecommunication Outlet (TCO):
   1. The TCO shall consist of one telephone multipin jack and two data multipin jacks mounted in a steel outlet box. A separate 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled stainless steel faceplate will be used. A second 100mm (4in.) x 100mm (4in.) x 63mm (2.5in.) steel outlet box with a labeled faceplate shall be provided as required adjacent to the first box to ensure system connections and expandability requirements are met.
   2. All telephone multipin connections shall be RJ-45/11 compatible female types. All data multipin connections shall be RJ-45 female types.
   3. The TCO shall be fed from the appropriate CCS located in the respective RTC in a manner to provide a uniform and balanced distribution system.
   4. Interface of the data multipin jacks to appropriate patch panels (or approved “punch down” blocks) in the associated RTC, is the responsibility of the Contractor. The Contractor shall not extend data cables from the RTCs to data terminal equipment or install data terminal equipment.
   5. The wall outlet shall be provided with a stainless steel or approve alternate cover plate to fit the telephone multipin jack, data multi- pin jacks and the outlet box provided (100mm (4in.) x 100mm (4in.) for single and 100mm (4in.) x 200mm (8in.) for dual outlet box applications). For PBPU installations, the cover plate shall be stainless steel.

B. Distribution Cables: Each cable shall meet or exceed the following specifications for the specific type of cable. Each cable reel shall be sweep tested and certified by the OEM by tags affixed to each reel. The Contractor shall turn over all sweep tags to the RE or PM. Additionally, the Contractor shall provide a 610 mm (2 ft.) sample of each provided cable, to the RE and receive approval before installation. Cables installed in any outside location (i.e. above ground, under ground in conduit, ducts, pathways, etc.) shall be filled with a waterproofing compound between outside jacket (not immediately touching any provided armor) and inter conductors to seal punctures in the jacket and protect the conductors from moisture.
   1. Remote Control:
      a. The remote control cable shall be multi-conductor with stranded (solid is permissible) conductors. The cable shall be able to handle the power and voltage necessary to control specified system equipment from a remote location. The cable shall be UL listed and pass the FR-1 vertical flame test, at a minimum. Each conductor shall be color-coded. Combined multi-conductor and coaxial cables are acceptable for this installation, as long as all system performance standards are met.
      b. Technical Characteristics:

Length	As required, in 1K (3,000 ft.) reels minimum
Connectors	As required by system design
Size	18 AWG, minimum, Outside 20 AWG, minimum, Inside
Color coding	Required, EIA industry standard
Bend radius	10X the cable outside diameter
Impedance	As required
Shield coverage	As required by OEM specification

Attenuation	
Frequency in mHz	dB per 305 M (1,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
50.0	52.0

2. Telephone:
   a. The System cable shall be provided by the Contractor to meet the minimum system requirements of Category Six service. The cable shall interconnect each part of the system. The cable shall be completely survivable in areas where it is installed.
   b. Technical Characteristics:

Length	As required, in 1K (3,000 ft.) reels minimum
Cable	Voice grade category six
Connectors	As required by system design
Size	22 AWG, minimum, Outside 24 AWG, minimum, Inside
Color coding	Required, telephone industry standard
Bend radius	10X the cable outside diameter
Impedance	120 Ohms + 15%, BAL
Shield coverage	As required by OEM specification
Attenuation	
Frequency in mHz	dB per 305 M (1,000ft.), maximum
0.7	5.2
1.0	6.5
4.0	14.0
8.0	19.0
16.0	26.0
20.0	29.0
25.0	33.0
31.0	36.0
62.0	52.0
100.0	68.0

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

Wire size	22 AWG, minimum

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

4. Fiber Optic:
   a. Multimode Fiber:
      1) The general purpose multimode fiber optic cable shall be a dual window type installed in conduit for all system locations. A load-bearing support braid shall surround the inner tube for strength during cable installation.
      2) Technical Characteristics:

Bend radius	6.0", minimum Outer jacket, As required
FIBER DIAMETER	62.5 MICRONS
Cladding	125 microns
Attenuation	
850 nM	4.0 dB per kM, maximum
1,300 nM	2.0 dB per kM, maximum
Bandwidth	
850 nM	160 mHz, minimum
1,300 nM	500 mHz, minimum
Connectors	Stainless steel

   b. Single mode Fiber:
      1) The general purpose single mode fiber optic cable shall be a dual window type installed in conduit for all system locations. A load-bearing support braid shall surround the inner tube for strength during cable installation.
      2) Technical Characteristics:

Bend radius	100 mm (4 in.) minimum
Outer jacket	PVC
Fiber diameter	8.7 microns
Cladding	125 microns

Attenuation at 850 nM	1.0 dBm per km
Connectors	Stainless Steel

5. AC Power Cable: AC power cable(s) shall be 3-conductor, no. 12 AWG minimum, and rated for 13A-125V and 1,625W. Master AC power, installation specification and requirements, are given in the NEC and herein.

C. Outlet Connection Cables:
1. Telephone:
   a. The Contractor shall provide a connection cable for each TCO telephone jack in the System with 10% spares. The telephone connection cable shall connect the telephone instrument to the TCO telephone jack. The Contractor shall not provide telephone instrument(s) or equipment.
   b. Technical Characteristics:

Length	1.8M (6ft.), minimum
Cable	Voice Grade
Connector	RJ-11/45 compatible male on each end
Size	24 AWG, minimum
Color coding	Required, telephone industry standard

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

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

D. System Connectors:
1. Solderless (Forked Connector):
   a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector barrel shall be insulated and color-coded.
   b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V

2. Multipin:
   a. The connector shall have a crimp-on coupling for quick connect/disconnect of wires or cables. The crimp-on connector shall be designed to fit the wire or cable furnished. The connector housing shall be fully enclosed and shielded. It shall be secured to the cable group by screw type compression sleeves.
   b. Technical Characteristics:

Impedance	As required
Working Voltage	500 V

Number of pins As requires, usually 25 pairs minimum

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

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

4. Fiber Optic: The connectors shall be commercial types for voice and high speed data transmission applications. The connector shall be compatible with telephone instruments, computer terminals, and other type devices requiring linking through the modular telecommunications outlet to the system. The connector shall be compatible with UTP and STP cables.

E. Terminators:
   1. Coaxial:
      a. These units shall be metal-housed precision types in the frequency ranges selected. They shall be the screw-on type that has low VSWR when installed and the proper impedance to terminate the required system unit or coaxial cable.
      b. Technical Characteristics:

Frequency	0-1 GHz
Power blocking	As required
Return loss	25 dB
Connectors	“F”, "BNC", minimum
Impedance	50 or 75 Ohms, UNBAL

   2. Audio:
      a. These units shall be metal-housed precision types in the frequency ranges selected. They shall be the screw-on audio spade lug, twin plug, XL types that has low VSWR when installed and the proper impedance to terminate the required system unit or coaxial cable.
      b. Technical Characteristics:

Frequency	20-20 kHz, minimum
Power blocking	As required
Return loss	15 dB
Connectors	"Audio spade lug", “1/4”, “1/8”, "XL" or "RCA"
Impedance	
Bal	100 Ohms, minimum
Unbal	75 Ohm, minimum

3. Fiber Optic:
   a. These units shall be metal-housed precision types in the frequency ranges selected. They shall be the screw-on type that has low VSWR when installed and the proper impedance to terminate the required system unit or fiber optic cable.
   b. Technical Characteristics:

Frequency	Lightwave
Power blocking	As required
Return loss	25 dB
Connectors	"ST", minimum
Construction	Stainless steel
Impedance	As required

F. Distribution Frames:
   1. A new stand-alone (i.e., self supporting, free standing) MDF shall be provided to interconnect the EPBX and computer room. The MDF shall be modular and equipped with modular terminating mini blocks (i.e. Ericsson, 3M, etc.), and patch panels that are as small as possible and provide all the requirements of this specifications as described herein.
   2. All cable distribution closets and MDFs shall be wired in accordance with industry standards and shall employ "latest state-of-the-art" modular cross-connect devices. The MDF/telephone closet riser cable shall be sized to satisfy all voice requirements plus not less than 50% spare (growth) capacity in each telephone closet which includes a fiber optic backbone. The MDF/telephone closet riser cable shall be sized to satisfy all voice and data requirements plus not less than 50% spare (growth) capacity in each telephone closet which does not include a fiber optic backbone.
   3. The MDF and all intermediate distribution frames shall be connected to the EPBX system ground.
   4. Technical Characteristics:

Telephone	
IDC type unit	As described in Part 2
Contact wires	50 micron of Gold over Nickel
Contact pressure	100 Grams, MIN
110A Punch blocks	Acceptable alternate to IDC
Data	110A blocks as described in Part 2
Fiber optic	Patch panel as described in Part 2
Analog Video	Patch panel as described in Part 2

2.3 TELECOMMUNCATIONS CLOSET REQUIREMENTS

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

2.4 ENVIRONMENTAL REQUIREMENTS

A. Technical submittals shall identify the environmental specifications for housing the system. These environmental specifications shall identify the requirements for initial and expanded system configurations for:

B. Floor loading for batteries and cabinets.

C. Minimum floor space and ceiling heights.

D. Minimum size of doors for equipment passage.

E. Power requirements: The bidders shall provide the specific voltage, amperage, phases, and quantities of circuits required.

F. Air conditioning, heating, and humidity requirements. The bidder shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.

G. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).

H. Proposed floor plan based on the expanded system configuration of the bidder's proposed EPBX for this Facility.

I. Conduit size requirement (between equipment room and console room).

2.5 INSTALLATION KIT

A. The kit shall be provided that, at a minimum, includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. Turn over to the RE all unused and partially opened installation kit boxes, coaxial, fiberoptic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware. The following are the minimum required installation sub-kits:

B. System Grounding:
   1. The grounding kit shall include all cable and installation hardware required. All radio equipment shall be connected to earth ground via internal building wiring, according to the NEC.
   2. This includes, but is not limited to:
      a. Coaxial Cable Shields.
      b. Control Cable Shields.
      c. Data Cable Shields.
      d. Equipment Racks.
      e. Equipment Cabinets.
      f. Conduits.
      g. Duct.
      h. Cable Trays.
      i. Power Panels.
      j. Connector Panels.

k. Grounding Blocks.

C. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.

D. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.

E. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.

F. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.

G. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.

H. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. System Installation:
   1. After the contract’s been awarded, and within the time period specified in the contract, the Contractor shall deliver the total system in a manner that fully complies with the requirements of this specification. The Contractor shall make no substitutions or changes in the System without written approval from the RE and PM.
   2. The Contractor shall install all equipment and systems in a manner that complies with accepted industry standards of good practice, OEM instructions, the requirements of this specification, and in a manner which does not constitute a safety hazard. The Contractor shall insure that all installation personnel understands and complies with all the requirements of this specification.

3. The Contractor shall install suitable filters, traps, directional couplers, splitters, TC's, and pads for minimizing interference and for balancing the System. Items used for balancing and minimizing interference shall be able to pass telephone and data signals in the frequency bands selected, in the direction specified, with low loss, and high isolation, and with minimal delay of specified frequencies and signals. The Contractor shall provide all equipment necessary to meet the requirements of Paragraph 2.1.C and the System performance standards.
4. All passive equipment shall be connected according to the OEM's specifications to insure future correct termination, isolation, impedance match, and signal level balance at each telephone/data outlet.
5. Where TCOs are installed adjacent to each other, install one outlet for each instrument.
6. All lines shall be terminated in a suitable manner to facilitate future expansion of the System. There shall be a minimum of one spare 25 pair cable at each distribution point on each floor.
7. All vertical and horizontal copper and fiber optic cables shall be terminated so any future changes only requires modifications of the existing EPBX or signal closet equipment only.
8. Terminating resistors or devices shall be used to terminate all unused branches, outlets, equipment ports of the System, and shall be devices designed for the purpose of terminating fiber optic or twisted pair cables carrying telephone and data signals in telephone and data systems.
9. Equipment installed outdoors shall be weatherproof or installed in weatherproof enclosures with hinged doors and locks with two keys.
10. Equipment installed indoors shall be installed in metal cabinets with hinged doors and locks with two keys.

C. Conduit and Signal Ducts:
1. Conduit:
   a. The Contractor shall employ the latest installation practices and materials. The Contractor shall provide conduit, junction boxes, connectors, sleeves, weatherheads, pitch pockets, and associated sealing materials not specifically identified in this document as GFE. Conduit penetrations of walls, ceilings, floors, interstitial space, fire barriers, etc., shall be sleeved and sealed. The minimum conduit size shall be 19 mm (3/4 in.).
   b. All cables shall be installed in separate conduit and/or signal ducts (exception from the separate conduit requirement to allow telephone cables to be installed in partitioned cable tray with data cables may be granted in writing by the RE if requested.) Conduits shall be provided in accordance with Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and NEC Articles 517 for Critical Care and 800 for Communications systems, at a minimum.
   c. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
   d. When "innerduct" flexible cable protective systems is specifically authorized to be provided for use in the System, it's installation guidelines and standards shall be as the specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.
   e. Conduit (including GFE) fill shall not exceed 40%. Each conduit end shall be equipped with a protective insulator or sleeve to cover the conduit end, connection nut or clamp, to protect the wire or cable during installation and remaining in the conduit. Electrical power conduit shall be installed in accordance with the NEC. AC power conduit shall be run separate from signal conduit.

f. When metal, plastic covered, etc., flexible cable protective armor or systems are specifically authorized to be provided for use in the System, their installation guidelines and standards shall be as specified herein, Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS, and the NEC.

g. Ensure that Critical Care Systems (as identified by NEC Section 517) are completely separated and protected from all other systems.

2. Signal Duct, Cable Duct, or Cable Tray:

a. The Contractor shall use existing signal duct, cable duct, and/or cable tray, when identified and approved by the RE.

b. Approved signal and/or cable duct shall be a minimum size of 100 mm x 100 mm (4 in. X 4 in.) inside diameter with removable tops or sides, as appropriate. Protective sleeves, guides or barriers are required on all sharp corners, openings, anchors, bolts or screw ends, junction, interface and connection points.

c. Approved cable tray shall be fully covered, mechanically and physically partitioned for multiple electronic circuit use, and be UL certified and labeled for use with telecommunication circuits and/or systems. The RE shall approve width and height dimensions.

D. Distribution System Signal Wires and Cables:

1. Wires and cables shall be provided in the same manner and use like construction practices as Fire Protective and other Emergency Systems that are identified and outlined in NFPA 101, Life Safety Code, Chapters 7, 12, and/or 13, NFPA 70, National Electrical Code, Chapter 7, Special Conditions. The wires and cables shall be able to withstand adverse environmental conditions in their respective location without deterioration. Wires and cables shall enter each equipment enclosure, console, cabinet or rack in such a manner that all doors or access panels can be opened and closed without removal or disruption of the cables.

a. Each wire and cable shall terminate on an item of equipment by direct connection. Spare or unused wire and cable shall be provided with appropriate connectors (female types) that are installed in appropriate punch blocks, barrier strips, patch, or bulkhead connector panels.

b. Fiber optic cables that are spare, unused or dark shall be provided with Industry Standard “ST” type female connectors installed in appropriate break out, patch, or bulkhead connector panels provided in enclosure(s) and shall be protected from the environment.

c. Coaxial cables that are spare, unused or dark shall be provided with the cable OEM specified type female connectors installed in appropriate break out, patch, or bulkhead connector panels provided in enclosure(s) and shall be protected from the environment.

d. All cable junctions and taps shall be accessible. Provide an 8” X 8” X 4” (minimum) junction box attached to the cable duct or raceway for installation of distribution system passive equipment. Ensure all equipment and tap junctions are accessible.

2. Routing and Interconnection:

a. Wires or cables between consoles, cabinets, racks and other equipment shall be in an approved conduit, signal duct, cable duct, or cable tray that is secured to building structure.

b. Wires and cables shall be insulated to prevent contact with signal or current carrying conductors. Wires or cables used in assembling consoles, panels, equipment cabinets and racks shall be formed into harnesses that are bundled and tied. Harnessed wires or cables shall be combed straight, formed and dressed in either a vertical or horizontal relationship to equipment, controls, components or terminations.

c. Harnesses with intertwined members are not acceptable. Each wire or cable that breaks out from a harness for connection or termination shall have been tied off at that harness or bundle point, and be provided with a neatly formed service loop.

d. Wires and cables shall be grouped according to service (i.e.: AC, grounds, signal, DC, control, etc.). DC, control and signal cables may be included with any group. Wires and cables shall be neatly formed and shall not change position in the group throughout the conduit run. Wires and cables in approved signal duct, conduit, cable ducts, or cable trays shall be neatly formed, bundled, tied off in 600 mm to 900 mm (24 in. to 36 in.) lengths and shall not change position in the group throughout the run. Concealed splices are not allowed.

e. Separate, organize, bundle, and route wires or cables to restrict EMI, channel crosstalk, or feedback oscillation inside any enclosure. Looking at any enclosure from the rear (wall mounted enclosures, junction, pull or interface boxes from the front), locate AC power, DC and speaker wires or cables on the left; coaxial, control, microphone and line level audio and data wires or cables, on the right. This installation shall be accomplished with ties and/or fasteners that will not damage or distort the wires or cables. Limit spacing between tied off points to a maximum of 150 mm (6 inches).

f. Do not pull wire or cable through any box, fitting or enclosure where change of cable tray or signal or cable duct alignment or direction occurs. Ensure the proper bend radius is maintained for each wire or cable as specified by it's OEM.

g. Employ temporary guides, sheaves, rollers, and other necessary items to protect the wire or cable from excess tension or damage from bending during installation. Abrasion to wire or cable jackets is not acceptable and will not be allowed. Replace all cables whose jacket has been abraded. The discovery of any abraded and/or damaged cables during the proof of performance test shall be grounds for declaring the entire system unacceptable and the termination of the proof of performance test. Completely cover edges of wire or cable passing through holes in chassis, cabinets or racks, enclosures, pull or junction boxes, conduit, etc., with plastic or nylon grommeting.

h. Cable runs shall be splice free between conduit junction and interface boxes and equipment locations.

i. Cables shall be installed and fastened without causing sharp bends or rubbing of the cables against sharp edges. Cables shall be fastened with hardware that will not damage or distort them.

j. Cables shall be labeled with permanent markers at the terminals of the electronic and passive equipment and at each junction point in the System. The lettering on the cables shall correspond with the lettering on the record diagrams.

k. Completely test all of the cables after installation and replace any defective cables.

l. Wires or cables that are installed outside of buildings shall be in conduit, secured to solid building structures. If specifically approved, on a case by case basis, to be run outside of conduit, the wires or cables shall be installed, as described herein. The bundled wires or cables must: Be tied at not less than 460 mm (18 in.) intervals to a solid building structure; have ultra violet protection and be totally waterproof (including all connections). The laying of wires or cables directly on roof tops, ladders, drooping down walls, walkways, floors, etc. is not allowed and will not be approved.

m. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.
   1) Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
   2) Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.

3) Closer wire or cable fastening intervals may be required to prevents sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.

4) Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the RE, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.

n. Wires or cables installed in underground conduit, duct, etc.

1) Wires or cables installed in underground installations shall be waterproofed by the inclusion of a water protective barrier (i.e. gel, magma, etc.) or flooding compound between the outside jacket and first shield. Each underground connection shall be accessible in a manhole, recessed ground level junction box, above ground pedestal, etc., and shall be provided with appropriate waterproof connectors to match the cable being installed. Once the System has been tested and found to meet the System performance standards and accepted by VA, the Contractor shall provide waterproof shrink tubing or approved mastic to fully encompass each wire or cable connection and overlay at least 150 mm (6 inches) above each wire or cable jacket trim point.

2) It is not acceptable to connect waterproofed cable directly to an inside CCS punch block or directly to an equipment connection port. When an under ground cable enters a building, it shall be routed directly to the closest TC that has been designated as the building's IMTC. The Contractor shall provide a "transition" splice in this TC where the "water proofed" cable enters on one side and "dry" cable exits on the other side. The "transition" splice shall be fully waterproof and be capable of reentry for system servicing. Additionally, the transition splice shall not allow the waterproofing compound to migrate from the water proof cable to the dry cable.

3) Warning tape shall be continuously placed 300 mm (12 inches) above buried conduit, cable, etc.

E. Outlet Boxes, Back Boxes, and Faceplates:

1. Outlet Boxes: Signal, power, interface, connection, distribution, and junction boxes shall be provided as required by the system design, on-site inspection, and review of the contract drawings.
2. Back Boxes: Back boxes shall be provided as directed by the OEM as required by the approved system design, on-site inspection, and review of the contract drawings.
3. Face Plates (or Cover Plates): Faceplates shall be of a standard type, stainless steel, anodized aluminum or UL approved cycolac plastic construction and provided by the Contractor for each identified system outlet location. Connectors and jacks appearing on the faceplate shall be clearly and permanently marked.

F. Connectors: Circuits, transmission lines, and signal extensions shall have continuity, correct connection and polarity. A uniform polarity shall be maintained between all points in the system.

1. Wires:

a. Wire ends shall be neatly formed and where insulation has been cut, heat shrink tubing shall be employed to secure the insulation on each wire. Tape of any type is not acceptable.

b. Audio spade lugs shall be installed on each wire (including spare or unused) end and connect to screw terminals of appropriate size barrier strips. AC barrier strips shall be provided with a protective cover to prevent accidental contact with wires carrying live AC current. Punch blocks are approved for signal, not AC wires. Wire Nut or "Scotch Lock" connectors are not acceptable for signal wire installation.

2. Cables: Each connector shall be designed for the specific size cable being used and installed with the OEM's approved installation tool. Typical system cable connectors include; but, are not limited to: Audio spade lug, punch block, wirewrap, etc.
3. Line or Microphone Audio: Each connector shall be installed according to the cable or connector OEM's instructions and use the OEM's approved installation tool. Install the connector's to provide and maintain the following audio signal polarity:
   a. XLR type connectors Signal or positive conductor is pin 3; common or neutral conductor is pin 2; ground conductor is pin 1.
   b. Two and 3 conductor 1/4" Signal or positive conductor is tip; neutral or 1/8" phono plugs conductor is ring and ground or shield and jacks conductor is sleeve.
   c. RCA Phono Plugs the Signal or positive conductor is tip; and Jacks neutral or shield conductor is sleeve.
4. Speaker Line Audio:
   a. Each connector shall be installed according to the cable, transformer or speaker OEM instructions and using the OEM's approved installation tool. The Contractor shall ensure each speaker is properly phased and connected in the same manner throughout the System using two conductor type wires.
   b. One of the conductors shall be color coded to aid in establishing speaker signal polarity. Each speaker line shall be permanently soldered or audio spade lug connected to each appropriate speaker or line matching transformer connection terminal. Speaker line connection to each audio amplifier shall use audio spade lugs, as described herein.

G. AC Power: AC power wiring shall be run separately from signal cable.

H. Grounding:
1. General: The Contractor shall ground all Contractor Installed Equipment and identified Government Furnished Equipment to eliminate all shock hazards and to minimize, to the maximum extent possible, all ground loops, common mode returns, noise pickup, crosstalk, etc. The total ground resistance shall be 0.1 Ohm or less.
   a. The Contractor shall install lightning arrestors and grounding in accordance with the NFPA and this specification.
   b. Gas protection devices shall be provided on all circuits and cable pairs serving building distribution frames located in buildings other than the building in which the is located or in any area served by an unprotected distribution system (manhole, aerial, etc.). The Contractor shall install the gas protection devices at the nearest point of entrance in buildings where protection is required and on the same circuits on the MDF in the telephone switch room.
   c. Under no conditions shall the AC neutral, either in a power panel or in a receptacle outlet, be used for system control, subcarrier or audio reference ground.
   d. The use of conduit, signal duct or cable trays as system or electrical ground is not acceptable and will not be permitted. These items may be used only for the dissipation of internally generated static charges (not to be confused with externally generated lightning) that may applied or generated outside the mechanical and/or physical confines of the System to earth ground. The discovery of improper system grounding shall be grounds to declare the System unacceptable and the termination of all system acceptance testing.
2. Cabinet Buss: A common ground buss of at least #10 AWG solid copper wire shall extend throughout each equipment cabinet and be connected to the system ground. Provide a separate isolated ground connection from each equipment cabinet ground buss to the system ground. Do not tie equipment ground busses together.

3. Equipment: Equipment shall be bonded to the 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 alternates.
4. Cable Shields: Cable shields shall be bonded to the cabinet ground buss with #12 AWG minimum stranded copper wire at only one end of the cable run. Cable shields shall be insulated from each other, faceplates, equipment racks, consoles, enclosures or cabinets; except, at the system common ground point. Coaxial and audio cables, shall have one ground connection at the source; in all cases, cable shield ground connections shall be kept to a minimum.

I. Labeling: Provide labeling in accordance with ANSI/EIA/TIA-606-A. All lettering for voice and data circuits shall be stenciled using laser printers. Handwritten labels are not acceptable.
1. Cable and Wires (Hereinafter referred to as "Cable"): Cables shall be labeled at both ends in accordance with ANSI/EIA/TIA-606-A. Labels shall be permanent in contrasting colors. Cables shall be identified according to the System "Record Wiring Diagrams".
2. Equipment: System equipment shall be permanently labeled with contrasting plastic laminate or bakelite material. System equipment shall be labeled on the face of the unit corresponding to its source.
3. Conduit, Cable Duct, and/or Cable Tray: The Contractor shall label all conduit, duct and tray, including utilized GFE, with permanent marking devices or spray painted stenciling a minimum of 3 meters (10 ft.) identifying it as the System. In addition, each enclosure shall be labeled according to this standard.
4. Termination Hardware: The Contractor shall label workstation outlets and patch panel connections using color coded labels with identifiers in accordance with ANSI/EIA/TIA-606-A and the "Record Wiring Diagrams".

3.2 TESTS

A. Interim Inspection:
1. This inspection shall verify that the equipment provided adheres to the installation requirements of this document. The interim inspection will be conducted by a factory-certified representative and witnessed by a Government Representative. Each item of installed equipment shall be checked to insure appropriate UL certification markings. This inspection shall verify cabling terminations in telecommunications rooms and at workstations adhere to color code for T568B pin assignments and cabling connections are in compliance with ANSI/EIA/TIA standards. Visually confirm Category 6 marking of outlets, faceplates, outlet/connectors and patch cords.
2. Perform fiber optical field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.
3. The Contractor shall notify the RE, in writing, of the estimated date the Contractor expects to be ready for the interim inspection, at least 20 working days before the requested inspection date.
4. Results of the interim inspection shall be provided to the RE and PM. If major or multiple deficiencies are discovered, a second interim inspection may be required before permitting the Contractor to continue with the system installation.
5. The RE and/or the PM shall determine if an additional inspection is required, or if the Contractor will be allowed to proceed with the installation. In either case, re-inspection of the deficiencies noted during the interim inspection(s), will be part of the proof of performance test. The interim inspection shall not affect the Systems' completion date. The Contracting Officer shall ensure all test documents will become a part of the Systems record documentation.

B. Pretesting:
   1. Upon completing the installation of the System, the Contractor shall align and balance the system. The Contractor shall pretest the entire system.
   2. Pretesting Procedure:
      a. During the system pretest, the Contractor shall verify (utilizing the approved spectrum analyzer and test equipment) that the System is fully operational and meets all the system performance requirements of this standard.
      b. The Contractor shall pretest and verify that all System functions and specification requirements are met and operational, no unwanted aural effects, such as signal distortion, noise pulses, glitches, audio hum, poling noise, etc. are present. The Contractor shall measure and record the aural carrier levels of each system telephone and data channel, at each of the following points in the system:
         1) Local Telephone Company Interfaces or Inputs.
         2) EPBX interfaces or inputs and outputs.
         3) MDF interfaces or inputs and outputs.
         4) EPBX output S/NR for each telephone and data channel.
         5) Signal Level at each interface point to the distribution system, the last outlet on each trunk line plus all outlets installed as part of this contract.
   3. The Contractor shall provide four (4) copies of the recorded system pretest measurements and the written certification that the System is ready for the formal acceptance test shall be submitted to the RE.

C. Acceptance Test: After the System has been pretested and the Contractor has submitted the pretest results and certification to the RE, then the Contractor shall schedule an acceptance test date and give the RE 30 days written notice prior to the date the acceptance test is expected to begin. The System shall be tested in the presence of a Government Representative and an OEM certified representative. The System shall be tested utilizing the approved test equipment to certify proof of performance and Life Safety compliance. The test shall verify that the total System meets the requirements of this specification. The notification of the acceptance test shall include the expected length (in time) of the test.

D. Verification Tests:
   1. Test the UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test the operation of shorting bars in connection blocks. Test cables after termination and prior to cross-connection.
   2. Multimode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with ANSI/EIA/TIA-568-B.3 and ANSI/EIA/TIA-526-14A. Perform verification acceptance test.
   3. Single mode Fiber Optic Cable: Perform end-to-end attenuation tests in accordance with ANSI/EIA/TIA-568-B.3 and ANSI/EIA/TIA-526-7. Perform verification acceptance test.

E. Performance Testing:
   1. Perform Category 6 tests in accordance with ANSI/EIA/TIA-568-B.1 and ANSI/EIA/TIA-568-B.2. Test shall include the following: wire map, length, insertion loss, return loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, propagation delay and delay skew.
   2. Fiber Optic Links: Perform end-to-end fiber optic cable link tests in accordance with ANSI/EIA/TIA-568-B.3.

F. Total System Acceptance Test: The Contractor shall perform verification tests for UTP copper cabling system(s) and the multimode fiber optic cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.
   1. Voice Testing: Connect to the network interface device at the demarcation point. Go off-hook and receive dial tone from the LEC. If a test number is available, place and receive a local, long distance, and FTS telephone call.

2. Data Testing: Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network is achieved.

3.3 TRAINING

A. Furnish the services of a factory-trained engineer or technician for a total of two four hour classes to instruct designated Facility IRM personnel. Instruction shall include cross connection, corrective, and preventive maintenance of the System and equipment.

B. Before the System can be accepted by the VA, this training must be accomplished. Training will be scheduled at the convenience of the Facilities Contracting Officer and Chief of Engineering Service.

3.4 GUARANTEE PERIOD OF SERVICE

A. Contractor's Responsibilities:
1. The Contractor shall guarantee that all installed material and equipment will be free from defects, workmanship, and will remain so for a period of one year from date of final acceptance of the System by the VA. The Contractor shall provide OEM's equipment warranty documents, to the RE (or Facility Contracting Officer if the Facility has taken procession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.
3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
4. Additionally, the Contractor shall accomplish the following minimum requirements during the one year guarantee period:
   a. Response Time:
      1) The RE (or facility Contracting Officer if the facility has taken possession of the building[s]) are the Contractor's reporting and contact officials for the System trouble calls, during the guarantee period.
      2) A standard workweek is considered 8:00 A.M. to 5:00 P.M., Monday through Friday exclusive of Federal Holidays.
      3) The Contractor shall respond and correct on-site trouble calls, during the standard work week to:
         a) A routine trouble call within one working days of its report. A routine trouble is considered a trouble which causes a system outlet, station, or patch cord to be inoperable.
         b) An emergency trouble call within 6 hours of its report. An emergency trouble is considered a trouble which causes a subsystem or distribution point to be inoperable at anytime. Additionally, the loss of a minimum of 50 station or system lines shall be deemed as this type of a trouble call.
      4) The Contractor shall respond on-site to a catastrophic trouble call within 4 hours of its report. A catastrophic trouble call is considered total system failure.
         a) If a system failure cannot be corrected within four hours (exclusive of the standard work time limits), the Contractor shall be responsible for providing alternate system CSS or TCO equipment, or cables. The alternate equipment and/or cables shall be operational within four hours after the four hour trouble shooting time.

b) Routine or emergency trouble calls in critical emergency health care facilities (i.e., cardiac arrest, intensive care units, etc.) shall also be deemed as a catastrophic trouble call if so determined by the RE or Facility Director. The RE or Facility Contracting Officer shall notify the Contractor of this type of trouble call at the direction of the Facilities Director.

b. Required on-site visits during the one year guarantee period

1) The Contractor shall visit, on-site, for a minimum of eight hours, once every 12 weeks, during the guarantee period, to perform system preventive maintenance, equipment cleaning, and operational adjustments to maintain the System according the descriptions identified in this SPEC.

a) The Contractor shall arrange all Facility visits with the RE or Facility Contracting Officer prior to performing the required maintenance visits.

b) The Contractor in accordance with the OEM's recommended practice and service intervals shall perform preventive maintenance during a non-busy time agreed to by the RE or Facility Contracting Officer and the Contractor.

c) The preventive maintenance schedule, functions and reports shall be provided to and approved by the RE or Facility Contracting Officer.

2) The Contractor shall provide the RE or Facility Contracting Officer a type written report itemizing each deficiency found and the corrective action performed during each required visit or official reported trouble call. The Contractor shall provide the RE with sample copies of these reports for review and approval at the beginning of the Total System Acceptance Test. The following reports are the minimum required:

a) Monthly Report: The Contractor shall provide a monthly summary all equipment and sub-systems serviced during this guarantee period to RE or Facilities Contracting Officer by the fifth working day after the end of each month. The report shall clearly and concisely describe the services rendered, parts replaced and repairs performed. The report shall prescribe anticipated future needs of the equipment and Systems for preventive and predictive maintenance

b) Contractor Log: The Contractor shall maintain a separate log entry for each item of equipment and each sub-system of the System. The log shall list dates and times of all scheduled, routine, and emergency calls. Each emergency call shall be described with details of the nature and causes of emergency steps taken to rectify the situation and specific recommendations to avoid such conditions in the future.

c. The RE or Facility Contracting Officer shall provide the Facility Engineering Officer, two (2) copies of actual reports for evaluation.

a) The RE or Facility Contracting Officer shall ensure copies of these reports are entered into the System's official acquisition documents.

b) The Facilities Chief Engineer shall ensure copies of these reports are entered into the System's official technical as-installed documents.

B. Work Not Included: Maintenance and repair service shall not include the performance of any work due to improper use, accidents, other vendor, contractor, owner tampering or negligence, for which the Contractor is not directly responsible and does not control. The Contractor shall immediately notify the RE or Facility Contracting Officer in writing upon the discovery of these incidents. The RE or Facility Contracting Officer will investigate all reported incidents and render findings concerning any Contractor's responsibility.

END OF SECTION

SECTION 28 05 11
REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section, Requirements for Electronic Safety and Security Installations, applies to all sections of Division 28.

B. Furnish and install electronic safety and security cabling, systems, equipment and accessories in accordance with the specifications and drawings. Capacities and ratings of, cable and other items and arrangements for the specified items are shown on drawings.

1.2 MINIMUM REQUIREMENTS

A. References to industry and trade association standards and codes are minimum installation requirement standards.

B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 QUALIFICATIONS (PRODUCTS AND SERVICES)

A. Manufacturers Qualifications: The manufacturer shall regularly and presently produce, as one of the manufacturer's principal products, the equipment and material specified for this project, and shall have manufactured the item for at least three years.

B. Product Qualification:
   1. Manufacturer's product shall have been in satisfactory operation, on three installations of similar size and type as this project, for approximately three years.
   2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within eight hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.4 MANUFACTURED PRODUCTS

A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.

B. When more than one unit of the same class of equipment is required, such units shall be the product of a single manufacturer.

C. Equipment Assemblies and Components:
   1. Components of an assembled unit need not be products of the same manufacturer.
   2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
   3. Components shall be compatible with each other and with the total assembly for the intended service.
   4. Constituent parts which are similar shall be the product of a single manufacturer.

D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.

E. When Factory Testing Is Specified:
   1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the Resident Engineer a minimum of 15 working days prior to the manufacturers making the factory tests.
   2. Four copies of certified test reports containing all test data shall be furnished to the Resident Engineer prior to final inspection and not more than 90 days after completion of the tests.
   3. When equipment fails to meet factory test and re-inspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

1.5 EQUIPMENT REQUIREMENTS

A. Where variations from the contract requirements are requested in accordance with GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.6 EQUIPMENT PROTECTION

A. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain:
   1. During installation, enclosures, equipment, controls, controllers, circuit protective devices, and other like items, shall be protected against entry of foreign matter; and be vacuum cleaned both inside and outside before testing and operating and repainting if required.
   2. Damaged equipment shall be, as determined by the Resident Engineer, placed in first class operating condition or be returned to the source of supply for repair or replacement.
   3. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
   4. Damaged paint on equipment and materials shall be refinished with the same quality of paint and workmanship as used by the manufacturer so repaired areas are not obvious.

1.7 WORK PERFORMANCE

A. Job site safety and worker safety is the responsibility of the contractor.

B. For work on existing stations, arrange, phase and perform work to assure electronic safety and security service for other buildings at all times. Refer to Article OPERATIONS AND STORAGE AREAS under Section 01 00 00, GENERAL REQUIREMENTS.

C. New work shall be installed and connected to existing work neatly and carefully. Disturbed or damaged work shall be replaced or repaired to its prior conditions, as required by Section 01 00 00, GENERAL REQUIREMENTS.

D. Coordinate location of equipment and conduit with other trades to minimize interferences. See GENERAL CONDITIONS.

1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS

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

B. Inaccessible Equipment:
   1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.
   2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.9 EQUIPMENT IDENTIFICATION

A. Install an identification sign which clearly indicates information required for use and maintenance of equipment.

B. Nameplates shall be laminated black phenolic resin with a white core with engraved lettering, a minimum of 6 mm (1/4 inch) high. Secure nameplates with screws. Nameplates that are furnished by manufacturer as a standard catalog item, or where other method of identification is herein specified, are exceptions.

1.10 SUBMITTALS

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

B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.

C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.

D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
   1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
   2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
   3. Submit each section separately.

E. The submittals shall include the following:
   1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
   2. Elementary and interconnection wiring diagrams for communication and signal systems, control system and equipment assemblies. All terminal points and wiring shall be identified on wiring diagrams.
   3. Parts list which shall include those replacement parts recommended by the equipment manufacturer, quantity of parts, current price and availability of each part.

F. Manuals: Submit in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
   1. Maintenance and Operation Manuals: Submit as required for systems and equipment specified in the technical sections. Furnish four copies, bound in hardback binders, (manufacturer's standard binders) or an approved equivalent. Furnish one complete manual as specified in the technical section but in no case later than prior to performance of systems or equipment test, and furnish the remaining manuals prior to contract completion.
   2. Inscribe the following identification on the cover: the words "MAINTENANCE AND OPERATION MANUAL," the name and location of the system, equipment, building, name of Contractor, and contract number. Include in the manual the names, addresses, and telephone numbers of each subcontractor installing the system or equipment and the local representatives for the system or equipment.
   3. Provide a "Table of Contents" and assemble the manual to conform to the table of contents, with tab sheets placed before instructions covering the subject. The instructions shall be legible and easily read, with large sheets of drawings folded in.

4. The manuals shall include:
   a. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
   b. A control sequence describing start-up, operation, and shutdown.
   c. Description of the function of each principal item of equipment.
   d. Installation and maintenance instructions.
   e. Safety precautions.
   f. Diagrams and illustrations.
   g. Testing methods.
   h. Performance data.
   i. Pictorial "exploded" parts list with part numbers. Emphasis shall be placed on the use of special tools and instruments. The list shall indicate sources of supply, recommended spare parts, and name of servicing organization.
   j. Appendix; list qualified permanent servicing organizations for support of the equipment, including addresses and certified qualifications.

G. Approvals will be based on complete submission of manuals together with shop drawings.

H. After approval and prior to installation, furnish the Resident Engineer with one sample of each of the following:
   1. A 300 mm (12 inch) length of each type and size of wire and cable along with the tag from the coils of reels from which the samples were taken.
   2. Each type of conduit and pathway coupling, bushing and termination fitting.
   3. Conduit hangers, clamps and supports.
   4. Duct sealing compound.

1.11 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.

1.12 TRAINING

A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01 00 00, GENERAL REQUIREMENTS.

B. Training shall be provided for the particular equipment or system as required in each associated specification.

C. A training schedule shall be developed and submitted by the contractor and approved by the Resident Engineer at least 30 days prior to the planned training.

END OF SECTION

SECTION 28 05 13
CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of the conductors and cables for electronic safety and security.

1.2 RELATED WORK

A. Excavation and backfill for cables that are installed in conduit: Section 31 20 00, EARTH MOVING.

B. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.

C. General electrical requirements that are common to more than one section in Division 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.

D. Conduits for cables and wiring: Section 28 05 33, RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY.

E. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.

1.3 SUBMITTALS

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

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.

B. American Society of Testing Material (ASTM):
   D2301-04 Standard Specification for Vinyl Chloride Plastic Pressure Sensitive Electrical Insulating Tape

C. Federal Specifications (Fed. Spec.):
   A-A-59544-00 Cable and Wire, Electrical (Power, Fixed Installation)

D. National Fire Protection Association (NFPA):
   70-05 National Electrical Code (NEC)

E. Underwriters Laboratories, Inc. (UL):
   44-02 Thermoset-Insulated Wires and Cables

83-03	Thermoplastic-Insulated Wires and Cables
467-01	Electrical Grounding and Bonding Equipment
486A-01	Wire Connectors and Soldering Lugs for Use with Copper Conductors
486C-02	Splicing Wire Connectors
486D-02	Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
486E-00	Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
493-01	Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
514B-02	Fittings for Cable and Conduit
1479-03	Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONTROL WIRING

A. Unless otherwise specified in other sections of these specifications, control wiring shall be as specified for power and lighting wiring, except the minimum size shall be not less than No. 14 AWG.

B. Control wiring shall be large enough so that the voltage drop under inrush conditions does not adversely affect operation of the controls.

2.2 COMMUNICATION AND SIGNAL WIRING

A. Shall conform to the recommendations of the manufacturers of the communication and signal systems; however, not less than what is shown.

B. Wiring shown is for typical systems. Provide wiring as required for the systems being furnished.

C. Multi conductor cables shall have the conductors color coded.

2.3 WIRE LUBRICATING COMPOUND

A. Suitable for the wire insulation and conduit it is used with, and shall not harden or become adhesive.

B. Shall not be used on wire for isolated type electrical power systems.

2.4 FIREPROOFING TAPE

A. The tape shall consist of a flexible, conformable fabric of organic composition coated one side with flame retardant elastomer.

B. The tape shall be self extinguishing and shall not support combustion. It shall be arc-proof and fireproof.

C. The tape shall not deteriorate when subjected to water, gases, salt water, sewage, or fungus and be resistant to sunlight and ultraviolet light.

D. The finished application shall withstand a 200-ampere arc for not less than 30 seconds.

E. Securing tape: Glass cloth electrical tape not less than 0.18 mm (7 mils) thick, and 19 mm (3/4 inch) wide.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Splice cables and wires only in outlet boxes, junction boxes, or pull boxes.

B. Seal cable and wire entering a building from underground, between the wire and conduit where the cable exits the conduit, with a non-hardening approved compound.

C. Wire Pulling:
   1. Provide installation equipment that will prevent the cutting or abrasion of insulation during pulling of cables.
   2. Use ropes made of nonmetallic material for pulling feeders.
   3. Attach pulling lines for feeders by means of either woven basket grips or pulling eyes attached directly to the conductors, as approved by the Resident Engineer.
   4. Pull in multiple cables together in a single conduit.

3.2 INSTALLATION IN MANHOLES

A. Install and support cables in manholes on the steel racks with porcelain or equal insulators. Train the cables around the manhole walls, but do not bend to a radius less than six times the overall cable diameter.

3.3 SPLICE INSTALLATION

A. Splices and terminations shall be mechanically and electrically secure.

B. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.4 CONTROL, COMMUNICATION AND SIGNAL WIRING INSTALLATION

A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.

B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.

C. Where separate power supply circuits are not shown, connect the systems to the nearest panelboards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

D. Install a red warning indicator on the handle of the branch circuit breaker for the power supply circuit for each system to prevent accidental de energizing of the systems.

E. System voltages shall be 120 volts or lower where shown on the drawings or as required by the NEC.

3.5 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION

A. Install a permanent wire marker on each wire at each termination.

B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.

C. Wire markers shall retain their markings after cleaning.

D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.6 EXISTING WIRING

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

END OF SECTION

SECTION 28 05 26
GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies general grounding and bonding requirements of electronic safety and security installations for equipment operations.

B. "Grounding electrode system" refers to all electrodes required by NEC, as well as including made, supplementary, grounding electrodes.

C. The terms "connect" and "bond" are used interchangeably in this specification and have the same meaning.

1.2 RELATED WORK

A. Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 28.

B. Section 28 05 13, CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY: Low Voltage power and lighting wiring.

C. Section 26 41 00, FACILITY LIGHTNING PROTECTION: Requirements for a lightning protection system.

1.3 SUBMITTALS

A. Submit in accordance with Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.

B. Shop Drawings:
   1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
   2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:
   1. Certification that the materials and installation is in accordance with the drawings and specifications.
   2. Certification, by the Contractor, that the complete installation has been properly installed and tested.

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. 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

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
81-1983 IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

D. National Fire Protection Association (NFPA):
70 2005 National Electrical Code (NEC)

D. Underwriters Laboratories, Inc. (UL):
44 2005 Thermoset Insulated Wires and Cables
83 2003 Thermoplastic Insulated Wires and Cables
467 2004 Grounding and Bonding Equipment
486A-486B-2003 Wire Connectors

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes 25 mm² (4 AWG) and larger shall be permitted to be identified per NEC.

B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 6 mm² (10 AWG) and smaller shall be ASTM B1 solid bare copper wire.

C. Isolated Power System: Type XHHW-2 insulation with a dielectric constant of 3.5 or less.

2.2 GROUND RODS

A. Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.

B. Quantity of rods shall be as required to obtain the specified ground resistance.

2.3 SPLICES AND TERMINATION COMPONENTS

A. Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.4 GROUND CONNECTIONS

A. Below Grade: Exothermic-welded type connectors.

B. Above Grade:
1. Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.
3. Rack and Cabinet Ground Bars: one-hole compression-type lugs using zinc-plated or copper alloy fasteners.

2.5 EQUIPMENT RACK AND CABINET GROUND BARS

A. Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 4 mm thick by 19 mm wide (3/8 inch x ¾ inch).

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 screw lug-type terminal blocks.

2.7 SPLICE CASE GROUND ACCESSORIES

A. Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 16 mm² (6 AWG) insulated ground wire with shield bonding connectors.

2.8 COMPUTER ROOM GROUND

A. Provide 50mm2 (1/0 AWG) bare copper grounding conductors bolted at mesh intersections to form an equipotential grounding grid. The equipotential grounding grid shall form a 600mm (24 inch) mesh pattern. The grid shall be bonded to each of the access floor pedestals.

PART 3 - EXECUTION

3.1 GENERAL

A. Ground in accordance with the NEC, as shown on drawings, and as hereinafter specified.

B. System Grounding:
   1. Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
   2. Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
   3. Isolation transformers and isolated power systems shall not be system grounded.

C. Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

A. Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.

3.3 CORROSION INHIBITORS

A. When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.4 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the building 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 gases and suction piping, at the outlets, directly to the room or patient ground bus.

3.5 COMPUTER ROOM GROUNDING

A. Conduit: Ground and bond metallic conduit systems as follows:
   1. Ground metallic service conduit and any pipes entering or being routed within the computer room at each end using 16 mm²(6AWG)bonding jumpers.
   2. Bond at all intermediate metallic enclosures and across all joints using 16 mm² (6 AWG) bonding jumpers.
   3. Bond every metallic conduit that penetrates the plan of the raised floor to the raised floor stringer system as follows:
      a. Unpainted Supports Attached to Raised Floor System: When conduit/strut clamps are used to attach conduit to Unistrut, no additional bonding is required.
      b. Unpainted Supports Not Attached to Raised Floor System: When conduit/strut clamps are used to attach conduit to Unistrut, use 16 mm² (6 AWG) bonding jumpers to connect Unistrut to the raised floor system.
      c. Painted Supports: Use 16 mm² (6 AWG) bonding jumpers to connect conduit to the stringer system. Mount a push-type conduit fastener onto every metallic conduit. Place fasteners no higher or lower than 75 mm (3 inches) from the raised floor stringer.

B. Equipotential Grounding Grid:
   1. Install a bolted stringer system to serve as the computer room equipotential grounding grid.
   2. If a bolted stringer system is not provided, install equipotential grounding grid in a 600 mm square grid consisting of 50 mm² (1/0 AWG) bare copper conductor welded at the intersection of each grid.
   3. 3. Attach the equipotential ground grid to the room signal ground bus using a 50 mm² (1/0 AWG) bare copper grounding conductor.

3.6 WIREWAY GROUNDING

A. Ground and Bond Metallic Wireway Systems as follows:
   1. Bond the metallic structures of wireway to provide 100 percent electrical continuity throughout the wireway system by connecting a 16 mm² (6 AWG) bonding jumper at all intermediate metallic enclosures and across all section junctions.
   2. Install insulated 16 mm² (6 AWG) bonding jumpers between the wireway system bonded as required in paragraph 1 above, and the closest building ground at each end and approximately every 16 meters (50 feet).
   3. Use insulated 16 mm² (6 AWG) bonding jumpers to ground or bond metallic wireway at each end at all intermediate metallic enclosures and cross all section junctions.
   4. Use insulated 16 mm² (6 AWG) bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 15 meters.

3.7 GROUND RESISTANCE

A. Grounding system resistance to ground shall not exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Government. Final tests shall assure that this requirement is met.

B. Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

C. Services at power company interface points shall comply with the power company ground resistance requirements.

D. Below-grade connections shall be visually inspected by the Resident Engineer prior to backfilling. The Contractor shall notify the Resident Engineer 24 hours before the connections are ready for inspection.

3.8 GROUND ROD INSTALLATION

A. Drive each rod vertically in the earth, not less than 3000 mm (10 feet) in depth.

B. Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

C. Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.

END OF SECTION

SECTION 28 05 33
RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, and connection of conduit, fittings, and boxes to form complete, coordinated, raceway systems. Raceways are required for all electronic safety and security cabling 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. Bedding of conduits: Section 31 20 00, EARTH MOVING.

B. Mounting board for communication closets: Section 06 10 00, ROUGH CARPENTRY.

C. Sealing around penetrations to maintain the integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.

D. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.

E. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07 92 00, JOINT SEALANTS.

F. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.

G. General electrical requirements and items that is common to more than one section of Division 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.

H. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 28 05 26, GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY.

1.3 SUBMITTALS

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

B. Shop Drawings:
1. Size and location of main feeders;
2. Size and location of panels and pull boxes
3. Layout of required conduit penetrations through structural elements.
4. The specific item proposed and its area of application shall be identified on the catalog cuts.

C. Certification: Prior to final inspection, deliver to the Resident Engineer four copies of the certification that the material is in accordance with the drawings and specifications and has been properly installed.

1.4 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. National Fire Protection Association (NFPA):

70-05	National Electrical Code (NEC)

C. Underwriters Laboratories, Inc. (UL):

1-03	Flexible Metal Conduit
5-01	Surface Metal Raceway and Fittings
6-03	Rigid Metal Conduit
50-03	Enclosures for Electrical Equipment
360-03	Liquid-Tight Flexible Steel Conduit
467-01	Grounding and Bonding Equipment
514A-01	Metallic Outlet Boxes
514B-02	Fittings for Cable and Conduit
514C-05	Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers
651-02	Schedule 40 and 80 Rigid PVC Conduit
651A-03	Type EB and A Rigid PVC Conduit and HDPE Conduit
797-03	Electrical Metallic Tubing
1242-00	Intermediate Metal Conduit

D. National Electrical Manufacturers Association (NEMA):

TC-3-04	PVC Fittings for Use with Rigid PVC Conduit and Tubing
FB1-03	Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 13 mm (1/2 inch) unless otherwise shown. Where permitted by the NEC, 13 mm (1/2 inch) flexible conduit may be used for tap connections to recessed lighting fixtures.

B. Conduit:
   1. Rigid galvanized steel: Shall Conform to UL 6, ANSI C80.1.
   2. Rigid aluminum: Shall Conform to UL 6A, ANSI C80.5.
   3. Rigid intermediate steel conduit (IMC): Shall Conform to UL 1242, ANSI C80.6.
   4. Electrical metallic tubing (EMT): Shall Conform to UL 797, ANSI C80.3. Maximum size not to exceed 105 mm (4 inch) and shall be permitted only with cable rated 600 volts or less.
   5. Flexible galvanized steel 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 IMC conduit fittings:
      a. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.

b. Standard threaded couplings, locknuts, bushings, 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:
   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 prohibited.
   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. Fittings shall meet the requirements of UL 514B and ANSI/ NEMA FB1.
   b. Only steel or malleable iron materials are acceptable.
   c. Couplings and connectors: Concrete tight and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 50 mm (2 inches) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 50 mm (2 inches). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
   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 steel 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 ANSI/ 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:
   a. Fittings shall meet the requirements of UL 514C and NEMA TC3.
   b. As recommended by the conduit manufacturer.
7. Surface metal raceway fittings: As recommended by the raceway manufacturer.
8. Expansion and deflection couplings:
   a. Conform to UL 467 and UL 514B.
   b. Accommodate, 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 fault currents in accordance with UL 467, and the NEC code tables for ground 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 by 38 mm (1 1/2 by 1 1/2 inch), 12 gage steel, cold formed, lipped channels; with not less than 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, Junction, and Pull Boxes:
1. UL-50 and UL-514A.
2. Cast metal where required by the NEC or shown, and equipped with rustproof boxes.
3. Sheet metal boxes: Galvanized steel, except where otherwise shown.
4. Flush mounted wall or ceiling boxes shall be installed with raised covers so that 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.

F. Wireways: Equip with hinged covers, except where removable covers are shown.

G. Warning Tape: Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, red with black letters, and imprinted with “CAUTION BURIED ELECTRONIC SAFETY AND SECURITY CABLE BELOW”.

PART 3 - EXECUTION

3.1 PENETRATIONS

A. Cutting or Holes:
1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the COTR prior to drilling through structural sections.
2. Cut 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 allowed, except where permitted by the COTR as required by limited working space.

B. Fire Stop: Where conduits, wireways, and other electronic safety and security 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, with rock wool fiber or silicone foam sealant only. Completely fill and seal clearances between raceways and openings with the fire stop material.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.2 INSTALLATION, GENERAL

A. Install conduit as follows:
1. In complete runs before pulling in cables or wires.

2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height head room, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 8’0” on center. Do not use other supports i.e., (suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts).
7. Support within 300 mm (1 foot) of changes of direction, and within 300 mm (1 foot) of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide a locknut on the inside of the enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
11. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
12. Do not use aluminum conduits in wet locations.
13. Unless otherwise indicated on the drawings or specified herein, all conduits shall be installed concealed within finished walls, floors and ceilings.

B. 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.

C. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have been submitted approved by the COTR.

D. Fire Alarm:
1. Fire alarm conduit shall be painted red (a red “top-coated” conduit from the conduit manufacturer may be used in lieu of painted conduit) in accordance with the requirements of Section 28 31 00, Fire Detection and Alarm.

3.3 CONCEALED WORK INSTALLATION

A. In Concrete:
1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
   a. Where shown on the structural drawings.
   b. As approved by the COTR prior to construction, and after submittal of drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 75 mm (3 inches) thick is prohibited.
   a. Conduit outside diameter larger than 1/3 of the slab thickness is prohibited.
   b. Space between conduits in slabs: Approximately six conduit diameters apart, except 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 (3/4 inch) of concrete around the conduits.

5. Make couplings and connections watertight. Use thread compounds that are UL approved conductive type to insure low resistance ground continuity through the conduits. Tightening set screws with pliers is prohibited.

B. Furred or Suspended Ceilings and in Walls:
   1. Conduit for conductors above 600 volts:
      a. Rigid steel or rigid aluminum.
      b. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.
   2. Conduit for conductors 600 volts and below:
      a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in the same system is prohibited.
   3. Align and run conduit parallel or perpendicular to the building lines.
   4. Connect recessed lighting fixtures to conduit runs with maximum 1800 mm (six feet) of flexible metal conduit extending from a junction box to the fixture.
   5. Tightening set screws with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for conductors above 600 volts:
   1. Rigid steel or rigid aluminum.
   2. Aluminum conduit mixed indiscriminately with other types in the same system is prohibited.

C. Conduit for Conductors 600 volts and below:
   1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in the system is prohibited.

D. Align and run conduit parallel or perpendicular to the building lines.

E. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

F. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.

G. Surface metal raceways: Use only where shown.

H. Painting:
   1. Paint exposed conduit as specified in Section09 91 00, PAINTING.
   2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 50 mm (two inch) high black numerals and letters, showing the cable voltage rating. Provide legends where conduits pass through walls and floors and at maximum 6000 mm (20 foot) intervals in between.

3.5 EXPANSION JOINTS

A. Conduits 75 mm (3 inches) 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 inches) with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 125 mm (5 inch) vertical drop midway between the ends. Flexible conduit shall have a copper green ground bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for 375 mm (15 inches) and larger conduits are acceptable.

C. Install expansion and deflection couplings where shown.

D. Seismic Areas: In seismic areas, provide conduits rigidly secured to the building structure on opposite sides of a building expansion joint with junction boxes on both sides of the joint. Connect conduits to junction boxes with 375 mm (15 inches) of slack flexible conduit. Flexible conduit shall have a copper green ground bonding jumper installed.

3.6 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load shall not exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 2.5 m (8 foot) on center.

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 90 kg (200 pounds). 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 (1/4 inch) bolt size and not less than 28 mm (1 1/8 inch) embedment.
      b. Power set fasteners not less than 6 mm (1/4 inch) diameter with depth of penetration not less than 75 mm (3 inches).
      c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry: Toggle bolts are permitted.

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.

3.7 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.

B. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap in metal covers for sheet metal boxes.

D. Outlet boxes in the same wall mounted back to back are prohibited. A minimum 600 mm (24 inch), center-to-center lateral spacing shall be maintained between boxes.)

E. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 100 mm (4 inches) square by 55 mm (2 1/8 inches) deep, with device covers for the wall material and thickness involved.

F. Stencil or install phenolic nameplates on covers of the boxes identified on riser diagrams; for example "SIG FA JB No. 1".

G. On all Branch Circuit junction box covers, identify the circuits with black marker.

3.8 ELECTRONIC SAFETY AND SECURITY CONDUIT

A. Install the electronic safety and security raceway system as shown on drawings.

B. Minimum conduit size of 19 mm (3/4 inch), but not less than the size shown on the drawings.

C. All conduit ends shall be equipped with insulated bushings.

D. All 100 mm (four inch) conduits within buildings shall include pull boxes after every two 90 degree bends. Size boxes per the NEC.

E. Vertical conduits/sleeves through closets floors shall terminate not less than 75 mm (3 inches) below the floor and not less than 75 mm (3 inches) below the ceiling of the floor below.

F. erminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter communication closets next to the wall and be flush with the backboard.

G. Were drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

H. All empty conduits located in communications closets or on backboards shall be sealed with a standard non hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

I. Conduit runs shall contain no more than four quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends shall be as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends mm, Inches
¾	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)

J. Furnish and install 19 mm (3/4 inch) thick fire retardant plywood specified in on the wall of communication closets where shown on drawings . Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.

K. Furnish and pull wire in all empty conduits. (Sleeves through floor are exceptions).

END OF SECTION

SECTION 28 08 00

COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 28.

B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the 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 electronic safety and security systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.

1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.
3. Activities and documentation for the LEED™ section on “Measurement and Verification” requirements for the Measurement and Verification credit.

D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Electronic Safety and Security systems will be commissioned:
   1. Fire Detection and Alarm (Master panel and software, addressable units – i.e. pull stations, flow detectors, hear detectors, etc., controls and alarm functions, horns/bells/door releases and other output devices, and fire command center functions – stairwell communications, stairwell pressurization fan start, mechanical systems shutdowns).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Resident Engineer prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 28 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 TRAINING OF VA PERSONNEL

A. Training of the VA's 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. The instruction shall be scheduled in coordination with the Resident Engineer after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 28 Sections for additional Contractor training requirements.

END OF SECTION

SECTION 28 13 11
PHYSICAL ACCESS CONTROL SYSTEM (PACS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install a complete Physical Access Control System, hereinafter referred to as the PACS.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

C. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

D. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

E. For infrastructure, Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS.

F. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

G. For perimeter lighting, Section 26 56 00, EXTERIOR LIGHTING.

H. For screening of personnel and shipments, Section 28 13 53, SECURITY ACCESS DETECTION.

I. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).

J. For control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.

K. For security camera systems, Section 28 23 00 VIDEO SURVEILLANCE.

L. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).

M. For Warranty of Construction, see GENERAL CONDITIONS.

N. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing, installing, and the operation of the PACS as shown. The Contractor shall also provide certification as required.

B. The security system will be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a complete list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all individual security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Clearly define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A detailed riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A detailed system drawing for each applicable security system shall:
      a. Clearly identify how all equipment within the system, from main panel to device, shall be laid out and connected.
      b. Provide full detail of all system components wiring from point-to-point.
      c. Identify wire types utilized for connection, interconnection with associate security subsystems.
      d. Show device locations that correspond to the floor plans.
      e. All general and drawing specific notes shall be included with the system drawings.
   5. A detailed schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
      a. Device ID.
      b. Device Location (e.g. site, building, floor, room number, location, and description).

c. Mounting type (e.g. flush, wall, surface, etc.).
d. Power supply or circuit breaker and power panel number.
e. In addition, for the PACS, provide the door ID, door type (e.g. wood or metal), locking mechanism (e.g. strike or electromagnetic lock) and control device (e.g. card reader or biometrics).

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall go through a full review process conducted by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
1. 35 percent
2. 65 percent
3. 90 percent
4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI)/ Security Industry Association (SIA):

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AC-01...................Access Control: Wiegand Card Reader
                         Interface Standard
AC-03...................Access Control: Badging Techniques
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C. American National Standards Institute (ANSI)/ International Code Council (ICC):

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A117.1..................Standard on Accessible and Usable
                         Buildings and Facilities
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D. Department of Justice American Disability Act (ADA)

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28 CFR Part 36-90.......ADA Standards for Accessible Design
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E. Government Accountability Office (GAO):

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GAO-03-8-02.............Security Responsibilities for Federally
                         Owned and Leased Facilities
```

F. National Electrical Contractors Association

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303-2005................Installing Closed Circuit Television
                         (CCTV) Systems
```

G. National Electrical Manufactures Association (NEMA):

250-03.....Enclosures for Electrical Equipment (1000 Volts Maximum)

H. National Fire Protection Association (NFPA):

70-05..... Article 780-National Electrical Code

I. Underwriters Laboratories, Inc. (UL):

294-99.....Standard for Access Control

305-97.....Standard for Panic Hardware

639-97.....Standard for Intrusion-Detection Units

752-05.....Standard for Bullet-Resisting Equipment

827-96.....Central Station Alarm Services

1076-95.....Standards for Proprietary Burglar Alarm Units and Systems

1981-03.....Central Station Automation System

2058-05.....High Security Electronic Locks

J. Homeland Security Presidential Directive (HSPD):

HSPD-12.....Policy for a Common Identification Standard for Federal Employees and Contractors

K. Federal Information Processing Standards (FIPS):

FIPS-201.....Personal Identity Verification (PIV) of Federal Employees and Contractors

L. National Institute of Standards and Technology (NIST):

IR 6887 V2.1.....Government Smart Card Interoperability Specification (GSC-IS)

Special Pub 800-96.....PIV Card Reader Interoperability Guidelines

M. Institute of Electrical and Electronics Engineers (IEEE):

C62.41.....IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

N. International Organization for Standardization (ISO):

7810.....Physical Characteristics of Credit Card Size Document

7811.....Physical Characteristics for Magnetic Stripe Cards

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7816-1..................Physical Characteristics of the Card
7816-2..................Dimensions and Contact Position of the
                        card
7816-3..................Electrical Signals and Transmission
                        Protocols
7816-4..................Inter-Industry Command for Interchange
14443...................RFID cards; Contactless Proximity Cards
                        Operating at 13.56 MHz in up to 5 inches
                        distance
15693...................RFID cards; Contactless Vicinity Cards
                        Operating at 13.56 MHz in up to 50 inches
                        distance
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O. Uniform Federal Accessibility Standards (UFAS) 1984

P. ADA Standards for Accessible Design 1994

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant PACS work subject to the Article “Warranty of Construction” of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment associated within the PACS shall be UL 294 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.

C. The system shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.

D. All PACS components located in designated “HAZARDOUS ENVIRONMENT” areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with NFPA 70, Chapter 5.

E. All equipment and materials for the system will be compatible to ensure correct operation as outlined in FIPS 201, March 2006 and HSPD-12.

2.2 EQUIPMENT ITEMS

A. The security system characteristics listed in this section will serve as a guide in selection of equipment and materials for the PACS. If updated or more suitable versions are available then the Contracting Officer will approve the acceptance of prior to an installation.

B. PACS equipment shall meet or exceed all requirements listed below.

C. PACS equipment shall be Johnson Controls Pegasys 2000 or equal.

D. PACS equipment shall be Bacnet protocol compliant to communicate with existing on campus.

E. A PACS shall be comprised of, but not limited to, the following components:
   1. Control/Communications Panels
   2. Electronic Security Management System
   3. Card Reader and Credential Cards
   4. Picture ID and Badging Station (To be provided in accordance with the VA PIV enrollment and issuance system.)
   5. Biometrics
   6. Portal Control Devices
   7. Door Status Indicators
   8. Entry Control Device
   9. Power Supplies
   10. Wires and Cables

F. Control/Communication Panels:
   1. Shall be a central point provided for monitoring, controlling, and programming the PACS.
   2. Shall provide a means of controlling up to 16 doors per panel.
   3. Shall be expandable and provide a means of networking multiple panels to provide overall control of all doors on the PACS via a primary panel.
   4. Shall be system specific addressable, Internet Protocol (IP) addressable, and programmable via a computer.
   5. Shall be able to be interfaced directly from a computer or via the Internet or Intranet. Access to the panels shall be password protected. All individuals with access to the panels shall have a user specific password.
   6. Shall be of the same manufacturer and part number to ensure full compatibility within the system.
   7. The operating system for the panel must utilize a single seamlessly integrated relational database for all functionality. This integration shall be provided with one operating environment. The operating environment shall be the fully multi-tasking multi-threading Microsoft Windows 2003/2000/Windows XP Operating System.
   8. The panel's web enabled client applications shall be capable of running on independent client operating systems including Windows 2003/2000, Windows XP, Windows NT, Windows 98, Windows 95, Macintosh, UNIX, Linux, and Solaris. The web-enabled applications shall utilize the same common database as the other system modules.
   9. The panel programming shall be written so that all system modules (e.g. access control, alarm monitoring, credential management, digital video, visitor management, intrusion detection, asset management, etc.) are developed and built from a unified 32-bit source code set. There absolutely shall not be separate source code bases for the individual modules of the PACS.
   10. Shall allow for the operation and control of up to 16 doors.
   11. Shall consist of or have the equivalent of, at a minimum, a General Control Module and an Access Control Module. Both modules shall be programmable via a computer.

12. The General Control Module shall:
    a. Provide for full distributed processing of access control and alarm monitoring operations.
    b. Store the following information and function using a high speed, local 32-bit microprocessor:
        1) access levels
        2) hardware configurations
        3) programmed alarm outputs assigned at a administration client workstation
    c. Process all access granted/denied decisions to provide fast responses to card reader transactions. A fully configured general control module with 64 card readers shall require less than one-half (0.5) seconds to grant access to an authorized cardholder or deny access to an unauthorized cardholder.
    d. Meet the following minimum requirements:
        1) A minimum host communications speed of 115,200 bps.
        2) Support direct connect connections.
        3) Have remote dial up.
        4) Minimum on-board memory of eight (8) MB.
        5) Local Area Network (LAN) Support RJ45 (10/100baseT) Ethernet Interface Token Ring four (4) MB connectivity.
        6) Minimum memory storage of up to 5,000 cardholders and 100,000 events.
        7) Downstream ports for connecting card readers and data gathering panels via RS-485 multi-drop wiring configuration.
        8) Support of multiple card technologies.
        9) Supervised Communications with PACS system software.
        10) Support of up to eight card formats and facility codes.
        11) RS-485 Full Duplex, UL 1076 Grade AA communication channel to the system head-end.
        12) Integration with all manufacturers' card readers.
        13) Biometric Interface Support.
        14) 12 VAC or 12 volts direct current (VDC) input power via a UL certified step-down transformer or power supply.
        15) Issue Code Support for both Magnetic and Wiegand Card Formats.
        16) Individual Shunt Times
        17) Up to Nine Digit PIN Codes.
        18) Downstream serial RS-232 device support.
        19) Status LED's to identify normal component and communication status.
13. The access control module shall:
    a. Control up to 16 doors utilizing input and output relays that are fully programmable via network software.
    b. Input relays shall meet the following minimum requirements:
        1) Provide up to 16 UL 1076 analog unsupervised alarm input zones to monitor and report alarm conditions, power faults, and tampers.
        2) Operate independently and in conjunction with output relays, which will send an output signal to a corresponding output device upon alarm input activation. Once an alarm has been received, the input relay shall activate any or all alarm outputs.
        3) Contain the following features:
            a) UL 294 Certified.
            b) Alarm contact status scanning at up to 120 times per second for each zone.
            c) A low power Complementary-symmetry/metal-oxide semiconductor (CMOS) microprocessor.
            d) Filtered data for noise rejection to prevent false alarms.

e) Up to 16 supervised inputs.
f) 12 VAC or 12 VDC Input Power.
g) Two (2) dedicated inputs for tamper and power status.

14. Output relays shall meet the following minimum requirements:
    a. Shall be capable of controlling a corresponding output device upon any input activation or on command from the PACS.
    b. Shall be capable of responding to:
        1) Input alarms.
        2) Commands from a System Operator.
        3) Time zone control commands for automatic operation.
    c. Shall be capable of:
        1) Pulsing for a predetermined duration. Duration shall be programmable for each relay individually.
        2) Responding on command from the System Operator to pulse, command on, command off, or reset to normal state.
        3) Operating outputs rated at 5 amps (A) @ 30 VDC.

G. Electronic Security Management System (SMS) :
1. Shall allow the configuration of an enrollment and badging, alarm monitoring, administrative, asset management, digital video management, intrusion detection, visitor enrollment, remote access level management, and integrated client workstations or any combination of all or some.
2. Shall be expandable to support an unlimited number of individual module or integrated client workstations. All access control field hardware, including Intelligent System Controllers (ISC), shall be connected to all Windows 2003/2000/XP based access control system workstation on the network.
3. Shall have the ability to compose, file, maintain, update, and print reports for either individuals or the system as follows.
    a. Individual reports that consist of an employees name, office location, phone number or direct extension, and normal hours of operation. The report shall provide a detail listing of the employee's daily events in relation to accessing points within a facility.
    b. System reports shall be able to produce information on a daily/weekly/monthly basis for all events, alarms, and any other activity associated with a system user.
    c. All reports shall be in a date/time format and all information shall be clearly presented.
4. Shall be designed to allow it to work with any industry standard network protocol and topology listed below:
    a. Transmission Control Protocol (TCP)/IP
    b. Novell Netware (IPX/SPX)
    c. Banyan VINES
    d. IBM LAN Server (NetBEUI)
    e. Microsoft LAN Manager (NetBEUI)
    f. Network File System (NFS) Networks
    g. Remote Access Service (RAS) via ISDN, x.25, and standard phone lines.
5. Shall provide full interface and control of the PACS to include the following subsystems within the PACS:
    a. Public Key Infrastructure
    b. Card Management
    c. Identity and Access Management
    d. Personal Identity Verification
6. Shall have the following features or compatibilities:
    a. The ability to be operated locally or remotely via a LAN, WAN, internet, or intranet.

b. Event and Alarm Monitoring
c. Database Partitioning
d. Ability to fully integrate with all other security subsystems
e. Enhanced Monitoring Station with Split Screen Views
f. Alternate and Extended Shunt by Door
g. Escort Management
h. Enhanced IT-based Password Protection
i. N-man Rule and Occupancy Restrictions
j. Open Journal Data Format for Enhanced Reporting
k. Automated Personnel Import
l. ODBC Support
m. Windows 2000 Professional, Windows Server 2003, Windows XP Professionals for Servers
n. Field-Level Audit Trail
o. Cardholder Access Events

7. For the SMS network a server and client workstation shall be required and must meet the following minimum technical characteristics:
   a. Server:

Processor	1.8 GHz Intel Pentium IV
Free Hard Disk Space	3.0 GB
Memory	1.0 GB
Network Card	10/100 Base-T
CD-ROM Drive	10X
Monitor/Video Adapter board	17” SVGA (1024 x 768)
Operating System	Windows 2000 Professional, Windows Server 2003, Windows XP Professional
Ports	2 serial, 1 parallel, USB
Backup	Tape or CDRW
Modem	56.7 Kbps

   b. Client Workstation:

Processor	1.5 GHz Intel Pentium III
Free Hard Disk Space	2.0 GB
Memory	512 MB RAM
Network Card	10 Base-T
CD-ROM Drive	10X
Monitor/Video Adapter board	17” SVGA (1024 x 768), 64 MB RAM
Operating Systems	Windows 2000 Professional or XP Professional

H. Card Readers and Credential Cards:
1. Shall be utilized for controlling the locking hardware on a door and allows for reporting back to the main control panel with the time/date the door was accessed, the name of the person accessing the point of entry, and its location.
2. Will be fully programmable and addressable, locally and remotely, and hardwired to the system.
3. Shall be individually home run to the main panel.
4. Shall be installed in a manner that they comply with:
   a. The Uniform Federal Accessibility Standards (UFAS)
   b. The Americans with Disabilities Act (ADA)
   c. The ADA Standards for Accessible Design

5. Shall support a variety of card readers that must encompass a wide functional range. The PACS may combine any of the card readers described below for installations requiring multiple types of card reader capability (i.e., card only, card and/or PIN, card and/or biometrics, card and/or pin and/or biometrics, supervised inputs, etc.). These card readers shall be available in the approved technology to meet FIPS 201 and is ISO 14443 A or B compliant. The reader output can be Wiegand, RS-22, 485 or TCP/IP.
6. Are to be housed in an aluminum bezel with a wide lead-in for easy card entry.
7. Shall contain read head electronics, and a sender to encode digital door control signals.
8. LED's shall be utilized to indicate card reader status and access status.
9. Shall be able to support a user defined downloadable off-line mode of operation (e.g. locked, unlocked, or facility code), which will go in effect during loss of communication with the main control panel.
10. Shall provide audible feedback to indicate access granted/denied decisions. Upon a card swipe, two audible tones or beeps shall indicate access granted and three tones or beeps shall indicate access denied. All keypad buttons shall provide (tactile?? What does this mean) audible feedback.
11. Shall have a minimum of two programmable inputs and two programmable outputs.
12. All card readers that utilize keypad controls along with a reader and shall meet the following specifications:
    a. Entry control keypads shall use a unique combination of alphanumeric and other symbols as an identifier. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII code ordinal sequence. Communications protocol shall be compatible with the local processor.
    b. Shall include a Light Emitting Diode (LED) or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected. The design of the keypad display or keypad enclosure shall limit the maximum horizontal and vertical viewing angles of the keypad. The maximum horizontal viewing angle shall be plus and minus five (5) degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display. The maximum vertical viewing angle shall be plus and minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.
    c. Shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 milliseconds or less from the time the last alphanumeric symbol is entered until a response signal is generated.
    d. Shall be powered from the source as designed and shall not dissipate more than 150 Watts.
    e. Shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.
    f. Shall provide a means for users to indicate a duress situation by entering a special code.
13. Card readers shall come in the following formats:
    a. Magnetic Stripe Card Reader
        1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.
        2) Shall read credential cards that utilize single layer 4000 units of magnetic field strength per magnetic tape material.
        3) The magnetic tape material shall be coated with Teflon and affixed to the back of the credential card near the top. This reader shall allow the card to either be swiped or inserted into the reader.
        4) Shall meet or exceed the following minimum technical characteristics:

Card Speed	5 to 30 inches (203 to 1270mm) per second

Data Rate	1 ms per bit
Connections	Plug-in with 8” (200mm) pigtail cable
Output Format	26 or 34-bit
Power	Per Manufacturers Specifications
Lifetime	250,000 wear cycles with a MTBF 22,000 hours
Error Rate	5% false reject 2x10-6 false accept
Static Discharge	Withstands up to 20,000 volts
LED	If required per the design package.
Card Format Output Format	EMPI 26 or 34-bit ANSI/ABA All bits Clock-and-Data up to 37 characters 10 Digit ANSI/ABA 26 or 34-bit

b. Wiegand Card Reader:
   1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.
   2) Shall read credential cards which are encoded using Wiegand effect ferromagnetic wires laminated into the credential card.
   3) Shall create a magnetic field and output a coded representation of the unique pattern of magnetic flux changes produced by moving the credential card through the card reader.
   4) The output shall be a series of electrical signals and shall constitute a unique identification code number.
   5) Wiegand credential cards shall use at least 24 binary digits to generate a unique credential card identification code.
   6) The card reader shall meet or exceed the following technical characteristics:

Card Speed	5 to 30 inches (203 to 1270mm) per second
Data Rate	1ms per bit
Connections	RJ-45 Jack or multi- conductor quick disconnect
Output Formats	26 or 34-bit
Power	Per Manufacturers Specifications
Lifetime	600,000 pass read head
Error Rate	false accept
Static Discharge	Withstands 20,000 volts
LED	If required per the design package
Card Output Format	EMPI 26 or 34-bit ANSI/ABA All bits Clock-and-Data up to 37 characters 10 Digit ANSI/ABA 26 or 34-bit

c. Contactless Smart Cards and Readers:
   1) Smart card readers shall read credential cards whose characteristics of size and technology meet those defined by ISO/IEC 7816, 14443, 15693.
   2) The readers shall have "flash" download capability to accommodate card format changes.
   3) The card reader shall have the capability of reading the card data and transmitting the data to the main monitoring panel.
   4) The card reader shall be contactless and meet or exceed the following technical characteristics:

a) Data Output Formats: FIPS 201 low outputs the FASC-N in an assortment of Wiegand bit formats from 40 – 200 bits. FIPS 201 medium outputs a combination FASC-N and HMAC in an assortment of Wiegand bit formats from 32 – 232 bits. All Wiegand formats or the upgradeability from Low to Medium Levels can be field configured with the use of a command card.

b) FIPS 201 readers shall be able to read, but not be limited to, DESfire and iCLASS cards.

c) Reader range shall comply with ISO standards 7816, 14443, and 15693, and also take into consideration conditions, are at a minimum 1" to 2" (2.5 – 5 cm).

d. Proximity (PROX) Card Reader:

1) Shall be utilized during the transition from the existing technology to the contactless smart card technology as defined in FIPS-201.

2) Shall use active/passive proximity detection and shall not require contact with the proximity credential card for operation.

a) Active detection proximity card readers shall provide power to compatible credential cards through magnetic induction and receive and decode a unique identification code number transmitted from the credential card.

b) Passive detection proximity card readers shall use a swept-frequency, radio frequency field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.

3) Shall read proximity cards in a range from 0 to at least six (6) inches (0 to at least 15 cm) from the reader. The credential card design shall allow for a minimum of 32,000 unique identification codes per facility.

4) Shall be able to read cards from two (2) inches (5cm) to 6 inches (15cm).

5) For exterior parking lots or garages shall be 16 inches (40 cm).

6) The operating frequency shall be determined by the type of access control system being utilized.

e. Credential Cards: Shall be in accordance with FIPS 201 and controlled by the PIV enrollment and issuance system.

I. Picture ID and Badging Station:

1. Shall be FIPS 201 compliant and will be controlled by the PIV enrollment and issuance system.
2. Shall provide a form-based interface for the entry of badge holder data and access information. All data, including images, shall be stored on the system server.
3. Shall allow image and signature capture for use in badge production, and provides tools for badge design. Both video and digital cameras may be utilized.
4. Shall meet the following minimum characteristics:

a. Windows 2000/XP
b. Support for all ID Cards, Reader and Printer Technologies
c. Centralized User Enrollment
d. Password Protected
e. High Speed Photo Capture
f. Signature and/or Biometric Data Capture
g. Digital Certificate Management
h. Report Generator
i. Intelli-Check ID Check Integration or Equivalent
j. Photo Capture via Digital or Video Camera
k. In-line Encoding of Magnetic Stripe and Barcode
l. ZD (PDF-417) Barcode Support

m. Image Compression Control
n. Image FX Gallery
o. Program Badge
p. Chromakey and Ghosting

J. Biometrics:
1. Shall be FIPS 201 and NIST SP 800-76 compliant.
2. Shall utilize hand/palm, fingerprint, retinal, or voice verification and could be utilized as secondary authentication in conjunction with card readers in high security area as defined by the VA. (Note: VA policy requires that the use of biometric measurements is limited to secondary authentication in high or medium security applications).
3. Shall be programmable, addressable, and hardwired directly to the main control panel and individually home run to the main control panel.
4. Shall be installed in a manner that they comply with:
   a. The Uniform Federal Accessibility Standards (UFAS)
   b. The Americans with Disabilities Act (ADA)
   c. The ADA Standards for Accessible Design
5. Shall include a means to construct individual templates or profiles based upon measurements taken from the person to be enrolled. This template shall be stored as part of the System Reference Database Files. The stored template shall be used as a comparative base by the personnel identity verification equipment to generate appropriate signals to the associated local processors.
6. Shall interface with PACS and SMS and provide the employee's name, contact information, and point of access.
7. Shall allow for surface, flush, or pedestal mounting.
8. Shall have communications protocol in place that shall allow for communications with the SMS.
9. Shall determine when multiple attempts were made for verification, and shall automatically prompt the user for additional attempts up to a maximum of three tries. After a third failed attempt the unit shall generate an entry control alarm. This alarm will report to the SMS and the CCTV system. The camera viewpoint for where the alarm was generated shall automatically be called up onto a monitor and be recorded via the recording equipment. An alarm within the SMS shall also be generated recording, at a minimum, the date, time, and attempted point of entry.
10. Hand/Palm Geometry Verification:
    a. Shall utilize unique human hand measurements to identify authorized, enrolled personnel.
    b. During the scan process the hand geometry device, which shall allow the user's hand to remain in full view during the scanning process, shall a three (3) dimensional measurement of the user's hand identifying its size and shape.
    c. This scan process shall start automatically once the user's hand is positioned. The hand geometry device shall be able to use either left or right hands for enrollment and verification.
    d. Shall include an LED or other type of visual indicator display and provide visual or visual and audible status indications and user prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
    e. Shall only be updated at the unit itself and automatic updates via the SMS shall not be allowed.
    f. Any significant change to the user's hand, scars, loss of digit, or any other change that will alter the three dimension view of the hand shall require an update to the unit and SMS.

g. Shall provide an enrollment, recognition, and code/credential verification mode. The enrollment mode shall create a hand template for new personnel and enter the template into the entry control database file created for that person. Template information shall be compatible with the system application software. The operating mode shall be selectable by the system manager/operator from the central processor. When operating in recognition mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches a hand geometry template stored in the database files. When operating in code/credential verification mode, the hand geometry device shall allow passage when the hand scan data from the verification attempt matches the hand geometry template associated with the identification code entered into a keypad; or matches the hand geometry template associated with credential card data read by a card reader.

11. Fingerprint Verification:
    a. Shall use a unique human fingerprint pattern to identify authorized, enrolled personnel.
    b. Shall allow the user's hand to remain in full view during the scanning process, shall incorporate positive measures to establish that the hand or fingers being scanned by the device belong to a living human being.
    c. Shall provide an optical or other type of scan of the user's fingers. The fingerprint verification scanner shall automatically initiate the scan process provided the user's fingers are positioned.
    d. LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
    e. Any significant change to the user's finger such as scars, loss of digit, or any other change that will alter the finger print shall require an update to the unit and SMS.
    f. Shall provide an adjustable acceptance tolerance or template match criteria under system manager/operator control.
    g. Shall respond to passage requests by generating signals to the local processor. The verification time shall be 2.0 seconds or less from the moment the finger print analysis scanner initiates the scan process until the fingerprint analysis scanner generates a response signal.
    h. Shall:
        1) Provide an enrollment mode, recognition mode, and code/credential verification mode. The enrollment mode shall create a fingerprint template for new personnel and enter the template into the system database file created for that person.
        2) Template information shall be compatible with the system application software.
        3) The operating mode shall be selectable by the system manager/operator from the central station.
    i. When operating in recognition mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template stored in the database files.
    j. When operating in code/credential verification mode, the fingerprint analysis scanner shall allow passage when the fingerprint data from the verification attempt matches a fingerprint template associated with the identification code. When entered into a keypad or it matches the fingerprint template associated with credential, the card data will then be recognized by the card reader.
    k. Shall store template transactions involving fingerprint scans. The template match scores shall be stored in the matching personnel data file in a format compatible with the system application software, and shall be used for report generation.
12. Iris Verification:

a. Shall utilize unique patterns within the human eye to identify authorized, enrolled personnel.
b. Shall use ambient light to capture an image of the iris of the person presenting themselves for identification. The resulting video image shall be compared against a stored template that was captured during the enrollment process.
c. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who wear contact lenses or eye glasses.
d. Shall provide a means for enrollees to align their eye for identification that does not require facial contact with the device.
e. Initiation for the scan should be automatic, but push-button could be provided to initiate the scan process. The device shall include adjustments to accommodate differences in enrollee height and mounting height shall be UFAS compliant.
f. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
g. Verification time for the retinal verification unit shall be no greater that 1.5 seconds from the moment the action is initiated until a response signal has been generated.
h. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:
   1) The enrollment mode shall create an iris template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.
   2) When operating in recognition mode, the retinal verification unit shall allow passage when the retinal verification data from the verification attempt matches an iris template stored in the database files.
   3) When operating in code/credential verification mode, the iris scanner shall allow passage when the retinal verification data from the verification attempt matches the retinal verification template. This will occur when the associated information matches the identification code entered into a keypad or matches the retinal verification template associated with the credential card data when recognized by a card reader.
i. Shall store template transactions involving retinal verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, and shall be used for report generation.

13. Voice Verification:
   a. Shall utilize unique patterns within the human speech pattern to identify authorized, enrolled personnel.
   b. Shall digitize a profile of a person's speech to produce a stored model voice print, or template. Users shall record their full names utilizing their natural voice tendencies. This process shall be initiated by a push to talk button on the voice verification device.
   c. Shall utilize a threshold for identification. The efficiency and accuracy of the device shall not be adversely affected by enrollees who have a speech impediment.
   d. Shall provide a means for enrollees to align their voice for identification that does not require contact with the device.
   e. The LED or other type of visual indicator displays shall provide a visual or visual and audible status indication and enrollee prompts. The display shall indicate power on/off, and whether user passage requests have been accepted or rejected.
   f. Verification time for the voice verification unit shall be no greater that 1.5 seconds from the moment the action is initiated until a response signal has been generated.
   g. Shall provide an enrollment mode, recognition mode, and code/credential verification mode:

1) The enrollment mode shall create a voice template for new personnel and enter the template into the system database file created for that person. Template information shall be compatible with the system application software.
2) When operating in recognition mode, the voice verification unit shall allow passage when the voice verification data from the verification attempt matches a voice template stored in the database files.
3) When operating in code/credential verification mode, the voice verifier shall allow passage when the voice verification data from the verification attempt matches the voice verification template. This will occur when the associated information of the identification code entered into a keypad matches the voice verification template associated with a credential card data is recognized by a card reader.

h. Shall store template transactions involving voice verifications. The template match scores shall be stored in the matching personnel data file in a file format compatible with the system application software, MPEG or equivalent, and shall be used for report generation.

K. Portal Control Devices:
1. Shall be used to assist the PACS.
2. Such devices shall:
   a. Provide a means of monitoring the doors status.
   b. Allow for exiting a space via either a push button, request to exit, or panic/crash bar.
   c. Provide a means of override to the PACS via a keypad or key bypass.
   d. Assist door operations utilizing automatic openers and closures.
   e. Provide a secondary means of access to a space via a keypad.
3. Shall be connected to and monitored by the main PACS panel.
4. Shall be installed in a manner that they comply with:
   a. The Uniform Federal Accessibility Standards (UFAS)
   b. The Americans with Disabilities Act (ADA)
   c. The ADA Standards for Accessible Design
5. Shall provide a secondary means of access control within a secure area.
6. Keypads: Refer to Section 2.2.F.12 for keypad requirements.
7. Push-Button Switches:
   a. Shall be momentary contact, back lighted push buttons, and stainless steel switch enclosures for each push button as shown. Buttons are to be utilized for secondary means of releasing a locking mechanism.
   b. In an area where a push button is being utilized for remote access of the locking device then no more than two (2) buttons shall operate one door from within one secure space. Buttons will not be wired in series with one other.
   c. In an area where locally stationed guards control entry to multiple secure points via remote switches. An interface board shall be designed and constructed for only the amount of buttons it shall house. These buttons shall be flush mounted and clearly labeled for ease of use. All buttons shall be connected to the PACS and SMS system for monitoring purposes.
   d. Shall have double-break silver contacts that will make 720 VA at 60 amperes and break 720 VA at 10 amperes.
8. Crash Bar:
   a. Emergency Exit with Alarm (Panic):
      1) Entry control portals shall include panic bar emergency exit hardware as designed.
      2) Panic bar emergency exit hardware shall provide an alarm shunt signal to the PACS and SMS.

3) The panic bar shall include a conspicuous warning sign with one (1) inch (2.5 cm) high, red lettering notifying personnel that an alarm will be annunciated if the panic bar is operated.
4) Operation of the panic bar hardware shall generate an intrusion alarm that reports to both the SMS and Intrusion Detection System. The use of a micro switch installed within the panic bar shall be utilized for this.
5) The panic bar shall a fully mechanical connection only and shall not depend upon electric power for operation.
6) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.I.9 for key-bypass specifications.

b. Normal Exit:
1) Entry control portals shall include panic bar non-emergency exit hardware as designed.
2) Panic bar non-emergency exit hardware shall be monitored by and report to the SMS.
3) Operation of the panic bar hardware shall not generate a locally audible or an intrusion alarm within the IDS.
4) When exiting, the panic bar shall depend upon a mechanical connection only. The exterior, non-secure side of the door shall be provided with an electrified thumb latch or lever to provide access after the credential I.D. authentication by the SMS.
5) The panic bar shall be compatible with mortise or rim mount door hardware and shall operate by retracting the bolt manually by either pressing the panic bar or with a key by-pass. Refer to Section 2.2.I.9 for key-bypass specifications. The strikes/bolts shall include a micro switch to indicate to the system when the bolt is not engaged or the strike mechanism is unlocked. The signal switches shall report a forced entry to the system in the event the door is left open or accessed without the identification credentials.

9. Key Bypass:
a. Shall be utilized for all doors that have a mortise or rim mounted door hardware.
b. Each door shall be individually keyed with one master key per secured area.
c. Cylinders shall be six (6)-pin and made of brass or equivalent. Keys for the cylinders shall be constructed of solid material and produced and cut by the same distributor. Keys shall not be purchased, cut, and supplied by multiple dealers.
d. All keys shall have a serial number cut into the key. No two serial numbers shall be the same.
e. All keys and cylinders shall be stored in a secure area that is monitored by the Intrusion Detection System.

10. Automatic Door Opener and Closer:
a. Shall be low energy operators.
b. Door closing force shall be adjustable to ensure adequate closing control.
c. Shall have an adjustable back-check feature to cushion the door opening speed if opened violently.
d. Motor assist shall be adjustable from 0 to 30 seconds in five (5) second increments. Motor assist shall restart the time cycle with each new activation of the initiating device.
e. Unit shall have a three-position selector mode switch that shall permit unit to be switched “ON” to monitor for function activation, switched to “H/O” for indefinite hold open function or switched to “OFF,” which shall deactivate all control functions but will allow standard door operation by means of the internal mechanical closer.
f. Door control shall be adjustable to provide compliance with the requirements of the Americans with Disabilities Act (ADA) and ANSI standards A117.1.

g. All automatic door openers and closers shall:
   1) Meet UL standards.
   2) Be fire rated.
   3) Have push and go function to activate power operator or power assist function.
   4) Have push button controls for setting door close and door open positions.
   5) Have open obstruction detection and close obstruction detection built into the unit.
   6) Have door closer assembly with adjustable spring size, back-check valve, sweep valve, latch valve, speed control valve and pressure adjustment valve to control door closing.
   7) Have motor start-up delay, vestibule interface delay; electric lock delay and door hold open delay up to 30 seconds. All operators shall close door under full spring power when power is removed.
   8) Are to be hard wired with power input of 120 VAC, 60Hz and connected to a dedicated circuit breaker located on a power panel reserved for security equipment.

L. Door Status Indicators:
   1. Shall monitor and report door status to the SMS.
   2. Door Position Sensor:
      a. Shall provide an open or closed indication for all doors operated on the PACS and report directly to the SMS.
      b. Shall also provide alarm input to the Intrusion Detection System for all doors operated by the PACS and all other doors that require monitoring by the intrusion detection system.
      c. Switches for doors operated by the PACS shall be double pole double throw (DPDT). One side of the switch shall monitor door position and the other side if the switch shall report to the intrusion detection system. For doors with electromagnetic locks a magnetic bonding sensor (MBS) can be used in place of one side of a DPDT switch, in turn allowing for the use of a single pole double throw (SPDT) switch in it place of a DPDT switch.
      d. Switches for doors not operated by the PACS shall be SPDT and report directly to the IDS.
      e. Shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2” (5 cm).
   3. Request-to-Exit (RTE) :
      a. Shall be utilized to de-energize the locking hardware on a door to allow for exiting a secure area.
      b. Shall be either an infrared sensor or a push button.
      c. Infrared sensors shall meet the following minimum technical characteristics:

Alarm Output	2 Form "C" relay contacts
Indicators	1 activation LED
Power Requirements	12 or 24 VAC, 12 or 24 VDC, 26 mA @ 12 VDC
Relay Latch	Time Adjustable to 60 seconds

M. Entry Control Devices:
   1. Shall be hardwired to the PACS main control panel and operated by either a card reader or a biometric device via a relay on the main control panel.
   2. Shall be fail-safe in the event of power failure to the PACS system.
   3. Shall operate at 24 VCD, with the exception of turnstiles and be powered by a separate power supply dedicated to the door control system. Each power supply shall be rated to operate a minimum of two doors simultaneously without error to the system or overload the power supply unit.

4. Shall have a diode or metal-oxide veristor (MOV) to protect the controller and power supply from reverse current surges or back-check.
5. Electric Strikes/Bolts: Shall be:
   a. Made of heavy-duty construction and tamper resistant design.
   b. Tested to over one million cycles.
   c. Rated for a minimum of 1000 lbs. holding strength.
   d. Utilize an actuating solenoid for the strike/bolt. The solenoid shall move from fully open to fully closed position and back in not more than 500 milliseconds and be rated for continuous duty.
   e. Utilize a signal switch that will indicate to the system if the strike/bolt is not engaged or is unlocked when it should be secured.
   f. Flush mounted within the door frame.
6. Electric Mortise Locks: Shall be installed within the door and an electric transfer hinge shall be utilized to allow the wires to be transferred from the door frame to the lock. If utilized with a double door then the lock shall be installed inside the active leaf.
7. Electromagnetic Locks:
   a. These locks shall be without mechanical linkage utilizing no moving parts, and securing the door to its frame solely on electromagnetic force.
   b. Shall be comprised of two pieces, the mag-lock and the door plate. The mag-lock shall be surface mounted to the door frame and the door plate shall be surface mounted to the door.
   c. Ensure a diode or MOV is installed in line with the DC voltage supplying power to the unit in order to prevent back-check on the system when the mag-lock is powered.
   d. Shall utilize a magnetic bonding sensor (MBS) to monitor the door status and report that status to the SMS.
   e. Electromagnetic locks shall meet the following minimum technical characteristics:

Operating Voltage		24 VDC
Current Draw		.5A
Holding Force	Swing Doors	1500 lbs (675 Kg)
	Sliding Doors	500 lbs (225 Kg)

8. Turnstiles:
   a. Shall operate at 110 VAC, 60 Hz or 220 VAC, 50 Hz supplied from a dedicated circuit breaker on a security power panel. This device does not require a back-up power source.
   b. Shall be utilized as a means of monitoring and controlling access in a lobby.
   c. Shall meet the following minimum requirements:
      1) Be UFAS compliant.
      2) Provide either an audible or visual confirmation that access has been granted to a cleared individual.
      3) Provide an audible alarm in the event a non-cleared individual is attempting to gain access.
      4) Interface with the SMS and utilize a card reader for accessing and exiting a facility, and provide a recorded event of personnel accessing these points.
      5) Have a built-in step-down transformer to provide power to a card reader unit.
      6) Have built-in signal wiring chassis to allow for plug and play capabilities with the PACS.
      7) Have the ability to detect tailgating within one quarter on an inch to prevent unauthorized access to a facility.

N. Power Supplies:

1. Shall be UL rated and able to adequately power two entry control devices on a continuous base without failure.
2. Shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ 2 amp
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC) Filtered and Regulated
BATTERY	Dependant on Output Voltage shall provide up to 14 Ah
OUTPUT CURRENT	10 amp max. @ 13.8 VDC 5 amp max. @ 27.6 VDC
PRIMARY FUSE SIZE	6.3 amp (non-removable)
BATTERY FUSE SIZE	12 amp, 3AG
CHARGING CIRCUIT	Built-in standard

O. Wires and Cables
1. Shall meet or exceed the manufactures recommendations for power and signal.
2. Shall be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
4. All conduit, pull boxes, and junction boxes shall be clearly marked every with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
5. Conduit fills shall not exceed 50 percent unless otherwise documented.
6. A pull rope shall be pulled along with signal and power cables to assist in future work.
7. At all locations where core drilling is conducted to allow for conduit to be installed, then fire stopping shall be applied to that area.
8. High power and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High power for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
9. Signal Cables:
   a. Shall meet or exceed all specifications and requirements called out by the manufactures.
   b. Shall be twisted pairs.
   c. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within 3 feet, (1 meter) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
      1) A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 volts and peak current of 60 amperes.
      2) An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
10. Power Cables:

a. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).
b. Shall be sized according and comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket.
c. Low Voltage Power Cables:
   1) All cables shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.
   2) Specific cable size shall determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.
d. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

2.3 INSTALLATION KIT

A. General: The kit shall be provided that at, a minimum includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outlined are the minimum required installation sub-kits:
   1. System Grounding:
      a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
      b. This includes, but is not limited to:
         1) Coaxial Cable Shields
         2) Control Cable Shields
         3) Data Cable Shields
         4) Equipment Racks
         5) Equipment Cabinets
         6) Conduits
         7) Cable Duct blocks
         8) Cable Trays
         9) Power Panels
         10) Grounding
         11) Connector Panels
   2. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
   3. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
   4. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.

5. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
6. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
7. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be in accordance with UL 294, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

B. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.

C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a operable system.

D. The PACS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.

E. For integration purposes, the PACS shall be integrated where appropriate with the following associated security subsystems:
   1. CCTV:
      a. Provide 24 hour coverage of all entry points to the perimeter and agency buildings. As well as all emergency exits utilizing a fixed color camera.
      b. Be able to monitor, control and record cameras on a 24 hours basis.
      c. Be programmed automatically call up a camera when an access point is but into an alarm state.
      d. For additional PACS system requirements as they relate to the CCTV, refer to Section 28 23 00, VIDEO SURVEILLANCE.
   2. IDS:
      a. Be able monitor door control sensors.
      b. Be able to monitor and control the IDS on a 24 hours basis.
      c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the operator via an audible alarm.
      d. For additional PACS system requirements as they relate to the IDS, refer to Section 28 16 11, INTRUSION DETECTION SYSTEM.
   3. Security Access Detection:
      a. Be able to monitor all objects that have been screened with an x-ray machine and be able to monitor all data acquired by the bomb detection unit.
      b. For additional PACS system requirements as they relate to the Security Access Detection, refer to Section 28 13 53, SECURITY ACCESS DETECTION.

4. EPPS:
    a. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Access Control System and Database Management of an alarm event.
    b. For additional PACS requirements as they relate to the EPPS, refer to Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM.

F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.

G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

H. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system. The Contractor shall not take any corrective action without written permission from the Government.

I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.

J. Existing Equipment:
    1. The Contractor shall connect to and utilize existing door equipment, control signal transmission lines, and devices as outlined in the design package. Door equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
    2. The Contractor shall perform a field survey, including testing and inspection of all existing door equipment and signal lines intended to be incorporated into the PACS, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
    3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
    4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
    5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

M. Control Panels:
   1. Connect power and signal lines to the controller.
   2. Program the panel as outlined by the design and per the manufacturer's programming guidelines.

N. SMS:
   1. Coordinate with the VA agency's IT personnel to place the computer on the local LAN or Intranet and provide the security system protection levels required to insure only authorized VA personnel have access to the system.
   2. Program and set-up the SMS to ensure it is in fully operation.

O. Card Readers:
   1. Connect all signal inputs and outputs as shown and specified.
   2. Terminate input signals as required.
   3. Program and address the reader as per the design package.
   4. Readers shall be surface or flushed mounted and all appropriate hardware shall be provided to ensure the unit is installed in an enclosed conduit system.

P. Biometrics:
   1. Connect all signal input and output cables along with all power cables.
   2. Program and ensure the device is in operating order.

Q. Portal Control Devices:
   1. Install all signal input and output cables as well as all power cables.
   2. Devices shall be surface or flush mounted as per the design package.
   3. Program all devices and ensure they are working.

R. Door Status Indicators:
   1. Install all signal input and output cables as well as all power cables.
   2. RTE's shall be surface mounted and angled in a manner that they cannot be compromised from the non-secure side of a windowed door, or allow for easy release of the locking device from a distance no greater than 6 feet from the base of the door.
   3. Door position sensors shall be surface or flush mounted and wide gap with the ability to operate at a maximum distance of up to 2" (5 cm).

S. Entry Control Devices:
   1. Install all signal input and power cables.
   2. Strikes and bolts shall be mounted within the door frame.
   3. Mortise locks shall be mounted within the door and an electric transfer hinge shall be utilized to transfer the wire from within the door frame to the mortise lock inside the door.
   4. Electromagnetic locks shall be installed with the mag-lock mounted to the door frame and the metal plate mounted to the door.

T. System Start-Up:
   1. The Contractor shall not apply power to the PACS until the following items have been completed:
      a. PACS equipment items and have been set up in accordance with manufacturer's instructions.
      b. A visual inspection of the PACS has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
      c. System wiring has been tested and verified as correctly connected as indicated.
      d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
      e. Power supplies to be connected to the PACS have been verified as the correct voltage, phasing, and frequency as indicated.
   2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

U. Supplemental Contractor Quality Control:
   1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed PACS; and are approved by the Contracting Officer.
   2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
   3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
   4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 13 16
ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install a complete Access Control System and Database Management as specified in this section.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For all signage and labeling applications and use, Section 10 14 00, SIGNAGE.

C. For power connections and cables, Section 26 05 21, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

D. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

E. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

F. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

G. For perimeter lighting, Section 26 56 00, EXTERIOR LIGHTING.

H. For access control, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEM (PACS).

I. For screening of personnel and shipments, Section 28 13 53, SECURITY ACCESS DETECTION.

J. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).

K. For security cameras, Section 28 23 00, VIDEO SURVEILLANCE.

L. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).

M. For Warranty of Construction see GENERAL CONDITIONS.

N. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing, installing, and the operation of the Access Control System and Database Management as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A system drawing for each applicable security system shall:
      a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
      b. Provide full detail of all system components wiring from point-to-point.
      c. Identify wire types utilized for connection, interconnection with associate security subsystems.
      d. Show device locations that correspond to the floor plans.
      e. All general and drawing specific notes shall be included with the system drawings.
   5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
      a. Device ID.
      b. Device Location (e.g. site, building, floor, room number, location, and description).
      c. Mounting type (e.g. flush, wall, surface, etc.).
      d. Power supply or circuit breaker and power panel number.

e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:

1. 35 percent
2. 65 percent
3. 90 percent
4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):

310D	Racks, Panels, and Associated Equipment

C. National Electrical Manufactures Association (NEMA):

250-03	Enclosures for Electrical Equipment

D. National Fire Protection Association (NFPA):

70-05	Article 780-National Electrical Code

E. Underwriters Laboratories, Inc. (UL):

752-05	Ballistic Level Protection (Class III)
827-96	Central Station Alarm Services
1981-03	Central Station Automation System

F. Uniform Federal Accessibility Standards (UFAS) 1984

G. Americans with Disabilities Act (ADA) 1975

H. ADA Standards for Accessible Design 1994

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant CCTV System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment associated within the Access Control System and Database Management shall be UL 827 and UL 1981 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.

C. The system shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.

D. All equipment and materials for the system will be compatible to ensure correct operation.

2.2 EQUIPMENT ITEMS

A. The Access Control System and Database Management shall be set up as a Security System Network (SSN).

B. The SSN shall be Johnson Controls Pegasys 2000 or equal.

C. The SSN shall be Bacnet protocol compliant to communicate with and tie into existing SSN on campus.

D. A SSN shall provide full interface with all components of the security subsystem as follows:
   1. Shall allow for communication between the Access Control System and Database Management and all subordinate work and monitoring stations, enrollment centers for badging and biometric devices as part of the PACS, local annunciation centers, the electronic Security Management System (SMS), and all other VA redundant or backup command center or other workstations locations.
   2. Shall provide automatic continuous communication with all systems that are monitored by the Access Control System and Database Management, and shall automatically annunciate any communication failures or system alarms to the Access Control System and Database Management operator providing identification of the system, nature of the alarm, and location of the alarm.
   3. Controlling devices shall be utilized to interface the Access Control System and Database Management with all field devices.
   4. The Access Control System and Database Management and security console will be supported by an uninterrupted power supply (UPS) or dedicated backup generator power circuit.
   5. The Access Control System and Database Management shall house the following equipment i.e. refer to individual master specifications for each security subsystem's specific requirements:
      a. Security Console Bays and Equipment Racks
      b. Security Network Server and Workstation
      c. CCTV Monitoring, Controlling, and Recording Equipment
      d. PACS Monitoring and Controlling Equipment
      e. IDS Monitoring and Controlling Equipment
      f. Security Access Detection Monitoring Equipment

g. EPPS Monitoring and Controlling Equipment
h. Main Panels for all Security Systems
i. Power Supply Units (PSU) for all field devices
j. Life safety and power monitoring equipment
k. All other building systems deemed necessary by the VA to include, but not limited to, heating, ventilation and air conditioning (HVAC), elevator control, portable radio, fire alarm monitoring, and other potential systems.

E. Security Console Bays. Shall be EIA 310D compliant and:
1. Utilize stand-up, sit-down, and vertical equipment racks in any combination to monitor and control the security subsystems.
2. Shall be wide enough for equipment that requires a minimum 19 inch (47.5 cm) mounting area.
3. Shall be made of metal, furnished with wire ways, a power strip, a thermostatic controlled bottom or top mounted fan units, a hinge mounted rear door, a hinge mounted front door made of plexiglass, and a louvered top. When possible, pre-fabricated (standard off-the-shelf) security console equipment shall be used in place of customized designed consoles.
4. A wire management system shall be designed and installed so that all cables are mounted in a manner that they do not interfere with day-to-day operations, are labeled for quick identification, and so that high voltage power cables do not cause signal interference with low voltage and data carrying cables.
5. Shall be mounted on lockable casters.
6. Shall be ergonomically designed so that all devices requiring repetitive interaction with by the operator can be easily accessed, observed, and accomplished.
7. Controls and displays shall be located so that they are not obscured during normal operation. Control and display units installed with a work bench shall be a minimum of 3 in. (7.5 cm) from all edges of the work bench area.
8. All security subsystem controls shall be installed within the same operating console bay of their associated equipment.
9. Video monitors shall be mounted above all controls within a console bay and positioned in a manner that minimum strain is placed on the operator viewing them at the console.
10. At least one workbench for every three (3) console bays shall be provided free of control equipment to allow for appropriate operator workspace.
11. All console devices shall be labeled and marked with a minimum of quarter inch bold print.
12. All non-security related equipment that is required to be monitored shall be installed in a console bay separate from the security subsystem equipment and clearing be identified as such.
13. Console bays and related equipment shall be arranged in priority order and sequenced based upon their pre-defined security subsystem operations criticality established by the Contracting Officer.
    a. The following minimum console technical characteristics shall be taken into consideration when designing for and installing the security console and equipment racks:

	Stand-Up	Sit-Down	Vertical Equipment Rack
Workstation Height	No Greater than 84 in. (210 cm)	No greater than 72 in. (150 cm)	No greater than 96 in. (240 cm)
Bench board Slope	21 in. (52.5 cm)	25 in. (62.5 cm)	N/A
Bench board Angle	15 degrees	15 degrees	N/A
Depth of Console	24 in. (60 cm)	24 in. (60 cm)	N/A

Leg and Feet Clearance	6 sq. ft. from center of Console Slope front	6 sq. ft. from center of Console Slope front	6 sq. ft. from center of Console Slope front
Distance Between Console Rows	96 in. (240 cm)	96 in. (240 cm)	96 in. (240 cm)
Distance Between Console and Wall	36 in. (90 cm) from the rear and/or side of console or rack	36 in. (90 cm) from the rear and/or side of console or rack	36 in. (90 cm) from the rear and/or side of console or rack

F. Access Control System and Database Management and Security Console Configuration:
   1. The size shall be defined by the number of console bays required to house and operate the security subsystems, as well as any other factors that may influence the overall design of the space. A small Access Control System and Database Management shall contain no more than four (4) security console bays. A large Access Control System and Database Management shall contain no less than five (5) and no more than eight (8) security console bays.
   2. Shall meet the following minimum spacing requirements to ensure that a Access Control System and Database Management is provided to house existing and future security subsystems and other equipment listed in paragraph 2.3.C:
      a. 500 square feet for a large Access Control System and Database Management.
      b. 300 square feet for a small Access Control System and Database Management.
      c. If office, training room and conference space, is a processing area as well as holding cell space is to be located adjacent to the Access Control System and Database Management, these space requirements also need to be considered.
   3. Shall be located in an area within, at a minimum, the first level/line of security defense defined by the VA. If the Access Control System and Database Management is to be located outside the first level of security, then the area shall be constructed or retrofit to meet or exceed those requirements outlined in associated VA Master Specifications.
   4. Shall not be located within or near an area with little to no blast mitigation standoff space protection, adjacent to an outside wall exposed to vehicle parking and traffic, within a basement or potential flood zone area, in close approximately to major utility areas, or near an exposed air intake(s).
   5. Access shall meet UFAS and ADA accessibility requirements.
   6. Construction shall be slab to slab and free of windows, with the exception of a service window. All penetrations into the room shall be sealed with fire stopping materials. This material shall apply in accordance with Section 07 84 00, FIRESTOPPING.
   7. A service window shall be installed in the wall next to the main entrance of the Access Control System and Database Management or where it best can be monitored and accessed by the security console operator. The window shall meet all requirements set forth in UL 752, to include at a minimum, Class III ballistic level protection. The windows shall be set in a minimum or four (4) inches (100 mm) solid concrete units to ceiling height with either masonry or gypsum wall board to the underside of the slab above. It shall also contain a service tray constructed in a manner that only objects no larger than 3 inches (7.5 cm) in width may pass through it.
   8. The walls making up or surrounding the Access Control System and Database Management shall be made of materials that at a minimum offer Class III ballistic level protection for the security console operator(s).
   9. There will be a main power cut-off button/switch located inside the Access Control System and Database Management in the event of an electrical fire or related event occurs.
   10. Shall have a fire alarm detection unit that is tied into the main building fire alarm system and have at least two fire extinguishers located within it.

11. Shall utilize a fire suppression system similar to that used by the VA's computer and telecommunications room operating areas.
12. The floor shall be raised a minimum of 4 inches (10 cm) from the concrete floor base. Wire ways shall be utilized under the raised floor for separation of signal and power wires and cables.
13. Access shall be monitored and controlled by the PACS via card reader and fixed camera that utilizes a 2.8mm lens. A 1 in. (2.5 cm) deadbolt shall be utilized as a mechanical override for the door in the event of electrical failure of the PACS, card reader, or locking mechanism.
14. Their shall only be one point of ingress and egress to and from the Access Control System and Database Management. The door shall be made of solid core wood or better. If a window is required for the door, then the window shall be ballistic resistant with a Millar covering.
15. A two-way intercom shall be placed at the point of entry into the Access Control System and Database Management for access-communication control purposes.
16. A remote push-button door unlocking device shall not be installed for the electronic PACS locking mechanism providing access control into the Access Control System and Database Management.
17. All controlling equipment and power supplies that must be wall mounted shall be mounted in a manner that maximizes usability of the Access Control System and Database Management wall space. All equipment shall be mounted to three quarter inch fire retardant plywood. The plywood shall be fastened to the wall from slab to slab and fixed to the existing walls supports.

G. Access Control System and Database Management Room Ventilation
1. Shall meet or exceed all requirements laid out in VA Master Specification listed in Division 23, HEATING, VENTILATION, AND AIR CONDITIONING.
2. Controls shall be via a separate air handling system that provides an isolated supply and return system. The Access Control System and Database Management shall have a dedicated thermostat control unit and cut-off switch to be able to shut off ventilation to the control room in the event of a chemical, biological, or radiological (CBR) event or other related emergency.
3. There shall be a louver installed in the control room door to assist with ventilation of the room. The louver shall be exactly 12 x 12 inches (30 x 30 cm) and closeable.

H. Control Room Lighting:
1. The following factors shall taken into consideration for lighting of the Access Control System and Database Management and console area:
   a. Shadows: To reduce eye strain and fatigue, shadows shall be avoided.
   b. Glare: The readability of all display panels, labels, and equipment shall not be interfered with or create visibility problems.
2. The following table shall provide guidance on the amount of footcandles required per work area and type of task performed:

Work Area/Type of Task		Footcandles
Main Operating Panels		50
Secondary Display Panels		50
Seated Workstations		100
Reading	Handwriting	100
	Typed Documents	50
	Visual Display Units	10
Logbook Recording		100

Maintenance Area	50
Emergency/Back-up Lighting	10

I. Remote/Secondary Access Control System and Database Management's: For facilities that have a remote, secondary back-up control console or workstation shall apply the following requirements:
   1. The secondary stations shall the requirements outlined in Sections 2.2.A-G.
   2. Installation of an intercom station or telephone line shall be installed and provide direct one touch call-up for communications between the primary Access Control System and Database Management and secondary Access Control System and Database Management.
   3. Secondary stations shall not have priority over a primary Access Control System and Database Management.
   4. The primary Access Control System and Database Management shall have the ability to shut off power and a signal to a secondary control station in the event the area has been compromised.

J. Wires and Cables:
   1. Shall meet or exceed the manufactures recommendation for power and signals.
   2. Shall be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
   3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
   4. All conduit, pull boxes, and junction boxes shall be marked with colored permanent tape or paint that will allow it to be distinguished from all other infrastructure conduit.
   5. Conduit fills shall not exceed 50 percent unless otherwise documented.
   6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
   7. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area.
   8. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security subsystems shall be any cable or sets of cables carrying 30 VDC/VAC or higher.
   9. For all equipment that is carrying digital data between the Access Control System and Database Management or at a remote monitoring station, it shall not be less that 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
   10. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within three (3) ft. (one (1) m.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
      a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 watts and peak current of 60 amperes.
      b. An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
   11. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.

2.3 INSTALLATION KIT

A. General:
   1. The kit shall be provided that, at a minimum, includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:
   2. System Grounding:
      a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
      b. This includes, but is not limited to:
         1) Coaxial Cable Shields
         2) Control Cable Shields
         3) Data Cable Shields
         4) Equipment Racks
         5) Equipment Cabinets
         6) Conduits
         7) Cable Duct blocks
         8) Cable Trays
         9) Power Panels
         10) Grounding
         11) Connector Panels
   3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
   4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
   5. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.
   6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
   7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
   8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be in accordance with manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

B. All equipment shall be installed per the design package and the manufacturer's installation specifications.

C. The Access Control System and Database Management will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a network.

D. For integration purposes, the Access Control System and Database Management shall operate and control the following associated security subsystems:
   1. The Access Control System and Database Management shall be the central point of monitoring, controlling, programming, and recording all security subsystems utilizing the Electronic Security Management System (SMS).
   2. The SMS shall utilize a central computer station that is capable of being connected to the VA's Local Area Network (LAN) or Internet.

E. Integration with security subsystems shall be achieved by computer programming and the direct hardwiring of the systems. Determination of methodology should be addressed and outlined in advance with the Contracting Officer prior to the system(s) is/are being designed and engineered.

F. For programming purposes, the Contractor shall refer to the manufacturer's requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

G. The Contractor shall visit the site and verify that site conditions are in agreement with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the security subsystems. The Contractor shall not take any corrective action without written permission from the Contracting Officer.

H. System Startup:
   1. The Contractor shall not apply power to the Access Control System and Database Management or security console until the following items have been completed:
      a. Access Control System and Database Management equipment items and have been set up in accordance with manufacturer's instructions.
      b. A visual inspection of the Access Control System and Database Management has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
      c. System wiring has been tested and verified as correctly connected as indicated.
      d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
      e. Power to be connected to all systems has been verified as the correct voltage, phasing, and frequency as indicated.
   2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installations, defective equipment items, or collateral damage as a result of Contractor work/equipment installation efforts.

I. Supplemental Contractor Quality Control:
   1. The following requirements supplement the contractor quality control requirements specified elsewhere in the contract:

a. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed Access Control System and Database Management and security console; and are approved by the Contracting Officer in advance.
b. The Contractor representatives will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
c. The Contractor representatives shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
d. The Contractor technical representatives shall participate in the testing and validation of the system and shall provide certification that their respective system portions meet its contractual requirements.

3.2 TESTING AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 13 53
SECURITY ACCESS DETECTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install a complete Detection and Screening System, hereinafter

B. referred to as the Security Access Detection as specified in this section.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For labeling and signs, Section 10 14 00, SIGNAGE.

C. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

D. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

E. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

F. For infrastructure, Section 26 05 33, RACEWAYS AND BOXES ELECTRICAL SYSTEMS.

G. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

H. For perimeter lighting, Section 26 56 00, EXTERIOR LIGHTING.

I. For access control, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEM (PACS).

J. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).

K. For control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGMENT.

L. For security cameras, Section 28 23 00, VIDEO SURVEILLANCE.

M. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).

N. For Warranty of Construction, see GENERAL CONDITIONS.

O. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing, installing, and the operation of the Security Access Detection as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a complete and thorough pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (in.) (1220 x 1220 millimeters)(mm); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Clearly define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a complete list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all individual security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a detailed device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Clearly define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements.
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A detailed riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one (1) diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A detailed system drawing for each applicable security system shall:
      a. Clearly identify how all equipment within the system, from main panel to device, shall be laid out and connected.
      b. Provide full detail of all system components wiring from point-to-point.
      c. Identify wire types utilized for connection, interconnection with associate security subsystems.
      d. Show device locations that correspond to the floor plans.
      e. All general and drawing specific notes shall be included with the system drawings.
   5. A detailed schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
      a. Device ID.
      b. Device Location (e.g. site, building, floor, room number, location, and description).

c. Mounting type (e.g. flush, wall, surface, etc.).
d. Power supply or circuit breaker and power panel number.
e. In addition, provide the Security Access Detection detector or screening device ID, type (e.g. walk-through screener, X-ray, explosive detector, etc.), type of technology used by system for detection and model number.

6. Provide detail and elevation drawings for all devices that define how they were installed and mounted.

E. The pre-installation design packages shall go through a full review process conducted by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
1. 35 percent
2. 65 percent
3. 90 percent
4. 100 percent

F. The Contractor shall provide manufacturer security system product cut-sheets that clearly and completely indicate the description and function of each component of the security systems they are associated with. Also, indicate all termination points of devices and interconnections required for operation of the system, and between modules and devices.

G. The Contractor shall submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include detailed procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

H. The Contractor shall submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing for all security system devices, power sources, control panels, and monitoring equipment.

I. The Contractor shall provide complete maintenance and operating manuals from the manufacturer that support as-builts and system design, to include all technical product sheets and overall system schematics. Two (2) weeks prior to the final inspection, four (4) copies of the maintenance and operating manuals also need to be submitted to the RE.

J. Certifications: Two (2) weeks prior to final inspection, submit four (4) copies of the following to the RE:
1. Complete maintenance and operating manuals from the manufacturer that support as-built and systems design, to include all technical data sheets and overall system schematics.
2. Certification by the Contractor that the materials submitted is in accordance with the drawings and specifications.
3. Certification by the Contractor that a complete security system installation has been installed, tested and adjusted.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) 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)
C1238-97 (R03) Standard Guide for Installation of Walk-Through Metal Detectors

C. Department of Justice American Disability Act (ADA)
28 CFR Part 36-90 ADA Standards for Accessible Design

D. Government Accountability Office (GAO):
GAO-03-8-02 Security Responsibilities for Federally Owned and Leased Facilities

E. Institute of Electrical and Electronics Engineers (IEEE):
C95.1-05 Standards for Safety Levels with Respect to Human Exposure in Radio Frequency Electromagnetic Fields

F. National Fire Protection Association (NFPA):
70-05 Article 780-National Electrical Code

G. National Institute of Justice (NIJ)
0601.02-03 Standards for Walk-Through Metal Detectors for use in Weapons Detection
0602.02-03 Hand-Held Metal Detectors for Use in Concealed Weapon and Contraband Detection

H. National Electrical Manufactures Association (NEMA)
250-03 Enclosures for Electrical Equipment (1000 Volts Maximum)

I. Occupational and Safety Health Administration (OSHA):
29 CFR 1910.97 Radiation Protection Guide

J. Security Industry Association (SIA):
AG-01 Security CAD Symbols Standards

K. Underwriters Laboratories, Inc. (UL):
187-98 Standard for X-ray Equipment
464-03 Audible Signal Appliances

L. United States Department of Commerce:
Special Pub 500-101 Care and Handling of Computer Magnetic Storage Media

M. Uniform Federal Accessibility Standards (UFAS), 1984

N. Architectural Barriers Act (ABA), 1968

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant Security Access Detection work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 hertz (Hz) or 60 Hz alternating current (AC) power system unless documented otherwise in subsequent sections listed within this spec. All equipment shall have a battery back-up source of power that will provide 12 hours (hrs.) of run time in the event of a loss of primary power to Security Access Detection systems until a backup generator comes on-line.

B. Walk-through metal detectors and X-ray machines shall meet the National Institute of Justice (NIJ) Standards and Safety requirements.

C. The Security Access Detection shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.

D. All Security Access Detection components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with NFPA 70, Chapter 5.

E. All Security Access Detection equipment and materials provided shall be new, first grade, standard, current products of the manufacturer and shall be suitable for the systems being installed and the intent of the design.

F. All Security Access Detection equipment and materials shall be stored, adequately protected and carefully handled to prevent damage before and during installation and according to manufacture's instructions.

G. All Security Access Detection equipment provided with a factory finish shall be maintained free of dust, dirt and foreign matter. Dents, marred finishes and other damage shall be repaired to its original condition or shall be replaced, at no additional cost to the Owner.

H. The Contractor shall provide the RE with written verification, that the type of wire/cable being provided is recommended and approved by the OEM. Cabling shall meet the interconnecting wiring requirements of NFPA 70 (NEC). The Contractor is responsible for providing the correct protection cable duct and/or conduit and wiring.

I. The Contractor is responsible for interfacing Security Access Detection with other security subsystems. The Contractor shall utilize interfacing methods that are approved by the OEM and RE. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection; but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein.

J. The characteristics listed in this section will serve as a guide in selection of equipment and materials for the Security Access Detection. If updated or more suitable versions are available then the RE will approve the acceptance of prior to an installation.

K. If any obsolete, incompatible, or damaged equipment is offered by the Contractor at the time of installation, then the equipment will be returned and replaced with equipment at no cost to the government.

2.2 EQUIPMENT ITEMS

A. General
   1. All specifications listed within this section are the minimum requirements to be met to ensure a working Security Access Detection is in place.
   2. Detection Sensor subsystems shall consist of sensors capable of:
      a. Locating and identifying prohibited, threatening, contraband materials and items the system is designed to detect and protect against being brought into a facility.
      b. Sensors shall be adjustable to maximize capabilities based on environmental and security requirement changes.
   3. Annunciation: Shall contain one (1) or more indicator lamps, alphanumeric displays that provide status information about a circuit or condition of the operating units. Walk-Through or conveyer pass through units must provide a uniform two-digit error code to identify different types of system failures.
   4. Audible Signal Device: Shall consist of audible sound for alarms, supervisory, and trouble signals and shall be distinctive.
   5. Assessment: Shall consist of electronic devices required to visually and audibly verify the validity and functionality of Security Access Detection. Assessment also includes providing indication of tampering, fail-safe, low battery, and power losses.

6. Alarm Reporting: Shall consist of electronic devices to annunciate Security Access Detection information to at least two (2) separate locations. The alarms shall maintain the capability to respond with local and remote visible and audible signals upon activation of detection sensors. The alarms should have the capability of a silent mode only alerting personnel using the system.
7. Power Supply: Security Access Detection shall be capable of continuous operation and include a battery backup module capable of 12 hrs. of backup use. All non-portable systems shall operate on 100-240 VAC. Hand-Held Security Access Detection (Metal and Explosive Detectors) shall have the capability to operate on rechargeable batteries.

B. Walk-Through Metal Detectors:
1. Shall meet NIJ Standard 0601.02 and be able to detect and locate guns, knives, and other flat and rod-shaped objects regardless of orientation.
2. All electronics shall be modular in design for easy plug-in and replacement. The Detector shall use multiple coil circuits with dual alarm lights to indicate which side of the individual the detected item is located.
3. Shall be capable of self-diagnostics and conduct self-test of all systems to automatically identify failures or problems with components as displayed on the control unit liquid crystal display (LCD). The detection unit shall not require re-calibration each time the system is turned off and back on.
4. Shall provide for full body coverage: coverage on the left, center, right, front, and back of the body from head to floor, providing uniform detection.
5. Shall include individual zones that are adjustable for customization of detection characteristics and/or compensation for metallic environmental challenges.
6. Shall have the capability to detect and discriminate signals from two (2) or more detectable items located in close proximity that may be detected as only one (1).
7. Shall include adjustable legs to provide for accurate leveling on uneven floors.
8. Major components include:
   a. Walk-through portal/passage way
   b. Control Unit
   c. Test Unit
   d. Technical Characteristics:

Operating Temperatures	-4°F (-20°C) to 158°F (70°C) 95% humidity non-condensing
Power Supply Unit	Fully automatic input 100 to 240 VAC 50 or 60 Hz – five (5) watts Uninterrupted Power supply (UPS) Battery Backup (12 hours)
Construction	Minimum 3/32 in. (2.381mm) aluminum in strength and weather resistant
Opening Sizes	Interior Width: 30 in. (762mm) Interior Height: 80 in.(2.032 meters)
Programmable	Capable of 16 independent programs settings for zones and sensitivity
Sensitivity Boost	Three (3) levels at ankle level
Detection Sensors	Multi-dimensional coil 33 distinct pin-point zones – customizable
Sensitivity Levels	200
Interference Protection	Faraday shielding
Alarms	Audible and light-emitting diode (LED) Visual
Testing Device	Simulate size, shape, and composition of threat objects meet FAA testing requirements

Traffic Flow Indicators	LED Lights
Infrared Sensor	Traffic control and counter

9. Control Unit: Shall consist of the components to constantly monitor, input settings, and verify inputs of sensors.
   a. The control unit is to be attached to the exit side of the scanner or shall be able to be detached and operational from up to 50 feet (ft.) (15.24 meters)(m) from detector.
   b. The control unit will consist of a multiple functional electronic digital keypad/touchpad. The keypad/touchpad requires human/machine interface (HMI) with numerical or function keys that can activate, deactivate, observe or change sensitivity and detector settings using secure codes.
   c. The Control Unit shall be programmed to be self-prompting for input.
   d. The LCD display shall be large, easily seen, backlit with alpha-numeric display that reports in words to regulate, control and provide self-prompt functions of the control unit.
   e. Control Unit Technical Characteristics:

Display	LCD
Connection to Unit	Wired with extension of 50 ft. (15.24m) for remote use
Touchpad Controls	Operate, Off, Counter, Volume, +/-, Program and Access
Displays	LED bar-graphs for detection sensitivity Alarm lights Functionality Program in operation Errors Traffic Count Alarm activations Alarm Percentages
Tamper alarm	10 seconds after access of touchpad
Access Control	Dual-level access codes for: Operators Supervisors

10. Control Unit Interface:
   a. The system shall include an interface module for network transmission of data and remote monitoring of system at the Access Control System and Database Management.
   b. Integration with the Access Control System and Database Management shall allow for control, real time monitoring and diagnostics capabilities.
   c. Control Unit Interface Technical Characteristics:

Display	LCD (laptop or Desktop Monitor)
Connection	10-Base T Network
System Capabilities	Monitor up to 4 scanners
Capabilities	Change settings LED bar-graph display Functionality Program in operation Errors Traffic Count Alarm activations Alarm Percentages

	Technician trouble-shoot
Access Control	Dual-level access codes Operators Supervisory

C. Hand-Held Metal Detectors:
   1. Shall meet NIJ Standard 0602.02 and be rugged in design and water-proof; lightweight to reduce stress of handling; and provide ease of freedom of movement and control.
   2. Shall be easily made operational with a one (1) switch operation that does not require any adjustments.
   3. Technical Characteristics:

Operating Temperatures	-35°F (-37°C) to 158°F (70°C) 95% humidity non-condensing
Operating Frequency	93 kHz
Audio Frequency	2kHz Warble Earphone capable
Tuning	Automatic
Controls	Power switch On/Off Interference Elimination
LED Alert Lights	Power On, Battery Low, Alarm
Indicators	Silent/Vibrate Audible Speaker LED Alert Lights
Power	Standard 9 volt and Nickel-Metal Hydride(NiMH)rechargeable battery
Battery life	60 hours continuous operations
Minimum Detection Capability Distances	Medium Pistol – 9 in. (228.6mm) Large Knife- 5 in. (127mm) Razor Blade- 3 in. (76.2mm) Small foil and jewelry – 1 in.

D. X-ray Detectors:
   1. Shall be surface mounted, multilayer, fully integrated, high frequency, and solid state using high speed processors.
   2. Shall meet NIJ Standards including a Personal Computer (PC) based system that can be networked with other inspection systems and can transmit data.
   3. The type of X-ray unit selected shall require consideration of its application and use (i.e., used to screen items through lobby control points versus screening items, which may be larger in size, such as through mail room/shipping and receiving facility areas).
   4. The system should provide the capability to send images through a network to a central server PC where the images can be viewed, stored or printed.
   5. The conveyer belt system belts should be guaranteed to perform auto tracking for life.
   6. All x-ray systems shall be certified to be in full compliance with all international radiation safety requirements and external emissions limits.
   7. Technical Characteristics:

X-Ray Generator	Self Contained operating at 90 kilovolts
Controls	Edge sharpening, variable intensity control, zoom, atomic number measurement
Zoom Capability	2X to 32X penetration levels
Discrimination	Organic, inorganic, mixed
Penetration	0.39 in. (10 mm) steel

Resolution capability	Detect #40 AWG
Color Tones	Two (2) million (Multi-Energy Colors)
Conveyer belt weight capabilities	200 lbs. (90 kilograms)
Conveyer belt speed	Controllable – 48 fpm (24 cm/sec)- reversible
Network Capable	Ethernet using TCP/IP

8. Central Processing Unit Technical Characteristics:

Processor	2.4 GHz Intel Pentium IV
Hard Disk Size	40 GB
Memory	256 RAM
Network Card	10/100 Base-T
CD-ROM Drive	10X
Monitor/Video Adapter board	19" (482.6mm)SVGA (1280 x 1044)Flicker Free Flat Screen .28 dot pitch
Floppy Drive	1.44 MB
Ports	2 serial, 1 parallel, USB
Backup	Tape or CDRW

E. Explosives Detectors:

1. Handheld: Provide for a self-contained analytical unit, with on-board computer, printer and touch screen display. The detector shall be easy to operate by non-technical staff/operators:
   a. System will use dual vapor and particulate detection without any external carrier gas or radioactive source.
   b. Detector shall be a simple push-button automatic operation that displays go/no go results on a LCD display.
   c. Explosive Detectors Technical Characteristics:

Power	12 volt direct current (DC) rechargeable 12 volt External battery pack 12 volt AC adapter
Device Controls	Power switch, keypad, automatic vapor/particulate selector, volume control (with optional earphone, and sample switch.
Memory	Store a minimum of 1000 previous readings
Detection	Dual vapor and particulate
Detection Analysis	<20 seconds
Detection Capabilities	Nanogram levels of: C-4, TNT, Dynamite, PETN, Semtex, EGDN, DMNB, RDX, ANFO, Black Powder, Ammonium Nitrate, Urea Nitrate, Nitroglycerine and TATP

2. Desktop:
   a. Shall have a built-in networking and communication capability. The device shall easily interface with other screening systems and printer if it is not part of the unit.
   b. Shall be self-contained, self-cleaning, self-calibrating, and require no external gas supply.
   c. A touch screen display shall be provided that displays both alarm and compound identification information Red flashing light on unit and audible alarm Automatic "Print on Alarm" option.
   d. Contractor shall provide collection device for input of data.

e. Technical Characteristics:

Power	90 to 265 volts alternating current (VAC) 50-60 Hz
Technology	Dual- gas chromatography and Ion mobility spectrometer
Power Consumption	Less than 500 watts
Device Controls	Touch screen display Power switch
Operating Modes	Continuous and Single Cycle
Warm up time	< 20 minutes (cold start)
Memory	Store a minimum of 1000 previous readings
Detection	Dual vapor and particulate
Analysis Time	< 20 seconds
Detection Capabilities	Nanogram levels of: 1) Explosives: PETN, RDX,TNT, NG, Dynamite, Semtex, C4 2) Narcotics: Cocaine, Opiates (heroine & morphine), Cannabis marijuana & hashish), Amphetamine-type stimulants amphetamine, ecstasy & methamphetamine.

2.3 INSTALLATION KIT

A. A kit shall be provided and used, that at a minimum, includes all labeling systems, wire wrap terminals, cable ties, bolts, etc., required to accomplish a neat and secure installation. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:

1. System grounding shall include all cable and installation hardware required. All equipment shall be connected to earth ground via internal building wiring, according to the NEC.
2. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with other security subsystems, as required.
3. The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to completely and correctly label each subsystem according to the OEM requirements, as depicted on installation drawings, and referenced in this document.

B. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to completely and correctly provide the system documentation as required and outlined in this document.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be in accordance with appropriate NEC, UL, NFPA, Related Work VA specifications, and appropriate installation manual for each type of Security Access Detection.

B. The Security Access Detection system will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a complete network.

C. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.

D. All Security Access Detection requiring VAC connection will be installed with surge protection and Uninterrupted Power Supply (UPS).

E. Architectural space planning design requirements need to be considered and defined prior to the installation of metal detection, x-ray and explosive detection equipment at main lobby entrance or other security control points. This also applies to the use of x-ray and explosive detectors in mail and shipping/receiving facility areas.

F. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

G. Walk-through metal detectors will not be located on floors with high metal content that may interfere with screening without protection between the floor and detector being considered.

H. The Contractor shall provide walk-through metal detectors with the capability for floor mounting (OEM recommended brackets) to increase stability.

I. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.

J. Adjustment/Alignment/Synchronization: Contractor shall prepare for system activation by following manufacturer’s recommended procedures for adjustment, alignment, programming, or synchronization. Prepare each component in accordance with appropriate provisions of the component’s installation, operations, and maintenance instructions.

K. For integration purposes, the Security Access Detection system shall be integrated with the Access Control System and Database Management via CAT-V cables and where appropriate with CCTV and EPPS. The CCTV Security System will:
   1. Provide full coverage of all lobby entrance screening areas utilizing a fixed color camera.
   2. Record activity on a 24 hours basis.
   3. The CCTV system should have facial recognition software to assist in identifying individuals for current and future purposes.
   4. For additional CCTV system requirements as they relate to the Security Access Detection, refer to Section 28 13 53, SECURITY ACCESS DETECTION.

L. Integration with CCTV and EPPS security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.

M. For programming purposes, refer to the manufacturers requirements for correct system operations. Ensure computer hardware being utilized for system integration meets or exceeds the minimum system requirements as well as systems software requirements.

N. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.

O. Existing Equipment

1. The Contractor shall connect to and utilize existing equipment, and control signal transmission lines, and devices as outlined in the design package. Equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
2. The Contractor shall perform a field survey, including testing and inspection of all existing equipment, power outlets, and signal lines intended to be used by the Security Access Detection, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or improper installation of equipment.
5. The Contracting Officer shall provide a full list of all equipment that is to be removed or replaced by the Contractor. The Contractor shall dispose of all equipment that has been removed or replaced. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

P. System Start-Up
1. The Contractor shall not apply power to any installed Security Access Detection until the following items have been completed:
   a. Security Access Detection equipment items have been set up in accordance with manufacturer's instructions.
   b. A visual inspection of the Security Access Detection system has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   c. System wiring has been tested and verified as correctly connected as indicated.
   d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
   e. Power supplies to be connected to the Security Access Detection system have been verified as the correct voltage, phasing, and frequency as indicated by the manufacturer.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

Q. Supplemental Contractor Quality Control: The following requirements supplement the Contractor quality control requirements specified elsewhere in the contract:
1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of any installed Security Access Detection; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 16 11
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install a complete Intrusion Detection System, hereinafter referred to as IDS, as specified in this section.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For door installation, Section 08 11 73, SLIDING METAL FIRE DOORS.

C. For door and gate installation, Section 08 34 59, VAULT DOORS AND DAY GATES.

D. For door installation, Section 08 35 13.13, ACCORDING FOLDING DOORS.

E. For window installation, Section 08 51 13, ALUMINUM WINDOWS.

F. For door installation, Section 08 71 00, DOOR HARDWARE.

G. For electrical installation, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

H. For power cables, Section 26 05 21, LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

I. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

J. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

K. For underground installation of wiring, Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION.

L. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

M. For access control integration, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS (PACS).

N. For screening of personnel and shipments, Section 28 13 53, SECURITY ACCESS DETECTION.

O. For security cameras, Section 28 23 00, VIDEO SURVEILLANCE.

P. For control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.

Q. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).

R. For fences, Section 32 31 13, CHAIN LINK FENCES AND GATES.

S. For Warranty Construction, see GENERAL CONDITIONS.

T. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing, installing, and the operation of the IDS as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A system drawing for each applicable security system shall:
      a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.

b. Provide full detail of all system components wiring from point-to-point.
c. Identify wire types utilized for connection, interconnection with associate security subsystems.
d. Show device locations that correspond to the floor plans.
e. All general and drawing specific notes shall be included with the system drawings.

5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
   a. Device ID.
   b. Device Location (e.g. site, building, floor, room number, location, and description).
   c. Mounting type (e.g. flush, wall, surface, etc.).
   d. Power supply or circuit breaker and power panel number.
   e. In addition, for the IDS, provide the sensor ID, sensor type and housing model number.
6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
   1. 35 percent
   2. 65 percent
   3. 90 percent
   4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI)/Security Industry Association (SIA):

PIR-01-00	Passive Infrared Motion Detector Standard - Features for Enhancing False Alarm Immunity
CP-01-00	Control Panel Standard-Features for False Alarm Reduction

C. Department of Justice American Disability Act (ADA)

28 CFR Part 36-90	ADA Standards for Accessible Design

D. National Electrical Manufactures Association (NEMA):

250-03	Enclosures for Electrical Equipment (1000 Volts Maximum)

E. National Fire Protection Association (NFPA):

70-05	National Electrical Code
731-06	Standards for the Installation of Electric Premises Security Systems

F. Underwriters Laboratories, Inc. (UL):

464-03	Audible Signal Appliances
609-96	Local Burglar Alarm Units and Systems
634-00	Standards for Connectors with Burglar-Alarm Systems
639-97	Standards for Intrusion Detection Units
1037-99	Standard for Anti-theft Alarms and Devices
1635-96	Digital Alarm Communicator System Units

G. Uniform Federal Accessibility Standards (UFAS), 1984

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant IDS work subject to the Article "Warranty of Construction" of FAR 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. General
1. All equipment associated within the IDS shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
2. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.
3. The system shall be designed, installed, and programmed in a manner that will allow for ease of operation, programming, servicing, maintenance, testing, and upgrading of the system.
4. All IDS components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with National Fire Protection Association (NFPA) 70 National Electric Code, Chapter 5.
5. All equipment and materials for the system will be compatible to ensure functional operation in accordance with requirements.

2.2 EQUIPMENT ITEMS

A. General:
1. All requirements listed below are the minimum specifications that need to be met in order to comply with the IDS.
2. All IDS sensors shall conform to UL 639, Intrusion Detection Standard.
3. Ensure that IDS is fully integrated with other security subsystems as required to include, but not limited to, the CCTV, PACS, EPPS, and Access Control System and Database Management. The IDS provided shall not limit the expansion and growth capability to a single manufacturer and shall allow modular expansion with minimal equipment modifications.

B. IDS Components: The IDS shall consist of, but not be limited to, the following components:
1. Control Panel
2. Exterior Detection Devices (Sensors)
3. Interior Detection Devices (Sensors)

4. Power Supply
5. Enclosures

C. Control Panel:
1. The Control panel shall be the main point of programming, monitoring, accessing, securing, and troubleshooting the IDS. Refer to American National Standards Institute (ANSI) CP-01 Control Panel Standard-Features for False Alarm Reduction.
2. The Control Panel shall provide a means of reporting alarms to an Access Control System and Database Management via a computer interface or direct connection to an alarm control monitoring panel.
3. The Control panel shall utilize a Multifunctional Keypad, Input and Output Modules for expansion of alarm zones, interfacing with additional security subsystems, programming, monitoring and controlling the IDS.
4. The Control panel shall meet or exceed the following minimum functional requirements for programming outputs, system response, and user interface:
   a. Programming Outputs:
      1) 2 Amps (A) alarm power at 12 VDC
      2) 1.4 A auxiliary power at 12 VDC
      3) Four alarm output patterns
      4) Programmable bell test
      5) Programmable bell shut-off timer
   b. System Response:
      1) Selectable point response time
      2) Cross point capability
      3) Alarm verification
      4) Watch mode
      5) Scheduled events arm, disarm, bypass and un-bypass points, control relays, and control authority levels
   c. User Interface:
      1) Supervises up to eight command points (e.g. Up to 16 unsupervised keypads can be used)
      2) Provides custom keypad text
      3) Addresses full function command menu including custom functions
      4) Allows user authority by defined area and 16-character name
      5) Provides for 14 custom authority control levels allowing user's authority to change, add, delete pass codes, disarm, bypass points, and start system tests.
5. The Control panel shall meet or exceed the following technical characteristics:

Input Voltage via 110 VAC or 220 VAC Step-down Transformer	16 or 18 VAC
Operating Voltage	12 VDC
Output Voltage	12 VDC @ 2 A max
Direct Hardwire Zones	7
Partitions	8
Multifunctional Keypads	16 (2 per partition)
Communications Port	RJ-11

6. A multifunctional keypad shall be utilized as a user interface for arming, disarming, monitoring, troubleshooting, and programming the alarm control panel.
7. Keypads shall have the following features:

a. Multiple function keypads suitable for remote mounting, no greater than 4000 ft (1333 m), shall be provided from the control panel and have a light emitting diode (LED) readout of alarm and trouble conditions by zone.
b. An alphanumeric English language display, with keypad programmability, and EE-PROM memory, shall also be provided.
c. Trouble alarm indicators shall be distinguishable from intrusion alarms.
d. A minimum of four (4) zones selectable as entry and exit with programmable time delay.
e. Complete system test activated capability at the keypad.
f. Capability for opening and closing reports to a remote monitoring location.
g. Adjustable entry and exit delay times.
h. Capability for a minimum of two (2) multiple function keypads.
i. Capability to shunt or bypass selected interior zones while arming perimeter protection and remaining interior zones.
j. Capability for a minimum of seven assignable pass-codes that are keypad programmable from a suppressed master code.

8. Keypads shall meet or exceed the following technical characteristics:

Connections	4-wire flying lead for data and power
Operating Temperature	0°C to +50°C (+32°F to +122°F)
Display Window	8-point LED
Indicators: Illuminated keys	Armed Status-LED
	Point Status-LED
	Command Mode-LED
	Power-LED
Voltage	Nominal 12 VDC

9. An input module shall be utilized to connect additional detection devices to the control panel. This module will meet or exceed the following technical characteristics:

Operating Voltage	8.5 to 14.5 VDC Nominal
Zone Inputs	Style A (Class B) Supervised
Operating Temperature	32 to 140 degrees F (0 to 40 degrees C)

10. An output module shall be utilized to interface the control panel with other security subsystems. The output module shall meet or exceed the following technical characteristics:

Operating Voltage	8.5 to 14.5 VDC Nominal
Output Relays	“Form C” Dry Relay Contracts
Relay Contact Rating	4A @ 24 VDC
	4A @ 24 VAC
	1A @ 70 VAC
Operating Temperature	32 to 140 degrees F (0 to 40 degrees C)

11. The control panel shall have a communications port that will allow for communications with a computer for programming, monitoring, and troubleshooting purposes. The communications port will be, at a minimum, and RJ-11 or better.
12. The control panel will have a systems success probability of 95% or better, and shall include the following success considerations:
    a. False Alarm: Shall not exceed one (1) false alarm per 30 days per sensor zone.
    b. Nuisance Alarm: Shall not exceed a rate of one (1) alarm per seven (7) days per zone within the first 60 days after installation and acceptance. Sensor adjustments will be made and then shall not exceed one (1) alarm per 30 days.

13. The Control Panel will be able to detect either a line fault or power loss for all supervised data cables.
    a. Line Fault Detection: Communication links of the IDS shall have an active mode for line fault detection. Fault isolation at the systems level shall have the same geographic resolutions as provided for intrusion detection. The line fault alarm shall be clearly distinguishable from other alarms.
    b. Power Loss Detection: Provide the capability to detect when critical components experience temporary or permanent loss of power and annunciate to clearly identify the component experiencing power loss.

D. Exterior Detection Devices: (Sensors)
1. The IDS shall consist of interior, exterior, and other detection devices that are capable of:
    a. Locating intrusions at individually protected asset areas or at an individual portal;
    b. Locating intrusions within a specific area of coverage;
    c. Locating failures or tampering of individual sensors or components.
2. Audible annunciation shall meet UL 464 Audible Signal Appliance requirements as well as other stated within this specification. IDS shall provide and adjust for devices so that coverage is maximized in the space or area it is installed in. For large areas where multiple devices are required, ensure exterior device coverage is overlapping.
3. Detection sensitivity shall be set up to ensure maximum coverage of the secure area is obtained while at the same time limiting excessive false alarms due to the environment and impact of small animals. All detection devices shall be anti-masking with exception of video motion detection.
4. Dual sensor technology shall be used when possible. Sensor technology shall not be of the same type that is easily defeated by a single method. This will reduce the amount of false alarms.
5. Exterior sensors described in this section are intended for outdoor use for perimeter and fence control monitoring purposes. Some sensors described in the interior sensor section may be utilized that can provide both outdoor and indoor protection.
6. External Sensors Environmental Characteristics:

Temperature	-25°F - 140°F (-32°C - 60°C)
Pressure	Sea Level to 15,000 ft. (4573m) above sea level
Solar Radiation	Six (6) hrs. exposure at dry bulb temp. 120°F (60°C)
Rain	Two (2) in. (50 mm) per hour
Humidity	5% - 95%
Fungus	Components of non-fungus nutrient materials
Salt/fog	Atmosphere 5% salinity
Snow loading	48 lbs per sq. ft. (234 kg per sq. meter)
Ice accumulation	Up to ½ in. (12.7 mm) radial ice
Wind limitations	50 mph (80 km/h) Gusts to 66 mph (106 km/h)
Acoustical Noise Suitability	> 110 decibels (dB)

7. Electromechanical Fence Sensors: Shall sense mechanical vibrations or motion associated with scaling, cutting, or attempting to lift standard security chain link fence as follows: Note: Dead zones shall not exist from a monitoring and alarm coverage perspective.
    a. The sensor zone control unit shall alarm when a sufficient number of sensing unit activations surface within a specified time period.

b. Individual sensing units and the alarm thresholds shall be field adjustable (i.e., performed by an authorized technician or trained maintenance personnel). Midrange sensitivity settings shall alarm a sensor when an intruder attempts to scale or climb the fence in areas of reduced sensitivity (e.g. around poles and rigid supports, etc.) and attempted lifting or scaling of a fence, including using assisted methods (e.g. items leaned against the fence, etc.)occur. Sensors shall allow gradual changes in fence positioning due to expansion, settling, and aging, without increased numbers of nuisance alarms taking place.

c. Exterior sensor components shall be housed in rugged, corrosion-resistant enclosures, protected from environmental impact and degradation.

d. Fence cable support hardware shall be weather-resistant. Interfacing between sensor zones and alarm enunciators, require they be installed in underground conduit and cables.

e. Fencing Cable Technical Characteristics:

Input voltage	12-30 V DC
Current requirement	4 mA quiescent 25 mA (max) in alarm
Transient suppression	On data, power input lines and on relay output
Enclosure	Weatherproof
Sensor type	Inertial band-pass-filter
Transponder	4 zone controller Output relays for dry contacts, or RS-485 communication Inputs for weather sensor
Sensor spacing	8.2 to 9.9 ft. (2.5 to 3 m)
Data I/O	RS 485 communications
Data output	• Vibration alarm (in either line) • Line alarm (in either line) • End of line action • Wind situation • Weather sensor line failure • Enclosure tamper switch • Program fail • A dry contact output with end of line resistor per each of 4 vibration inputs

8. Strain-Sensitive Cable Sensors: These devices shall detect movement on a standard security chain link fence associated with an intruder scaling, cutting through, or attempting to lift the fence fabric. The entire sensor system shall be mounted directly on the fence and able to withstand the same environmental condition exposures. Note: The length of the fence shall also maintain no sensor monitoring dead zones.

   a. Individual sensing units and the alarm threshold shall be field adjustable (i.e. by authorized technicians or trained maintenance personnel) for compensation of winds up to 25 mph (40 km/h) or by zone without increased nuisance alarms while maintaining specified sensor performance as under ambient conditions.

b. Sensor zone control units shall provide an analog audio output for interface to an external audio amplifier to permit remote audio assessment regardless of sensor alarm status. The sensor zone control unit alarm output interface shall be a separately supervised relay contact normally open or normally closed.
c. The length of the fence shall be divided into 300 ft. (100 m) zones.
d. The sensing unit shall consist of transducer cable capable of achieving specified performance either by attachment directly to the fence fabric by plastic cable every 12 to 18 in. (300 to 455 mm) or by installation inside electrical metallic tubing conduit mounted on the fence.
e. The sensing unit shall have equal adjustable sensitivity throughout the entire fence length. Only conventional waterproof coaxial cable connectors shall be used for connections of the sensing unit to avoid electrical magnetic interference.
f. The entire sensor system shall be tamper resistant and capable of detecting tampering within each portion of the system by sensor zone.
g. Magnetic Sensor Cable Technical Characteristics:

Magnetic Sensor Cable	
Type cable	Four (4) conductor magnetically loaded, aluminum foil shield and ground wire
Maximum zone length	1000 ft. (300 m)
Life expectancy	10 years
Sensitivity	Uniform over length of cable
Audio Bandwidth	Five (5) kHz
Outer Cover	Black Polyurethane, Ultraviolet resistant
Insensitive Cable (remote processing)	
Type cable	2 twisted pair, individually sealed
Outer Cover	Black Polyurethane, Ultraviolet resistant
Dual Channel Signal Processor	
Input Power	10.2 – 13.8 VDC 65 mA
Alarm Output	Alarm contacts SPNC 0.75 mA, 200 VDC
Indicators	Three (3):Alarm, tamper, events
Cut processor	Sensitivity - 10 settings Time window – 0.5 – 4.5 min Event Counter – nine (9)
Climb processor	Sensitivity – 10 settings

9. Buried Electromagnetic Cable Sensor:
a. The system shall be able to function as a standalone system or as an integral component of a centralized security control system.
b. The detection field shall be formed by radio-frequency (RF) signals carried by sensor cables that are buried along the perimeter.
c. The RF signals shall form an invisible electromagnetic detection field around the sensor cables that can detect the presence of an intruder passing through the field.
d. The system shall detect moving intruders that have a significant electromagnetic field (e.g. humans, vehicles, and other large conductive objects) while rejecting other environmental stimuli such as birds, small animals, weather elements.
e. A sensor module shall contain the electronics required to:
1) Transmit and receive the RF signal without the use of an external antenna.

2) Monitor the detection fields of two (2) zones and produce an alarm when an intruder enters the zones.

f. Field power modules shall be available for standalone systems and networked systems.

g. As a standalone system, the primary operator interface shall be a local interface module that is connected directly to the sensor module.

h. As part of a network configuration, the primary operator interface shall be a personal computer (PC) based central controller. The central controller shall monitor the performance of the entire buried coaxial cable outdoor intrusion detection system and any auxiliary sensors. The central controller shall have the capability of acknowledging, processing and reporting alarms. A customized color site map that is displayed on the PC monitor shall be an available option for the system to monitor sensor locations.

i. Transmission and reception shall be accomplished without the use of antennae. The RF signal shall be monitored and analyzed by the sensor module for any changes in the detection field properties that would indicate the presence of an intruder.

j. Alarms generated by internal electronic processes (cables excluded) shall not exceed one (1) per zone per month. System generated alarms are averaged based on the total number of zones in the system.

k. When the system is calibrated in accordance with the manufacturers' recommendations, the detection field shall be continuous and uniform over the protected site perimeter.

l. When system sensitivity is calibrated according to manufacturers' recommendations, the detection field shall not detect a valid target that is a minimum of 6.5 ft. (2 m) from the nearest sensor cable.

m. Buried Electromagnetic Cable Sensor Technical Characteristics:

Burial Medium	Clay, sand, soil, asphalt, concrete
Snow limitation	Up to 1 ft. (30cm) deep
Degradation Guaranty	Minimum 10 yr.
Detection Medium	Radio Frequency (RF)
Detection Coverage	Maximum 656 ft. (200m) per zone
Detection Capability	Human: >75 lbs. (34 kg)
Detection Speed	Human walk, crawl, run, roll, jump 1 in./sec. (2.5 cm/sec) – 50 ft./sec. (15 m/sec. regardless of direction across field
Velocity Response	Programmable
Detection Probability	Human: 99% with 95% confidence factor Animal: Less than 22 lbs. (10 kg.) Less than 5% with 90% confidence factor
Terrain Detection Capabilities	Even to uneven ground with maximum (max) grade 13 ft. (4 m) Corner bend radius 22 ft. (6.5m)
Detection Field Cross Section	Upright walking; Height: 3.2 ft. (1m) above ground Width: 6.5 ft. (2m) single cable 9.75 ft. (3m) double cable
Sensing Element	Ported (leaky) coaxial cables
Cable Construction	Abrasion and chemical resistant, high density polyethylene, with flooding compound
Cable Requirements	Two (2):Transmit cable, receive cable
Configurations Available	Two (2):Single cable, double cable
Cable Lengths	164 ft. (50 m), 328 ft. (100 m), 492 ft. (150 m), 656 ft. (200 m)

Zone Length Minimum	33 ft. (10 m)
Antenna Requirements	None
False alarm rate	Less than one (1) per day

n. Sensor Module: Each sensor module shall transmit, receive and process the electromagnetic detection fields independently from other sensor modules. Failure of one (1) sensor module shall not affect the remainder of the perimeter. The sensor module shall operate as either a standalone unit, or in a network configuration in conjunction with a central controller. The sensor module shall be mounted in a weatherproof enclosure when installed outdoors as follows.

1) The sensor module shall use an adaptive filter to analyze the detection signal and adjust the signal processing to reduce nuisance alarms caused by environmental factors such as rainfall or slow-running water.
2) The sensor module shall identify, by type, sensor, tamper, and failure alarms either locally at the sensor module, or centrally at a central controller. The sensor cables shall provide the data paths between the sensor modules, for the transmission, reception and display of alarm conditions.
3) Each sensor module shall include an internal interface for the collection of auxiliary sensor data.
4) 4) It shall be possible to supply power directly to each unit for applications that require either a single sensor module or multiple sensor modules with independent power sources.
5) The sensor module's response shall be demonstrated by an analog output signal that can be displayed on a voltmeter or on an analog voltage-recording device. The output signal shall be encoded to indicate the alarm trip-point, thereby showing the sensor module’s degree of detection above or below the level required to cause an alarm.
6) Sensor Module Technical Characteristics:

Sensor Module Power Output	12 VDC at 150 milliampere (mA)
Sensor Module Power Requirements	Stand-alone: 12 VDC 500 mA max Network: 48 VDC 175 mA max
Sensor capability	Two (2) zones independent of other sensor modules
Sensor coverage	1,312 ft. (400 m)
Calibration	Locally and remotely from Central Controller
Self Test	Via 4 relay drive points
Detection coverage	Unlimited expansion using multiple modules
Nuisance avoidance	Adaptive filtering
Connectivity	RS-485 twisted pair cable
Sensor Support	Dual redundant data paths
Transmission capability	Eight (8) contact-closure signals

o. The field power module shall be capable of supplying power to sensor modules as follows:

1) In a network configuration where power is supplied redundantly via the sensor cables, the sensor modules shall operate within specifications when power is removed from either of the two (2) sensor cables.

2) Each cable zone shall be capable of being calibrated either locally at the sensor module, or remotely from a central controller. Additional signal processing parameters, including high speed and low speed response, shall be capable of being set from a central controller.

3) Detection sensitivity for each zone shall be adjusted either locally at the sensor module with a local interface module, or from a central controller. Access to the local calibration controls shall require the removal of the enclosure's cover and shall cause a tamper alarm to be generated.

4) Power Module Technical Characteristics:

Output support	Nine (9) sensor modules max 3,063 yards (yds.) (2,800 m)
System block configuration	1,531 yds. (1,400 m)
Power Output	Stand-alone: 12 VDC 500 mA max Network: 48 VDC 175 mA max

10. Microwave Sensors: The system shall be a modular microwave outdoor intrusion detection sensor based on microwave radar technology. The detection field shall be formed by radio frequency (RF) signals, in the X-band, carried between a transmitter and a receiver. The RF signals shall form an invisible electromagnetic detection field that can detect the presence of an intruder who walks, crawls, rolls, jumps, or runs through a detection field as follows.

a. transmitter shall create the RF signals that form the detection field. A receiver shall house the necessary electronics to monitor the detection field and to raise an alarm when an intruder enters the field. The transmitter and receiver shall be powered individually, as a standalone unit.

b. An electromagnetic wave is emitted by the antenna of the transmitter and received by the antenna of the receiver. The receiver shall detect changes that are caused by the presence of an intruder.

c. The system shall detect moving intruders having a significant electromagnetic cross-section (e.g. humans, vehicles, and other large conductive objects) rejecting other environmental stimuli.

d. The system shall be capable of detecting human intruders moving through the detection field regardless of the direction of motion.

e. Processor description: The receiver shall contain the necessary electronics to perform the signal processing for the detection zone. The transmitter and receiver shall be operated as a standalone unit with independent power and data. Both the transmitter and receiver shall be installed in weatherproof enclosures.

f. Distributed processing: Transmitter-receiver pairs distributed along a perimeter shall provide extended range and fail-safe operation. The failure of one (1) pair shall not affect the coverage of the remainder of the perimeter.

g. Alarms: The signal processor shall identify intrusion and tamper/fail alarms locally, at the transmitter or receiver.

1) An alarm caused by opening the outer enclosure of the transmitter or receiver shall be identified as a tamper alarm. Tamper alarms shall be distinctive from intrusion alarms.

2) Alarms caused by power failure or internal electronic failure are fail alarms, distinctive from intrusion alarms.

h. Microwave Sensor System Technical Characteristics:

Operating voltage Transmitter	11 – 15 VDC 70mA max. current
Operating voltage Receiver	11 – 15 VDC 30mA max. current

Operating Environment	-22F (–30ºC) and 140 F (60ºC)
LEDs	POWER ON, WRONG CHANNEL, ALARM
Maximum zone length	33 ft. (10 m) and a maximum of 1500 ft. (457 m) per zone.
Detection Success Probability	75 lbs. (34 kg) 99% with a 95% confidence factor
Operating frequency	X Band 10.525 ± 0.025 gigahertz (GHz)
Type modulation	Class A2 with one (1) of six (6) selectable crystal-controlled frequencies.
Detection movement speed	2.0 in. sec. (5 cm/sec.) to 26 ft. sec. (8 m/sec.)
Audio assessment	Via 1/8 in. phone jack on receiver
Alarms	Tamper, failure, intrusion
Tamper/fail alarm	Via sealed relay rated one (1) ampere 28 VDC
Intrusion field alarm	Via sealed relay rated two (2) ampere 28 VDC.
Intrusion alarm latch time	Adjustable: 0.5 sec and 10 sec
Processing	Distributed: receiver/transmitter pairs
Perimeter Length	Single Receiver/transmitter pair: 1500 ft. (457 m) Multiple pairs: Unlimited

11. Taut-wire Sensors: These sensors shall consist of a perimeter intrusion detection sensor incorporated into a wire security fence. Intrusion detection shall be achieved by sensing the cutting of any single wire or deflection of the fence, such as by climbing.
    a. Sensor zone: Includes one (1) or more 200 ft. (61 m) maximum sections of seven (7) ft.(2.3 m) high parallel fence. Each sector shall consist of 13 horizontal barbed wires attached to the taut-wire fence posts, and three (3) strands as outriggers, and an "anti-ladder" trip wire supported by rods extending from the outriggers for a total vertical height of approximately eight (8) ft. (2.6 m).
    b. Displacement switches for each horizontal wire shall be mounted within a pre-wired channel fastened to the fabric fence post at the midpoint of each section. Outrigger barbed wire and tripwire may share the same switch in these locations.
    c. Abnormal displacement of a switch lever resulting from cutting or deflecting its attached wire, as by climbing on or through fence strands, shall initiate an alarm condition. A damping mechanism within the sensor shall reduce alarm thresholds due to slowly changing environmental phenomena such as the ground shifting, daily and seasonal temperature variations, winds changes, etc.
    d. Sensor switches shall be provided with electrical contact closures as a means for initiating an alarm condition.
    e. The system shall provide relay outputs to interface alarm outputs with the overall IDS.
    f. Taut-wire Sensor Technical Characteristics:

Power requirements	Input: 120 – 208 VAC
Sensor zone control unit capability	Up to 10 zones
Sensitivity	0.75 in. (19 mm)
Environment Limits	Winds up to 35 mph (56 km/h)

12. Electrostatic Field Sensors: These sensors generate an electrostatic field around one (1) or more horizontal wires and detect intrusion of the electrostatic field as follows.
    a. Sensors shall initiate an alarm when an intruder attempts to approach or scale a fence or physical barrier. Electrostatic field sensors shall detect human presence by generating an electric field around one (1) or more horizontal wires that detects the induced signal in parallel sensing wires.

b. Sensors shall monitor the induced signal for changes that result from the presence of a human body, which distorts coupling between transmitting and sensor wires.
c. Sensor components shall consist of one (1) or more signal generator field wires and mounting hardware, sensing wires, an amplifier/signal processors, power supplies, and necessary circuitry hardware. Mounting and support hardware shall be provided by the equipment manufacturer.
d. Wires shall be spring tension-mounted and provided with end-of-line terminators to detect cutting, shorting, or breaking of the wires.
e. Sensor configuration shall be able to detect an intruder that may crawl under the bottom wire, through the wires, or over the top wire by divided sensor zones.
f. Signal processing circuitry shall provide filtering to distinguish nuisance alarms.
g. Sensor configuration shall incorporate balanced, opposed field construction to eliminate distant field noise.
h. Sensor sensitivity shall be adjustable. Adjustment controls shall be inaccessible to operating personnel and system sensitivity controls shall be set at approximately midrange.
i. Sensors shall provide some means of indicating an alarm condition at the protected perimeter to facilitate installation and calibration.
j. The sensor system shall include an indicator disabling device within a tamperproof enclosure.
k. Electrostatic Field Sensor Technical Characteristics:

Power	115 -120 VAC transformer
Operating Power Requirements	16-22 VAC, 225 mA single zone 275 dual zone
Detection Sensitivity	77 lbs within 3 ft. (915 mm)- midrange setting
Detection Velocity	0.1 ft. (30 m) - 10 ft. (300 m) per sec
Supervision	AC Monitoring of fence and field wires – open, short, and grounded circuits
Tamper Switch	One (1)-pole, two (2) position
Lightening arrestor	Transistors on all relay output and power inputs
Battery Charger	Built-in
Processor Enclosure	Base plate, steel NEMA enclosure Weather resistant

13. Gate Sensors: They shall be provided in accordance with specific fence sensor manufacturer's recommendations to ensure continuous fence sensor zone protection for the entire protected perimeter.
    a. When gate units are not provided by the fence sensor manufacturer, provide separately zoned Balanced Magnetic Switch (BMS) gate sensors.
    b. Sensors shall perform as specified in Section 2.3-E.6 entitled "Balanced Magnetic Switches (BMS)."

E. Interior Detection Devices: (Sensors)
1. The IDS shall consist of interior, exterior, and other detection devices that are capable of:
    a. Locating intrusions at individually protected asset areas or at an individual portal;
    b. Locating intrusions within a specific area of coverage;
    c. Locating failures or tampering of individual sensors or components.
2. Provide and adjust for devices so that coverage is maximized in the space or area it is installed in. For large rooms where multiple devices are required, ensure device coverage is overlapping.

3. Detection sensitivity shall be set up to ensure maximum coverage of the secure area is obtained while at the same time limiting excessive false alarms due to the environment and impact of small animals. All detection devices shall be anti-masking with exception of video motion detection.
4. Dual sensor technology shall be used when possible. Sensor technology shall not be of the same type that is easily defeated by a single method. This will reduce the amount of false alarms.
5. Interior Environmental Conditions: Systems shall be able to operate in environmentally protected interior areas and shall meet operational performance requirements for the following ambient conditions:
   a. If components are installed in unheated areas they shall be able to operate in temperatures as low as 0 F (-17 C);
   b. Interior Sensor Environmental Characteristics:

Temperatures	32F to 120 F (0 to 50 C)
Pressure	**Sea Level to 15,000 ft. (4573m) above sea level**
Humidity	**5% - 95%**
Fungus	**Components of non-fungus nutrient materials**
Acoustical Noise	Suitable for high noise environments above 100db

6. Balanced Magnetic Switches (BMS)
   a. BMS switches shall be surface or recessed mounted according to manufacture's instructions. Recessed mounted is the preferred method to reduce tampering or defeating of the system. Switches shall activate when a disturbance in the balanced magnetic field occurs.
   b. Switches shall have a minimum of two (2) encapsulated reed switches.
   c. Contractor shall provide each BMS with a current protective device, rated to limit current to 80% of the switch capacity.
   d. Surface Mounted BMS: For exterior application, components shall be housed in weatherproof enclosures.
   e. BMS field adjustments in the fixed space between magnet and switch housing shall not be possible. Attempts to adjust or disturb the magnetic field shall cause a tamper alarm.
   f. BMS Technical Characteristics:

Maximum current	.25 amperes
Maximum voltage	30 VDC
Maximum power	3.0 W (without internal terminating resistors). 1.0 W (with internal terminating resistors).
Components	Three (3) pre-adjusted reed switches Three (3) pre-adjusted magnets
Output contacts	Transfer type SPDT
Contact rating	0.5 amperes, 28 VDC
Switch mechanism	Internally adjustable ¼ - ½ in. (6-13 mm)
Wiring	Two (2) wires #22 American Wire Gauge (AWG), three (3) or 11 foot attached cable
Activation lifetime	1,000,000 activations
Enclosure	Nonferrous materials
Tamper alarm activation	Cover opened 1/8 in. (3 mm) and inaccessible until actuated

7. Window Intrusion Detection: These IDS devices shall detect intrusions thru inertia (shock) or by sound, and shall utilize either a Breakwire Sensor or Acoustic and Seismic Sensor.
   a. Breakwire Sensors (wire trap):
      1) Detect intrusion thru shock or breakage of window glazing. Also used for the protection of utility openings.
      2) Sensors shall consist of fine wire embedded in or affixed to interior of glazing. Breakage of protected glazing shall result in wire breakage.
      3) Wire shall be hard-drawn copper up to #26 AWG diameter.
      4) If sensors are affixed to glazing the sensor shall be protected by a clear coating which shall not affect sensor functioning.
      5) Sensor shall be terminated in insulated connectors which are concealed and tamper resistant.
      6) Protection of inlet openings:
         a) Shall consist of up to 26 AWG hard-drawn copper wire with a tensile strength of 17.8 N 4 pounds maximum.
         b) Wire shall be interlaced throughout the opening such that no opening between wires shall be larger than 4 in. (100 mm) on center.
         c) Sensors shall be terminated so that attempts to cut the wire or otherwise enlarge openings between wires shall cause an alarm.
         d) Sensors shall be terminated in insulated connectors which are concealed and tamper resistant.
   b. Acoustic and Seismic Glass Break Detectors:
      1) Detects intrusion thru the use of audible sound and vibration emitted from the breaking of glass using a tuned frequency range and sound pattern recognition. This initiates an alarm when glass they protect is broken or cracked.
      2) Detectors shall be installed in strict conformance with manufacture's installation instructions.
      3) The detector's power circuit shall be switched via an output relay on the control panel to provide latching alarm LED reset capability.
      4) Sensors shall be contained in a fire-resistant ABS plastic housing and must be mounted in contact with a window.
      5) Sensing shall be accomplished through the use of a mechanical filtered piezoelectric element.
      6) Sensors shall have a sensitivity adjustment controlling output voltage from the piezoelectric element which triggers a solid-state latching device.
      7) Sensors shall selectively filter input to minimize false alarms and not initiate alarm in response to ambient seismic vibrations or other ambient stimuli.
      8) A manufacture's test unit will be used to validate the sensor by simulating glass breakage.
      9) The Contractor shall provide sensors for adjusting sensitivity and two-sided polyurethane tape with acrylic adhesive for window attachment.
      10) Sensor shall include exterior label to protect adhesive tape from direct sunlight.
      11) Window Intrusion Detection Sensor Technical Specifications:

Power	Auxiliary power supply 12 VDC @ 25 mA (+/-) 10%
Power Input	10 – 15 VDC at 16mA protected against reverse polarity, 20 mA during relay closure
Relay Output Rating	Minimum of 25 VDC mA
Coverage Audio	6,000 Square ft.
Coverage Glass Break	25 ft. (7.5 m) wide by 25 ft. wide (7.5 m)

	Minimum: 25 feet (7.62 m) from the detector to the furthest point on protected glass.
Audio Output	300 – 12,000 HZ
Alarm Output	Relay NO or NC selectable
Interconnection	12 pin Panduit connector, 22 AWG
Radio Frequency Interface	No alarm or setup on between frequencies 26 – 100 MHz 50 v/m Immunity to mobile RF interference 100 watts @ 9.8 Ft. (3 m) in 27-100 MHz range
Alarm period	Two (2) to three (3)
Mounting	Ceiling, same wall, adjacent wall, opposite wall
Features	Test and alarm LEDs for acoustic seismic and alarm condition latching, Alarm LED and tamper switch on cover.
Alarm verification	Digital signal processing or dual acoustic processing technologies
Detection ability	Single and multi-pane glass, wired glass, tempered and laminated glass to ¼ inch (6 mm) or thickness

8. Screening: This material shall be used on windows to protect and detect intrusion as follows.
   a. Security screens shall be constructed from a maximum of 26 AWG insulated hard-drawn copper.
   b. Screens shall be connected to an alarm circuitry by means of flexible armored cords. Security screen circuitry shall provide end-of-line resistors in series or equivalent methods ensuring alarm activation if short-circuiting of the screen is attempted.
   c. If unable to install a break wire sensor (wire traps), then tamper switches will be provided.
   d. Contractor shall provide tamper switches in the frames as required with not less than one (1) switch on each side if dimensions are two (2) ft. square (610 mm) or less, and two (2) switches if dimensions exceed two (2) ft. square (610 mm). Tamper switches shall be corrosion-resistant, spring-operated, and shall initiate an alarm with a movement of two (2) in. (50 mm) or less before access to the switch is possible.
   e. Electrical characteristics of the switch shall match the alarm system requirements.
9. Vibration Sensors: These sensors shall initiate alarms upon detecting drilling, cutting, or blasting through walls, or other methods of forced entry through a structure as follows.
   a. Sensors shall detect and selectively amplify signals generated by forced penetration of a protective structure.
   b. Sensors shall be designed to give peak response to structurally conveyed vibrations associated with forcible attack on the protected surface.
   c. Sensors will initiate an alarm if attempts are made to remove them from the surface of the wall.
   d. Sensors shall be enclosed in protective mountings.
   e. Sensors shall include an adjustable alarm discriminator to prevent incidental vibrations which may occur from triggering the alarm circuit.
   f. Sensors shall be provided with a tamper switch.

g. Sensor sensitivity shall be individually adjustable unless a sensor is designed to accommodate vibration ranges of specific surface type on which it will be mounted. Sensitivity adjustments shall not be accessible without removing the sensor cover. Also, a sensor shall not be responsive to airborne sound.

h. Vibration Sensor Technical Characteristics:

Power requirements	External DC power source Eight (8)- 14.5 VDC, two (2) volt max peak to peak ripple
Alarm output	Form C (NO/C/NC) solid state alarm relay, rated 100 mA, 28 VDC
Tamper Connection	Tamper switch and external magnetic
Current rating and alarm output	No alarm state 20mA SPDT relay contact rating (Form C)
Sensor range	Concrete (poured) 13.2 ft. (4 m) Concrete block 6.6 ft. (2 m) Brick block 3.3 ft. (1 m)
Frequency range	3kHz-20kHz (-15db) 7kHz-10kHz (-10db)
Adjustable	Sensitivity eight (8) steps Alarm response 0-30 sec

10. Passive Infrared Motion Sensors (PIR): These sensors shall detect an intruder presence by monitoring the level of infrared energy emitted by objects within a protected zone and meet ANSI PIR-01 Passive Infrared Motion Detector Standards Features for Enhancing False Alarm Immunity. An alarm shall be initiated when motion and temperature changes within set patterns are detected as follows.
    a. The detector shall provide multiple detection zones distributed at a variety of angles and distance.
    b. Sensors shall be passive in nature; no transmitted energy shall be required for detection.
    c. Sensors shall be sensitive to infrared energy emitted at wavelengths corresponding to human body and other objects at ambient temperatures.
    d. Sensors shall not alarm in response to general area thermal variations and shall be immune to radio frequency interference.
    e. Sensors shall not be susceptible to changes in temperature due to an air conditioner being turned on or off.
    f. Sensors shall be housed in a tamper-alarmed enclosure.
    g. Sensor detectors shall include motion analyzer processing, adjustable lens, and walk test LED's visible from any angle.
    h. Sensors shall provide some means of indicating an alarm condition during installation and calibration. A means of disabling the indication shall be provided within the sensor enclosure.
    i. Sensor detectors shall include a motion monitoring verification circuit that will signal trouble or alarm if the detector fails to detect motion for an extended period.
    j. PIR Technical Characteristics:

Power	Six (6) – 12 VDC 25 mA continuous current draw 38 mA peaks
Alarm Velocity	Five (5) ft. (1500 mm) at a velocity of 0.1 ft.

	(30 mm) per second, and one (1) step per second, assuming 6 in. (150 mm) per step. Also, faster than 0.1 foot (30 mm) per second, up to 10 feet (3000 mm) per second
Maximum detection range	35 ft.(10.6 m)
Frequency range- non activation or setup use	26 to 950 MHz using a 50 watt transmitter located 1 ft. from the unit or attached wiring
Infrared detection	3°F (1 1/2°C) different from the background temperature
Detection Pattern	180 degrees for volumetric units, non PIR 360
PIR 360°Detection Pattern	Programmable 60 detection zones including one directly below
Mounting	Ceiling and walls
Ceiling heights	Eight (8) ft. (2.4 m) – 18 ft (5.4 m)
Sensitivity adjustments	Three (3) levels

11. Microwave-Passive Infrared Detector: This sensor shall be designed to detect the motion of a human body within a protected area by means of a combination of microwave sensing technology and passive infrared (MPIR) sensing technology as follows.
    a. The sensor shall require both technologies to sense intrusion before an alarm may occur.
    b. The sensor shall be designed for wall mounting on swivel bracket. A high-security gimbaled bracket shall be provided.
    c. The PIR fields of view shall be focused on the pyroelectric element by means of an internal multi-faceted mirror.
    d. The sensor shall incorporate a look-down lens system that detects the passing of an intruder directly beneath the sensor.
    e. The sensor shall incorporate a microwave supervision system which shall activate the trouble output if the device technology fails.
    f. The sensor shall incorporate self-diagnostics which shall monitor the sensor systems and report a trouble to the control panel if any system device fails.
    g. The sensor shall have compensation against loss of sensitivity as the ambient temperature nears human body temperature.
    h. MPIR Technical Characteristics:

Technology	Microwave and Passive Infrared
Power	Nine (9) – 15 VDC max current consumption 22 mA at 12 VDC
Operating Temperature	32°F (0° C) – 120° F (49° C)
Detection Area	98 ft. (30 m) long by 9.8 ft. (3 m) wide or 69 ft. (21 m) long by 69 ft. (21m) wide
Electronics	Microcontroller based
Alarm Contact	Form-C rated 125 mA, 28 VDC
Tamper Contact	125 mA, 28 VDC
Trouble Contact	Form-B rated 25 mA, 30 VDC
Microwave Operating Frequency	10.525 GHz
Microwave Sensitivity	Adjustable on circuit board
Detection pattern adjustment	Changing of internal lens
Sensing element	Pyro-electric
LED Indicators	PIR, microwave, alarm

Bug and Dust protection	zero-clearance, gasket bug guard
Lens	Interchangeable: standard 60x80 ft. (18x24 m), corner mounting, ultra-wide, pet alley, long range, room and corridor combo, room and ceiling combo, creep zone

12. Ultrasonic Sensors: These sensors shall transmit ultrasonic energy into a protected zone, receiving the direct and reflected energy, and monitoring frequency shift between transmitted and received signals as follows.
    a. Sensors shall automatically adapt to changing levels of air turbulence and shall consist of a control unit and as many transceivers as required to protect a zone within limitations of the control unit per manufacture's instructions.
    b. Ultrasonic system sensors shall provide a means of indicating an alarm condition at the protected zone during installation and calibration. This indication shall be provided with a disabling device within the sensor enclosure.
    c. Transceivers shall consist of an adjustable-gain preamplifier, an ultrasonic-to-electrical transducer, and an electrical-to-ultrasonic transducer in a single enclosure. Transducers shall be adjustable in position to allow adequate adjustment and directivity.
    d. Each sensor will consist of sensitivity adjustments. Controls shall be inaccessible to operating personnel and sensitivity requirements shall be set approximately at midrange.
    e. Sensor elements shall be housed in a tamper-alarmed enclosure.
    f. Ultrasonic Sensor Technical Characteristics:

Power output	Peak not to exceed 105 dB at three (3) ft. (900 mm)
Transceiver protection zone	20 ft. (6 m) by 30 ft. (9.2 m) in a zone with an 8 ft. (2440 mm) to 12 ft. (3660 mm) ceiling
Nuisance alarm reduction	Selective filtering
Detection frequency range	Above 24 kHz and below 30 kHz (nominally 26 kHz)
Detection velocity	5 ft. (1500 mm) at a velocity of 0.5 ft. (150 mm) per second to 15 feet (4570 mm) per second, also Higher than 0.5 foot (150 mm) per second, up to eight (8) ft. (2440 mm) per second

13. Photoelectric Sensors: The sensor devices shall be able to detect an intruder presence by sending out a series of infrared or ultraviolet beams. Intrusion is based on disruption of the signal beams as follows.
    a. Sensors shall consist of a modulating transmitter, focusing lenses, mirrors, demodulating receiver, power supply, and interconnecting lines.
    b. Beam transmitters shall be designed to emit light. Beams may be reflected by one (1) or more mirrors before being received and amplified.
    c. The photoelectric sensor shall initiate an alarm when the beam is interrupted with monitoring controls set at midrange.
    d. Transmitted beams shall be uniquely modulated to prohibit defeat of the IDS system by shining another light source into the receiver.
    e. Sensors shall provide a means of local alarm indication on the detector for use at the protected zone during installation and calibration.
    f. Sensors shall include an indicator-disabling device within the sensor enclosure.
    g. Sensors shall utilize automatic gain control or be provided with sensitivity adjustments to allow for various beam lengths.

h. Sensor controls shall be inaccessible to operating personnel.
i. Sensors that use multiple beams shall be tested by attempting to crawl under and jump through and over beams. Each system sensor shall provide cutoffs of at least 90% to handle a high percentage of light cutoffs prior to initiating an alarm.
j. Sensor components shall be housed in tamper-alarmed enclosure.
k. Photoelectric Sensor Technical Characteristics:

Power requirements	Nine (9)-16 VDC, protected against reverse polarity
Relay output	Normally closed. 18 ohm resister in series with contacts. 0.5 amperes resistance/24 VDC
Current	Transmitter 15 mA, Receiver 15 mA
LED	Alignment, walk-test alarm, off
Range	Indoor: 130 ft. (39 m) Outdoor: 65 ft. (19.5 m)
Alarm relay contacts	Two (2) amperes at 120 VAC minimum
Enclosure	High impact acrylic
Type	Dual beam
Mounting	Wall, corner, flush
Beam width	Six (6) degrees
Receiver field of view	Six (6) degrees horizontal and vertical
Adjustments	Vertical +10 – 20 degrees Horizontal 30 degrees
Alarm period	Two (2) – three (3) sec
Infrared source	Long-life Gallium Arsenide LED
Infrared sensor	PIN photodiode
Transmitter Frequency	One (1) kHz 10 microsecond pulse width
IR Wavelength	950 nm

14. CCTV Video Motion Detection Sensors: Refer to Section 28 23 00 VIDEO SURVEILLANCE that outlines related video motion detection requirements.
15. Pressure Mat Detectors: These devices shall be able to detect the presence of people in a localized zone. Pressure from standing or walking across an area where a mat is place detects a closed circuit as follows.
    a. The mat shall be easily interfaced directly to a micro-sensor controller.
    b. Shall be sealed on all edges and pre-wired and made of durable material that is waterproof for indoor/outdoor use.
    c. This pressure sensitive mat shall be capable of being easily hidden under existing carpet or other entry mat without effecting operation, to include the prevention of false or nuisance alarms.
    d. Shall have a slip resistant surface with four (4) lead fail-safe wiring.
    e. Mat detectors shall be resistant to water and dust and the wiring circuitry shall be capable of direct supervision.
    f. Pressure Mat Detector Technical Characteristics:

Operating Voltage	15 VDC AC with max current 20 mA
Activation Weight	80 lbs. (36.28kg. per 3 in. (76.2mm) square
Activation Lifespan	500,000 activations without failure

16. Tamper Alarm Switches: The following IDS sensors shall be used to monitor and detect potential tampering of sensors, control panels and enclosures.

a. Tamper Switches: All enclosures including cabinets, housings, boxes, raceways, and fittings with hinged doors or removable covers containing circuits and power supplies related to the IDS shall include corrosion-resistant tamper switches.
b. Tamper alarms shall be annunciated to be clearly distinguishable from IDS alarms.
c. Tamper switches will not be in a viewable from a direct line of sight perspective. The minimum amount of time the tamper switch becomes active and sends a signal after an enclosure is opened or panel removable is attempted, shall be one (1) second.
d. Tamper switches will initiate when enclosure doors or covers is removed as little as 1/4 in. (6.35 mm) from the closed position unless otherwise indicated. Tamper switches shall be:
   1) Push/pull automatic reset type;
   2) Inaccessible until switch is activated;
   3) Spring-loaded and held in closed position by door or cover; and
   4) Wired to break a circuit when door or cover is removed with each sensor annunciated individually at a central reporting processor.
e. Fail-Safe Mode: Shall provide the capability to detect and annunciate diminished functional capabilities and perform self-tests. Fail-safe alarms shall be annunciated to be clearly distinguishable from other types of alarms.

F. Power Supply
1. A power supply shall only be utilized if the control panel is unable to support the load requirements of the IDS system.
2. All power supplies shall be UL rated and able to adequately power two entry control devices on a continuous base without failure.
3. Power supplies shall meet the following minimum technical characteristics:

INPUT POWER	110 VAC 60 HZ 2 amp
OUTPUT VOLTAGE	12 VDC Nominal (13.8 VDC) 24 VDC Nominal (27.6 VDC) Filtered and Regulated
BATTERY	Dependant on Output Voltage shall provide up to 14 Ah, rechargeable
OUTPUT CURRENT	4 amp max. @ 13.8 VDC 3 amp max. @ 27.6 VDC
BATTERY FUSE SIZE	3.5 A @ 250 VAC
CHARGING CIRCUIT	Built-in standard

G. Enclosures:
1. All control panels, input and output modules, and power supplies shall be housed inside a metal enclosure in accordance with National Electrical Manufactures Association (NEMA) 250 Enclosures for Electrical Equipment.
2. The enclosure shall be UL rated, lockable and alarmed with a tamper alarm switch that is monitored by the control panel.
3. The enclosures will be NEMA 4 rated if exterior mounted.
4. All connections to the enclosure shall meet or exceed the requirements set forth in the NEC.

2.3 INSTALLATION KIT

A. General

1. The kit shall be provided that, at a minimum, includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:
2. System Grounding
   a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
   b. This includes, but is not limited to:
      1) Coaxial Cable Shields
      2) Control Cable Shields
      3) Data Cable Shields
      4) Equipment Racks
      5) Equipment Cabinets
      6) Conduits
      7) Cable Duct blocks
      8) Cable Trays
      9) Power Panels
      10) Grounding
      11) Connector Panels
3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
5. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.
6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.
7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this document.
8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. IDS installation shall be in accordance with Underwriters Laboratories (UL) 639 Standards for Intrusion Detection Units and UL 634 Standards for Connectors with Burglar Alarm Systems, and appropriate manufacture's installation manuals for each type of IDS.

B. Components shall be configured with appropriate "service points" to pinpoint system trouble in less than 30 minutes.

C. The Contractor shall install all system components including VA furnished equipment, and appurtenances in accordance with the manufacturer's instructions and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

D. The IDS will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or designed as a computer network.

E. The IDS shall be able to be integrated with other security subsystems. Integration with these security subsystems shall be achieved by computer programming and the direct hardwiring of the systems. Determination for methodology shall be outlined when the system(s) is/are being designed and engineered. For installation purposes, the IDS shall utilize an output module for integration with other security subsystems. The Contractor will ensure all connections are per the OEM and that any and all software upgrades required to integrate the systems are installed prior to system start-up.

F. For programming purposes, the Contractor shall refer to the manufacturer's requirements and Contracting Officer instructions for correct system operations. This includes ensuring computers being utilized for system integration meet or exceeds the minimum system requirements outlined in the IDS software packages.

G. Lightening and power surges to the central alarm reporting and display unit shall be protected at both ends against excessive voltages. This requirement shall apply for circuits that are routed both in underground conduits and overhead runs.

H. At a minimum, the Contractor shall install primary detection devices, such as three electrode gas-type surge arresters, and secondary protectors to reduce dangerous voltages to levels that will cause no damage. Fuses shall not be permitted as protection devices.

I. The Contractor shall provide fail-safe gas tube type surge arresters on exposed IDS data circuits. In addition, transient protection shall protect against spikes up to 1000 volts peak voltage with a one-microsecond rise time and 100-microsecond decay time, without causing false alarms. The protective device shall be automatic and self-restoring. Also, circuits shall be designed or selected assuming a maximum of 25 ohms to ground.

J. Product Delivery, Storage and Handling:
   1. Delivery: Deliver materials to the job site in OEM's original unopened containers, clearly labeled with the OEM's name, equipment model and serial identification numbers, and UL logo. The Contracting Officer may inventory the IDS equipment at the time of delivery and reject items that do not conform to this requirement.
   2. Storage and Handling: Store and protect equipment in a manner that will preclude damage as directed by the Contracting Officer.

K. Cleaning and Adjustments:

1. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.
2. Prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or synchronization. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.

L. Tamper Switches
1. Install tamper switches to initiate an alarm signal when a panel, box, or component housing door or cover is moved as little as 6.35 mm 1/4 inch from the normally closed position unless otherwise specified.
2. Locate tamper switches within enclosures, cabinets, housings, boxes, raceways, and fittings to prevent direct line of sight to any internal components and to prevent tampering with switch or circuitry.
3. Conceal tamper switch mounting hardware so that the location of the switch within the enclosure cannot be determined from the exterior.

M. Unique IDS Installation Components:
1. BMS Surface Mounted:
   a. Surface mounted BMS housing for the switch element shall have the capability to receive threaded conduit. Housing covers for surface mounted BMS, if made of cast aluminum, shall be secured by stainless steel screws. Magnet housing cover shall not be readily removable and BMS housings shall be protected from unauthorized access by a cover operated, corrosion-resistant tamper device.
   b. Conductors running from a door to alarm circuits shall be contained within a flexible armored cord constructed from corrosion-resistant metal. Each end of the armored cord shall terminate in a junction box or other enclosure. Armored cord ends shall be mechanically secured to the junction boxes by clamps or bushings. Conductors within the armored cord shall be provided with lug terminals at each end. Conductors and the armored cord shall experience no mechanical strain as the door is removed from fully open to closed position. Switch circuits shall initiate an alarm if a short circuit is applied to the door cord.
   c. For exterior application on double gates, both BMS elements must be mounted on the gate. Flexible armored cord constructed from corrosion-resistant metal shall be used to provide electrical connection.
2. BMS Recessed Mounted:
   a. Ball bearing door trips shall be mounted within vault door headers such that when the locking mechanism is secured, the door bolt engages an actuator, mechanically closing the switch.
   b. Door bolt locking mechanisms shall be fully engaged before the ball bearing door trip is activated. Also, circuit jumpers from the door shall be provided.
3. Vibration Sensors:
   a. Mount vibration sensors directly contacting the surface to be protected.
   b. Provide at least one (1) sensor on each monolithic slab or wall section, even though spacing closer than that required for midrange sensitivity may result.
   c. House sensors in protective mountings and fasten to surface with concealed mounting screws or an epoxy.
   d. Adjust discriminator on the job to precise needs of application. Connect sensors to an electronic control unit by means of wiring or fiber optics cable run in rigid steel conduit or electrical metallic tubing (EMT).
4. Ultrasonic Sensors:
   a. Installation shall ensure that transceiver zones slightly overlap.

b. Care shall be taken to ensure adequate sensitivity in area abundant in acoustic-absorbing materials such as carpets and drapes.
c. When the protected zone is broken up by furniture or large objects, it shall not be possible to traverse the zone undetected by moving the blind zones created by the objects.

5. Passive Infrared Detectors: (PIR)
   a. The protective beam shall be focused in a straight line.
   b. Installed beam distance from transmitter to receiver shall not exceed 80% of the manufacturer's maximum recommended rating.
   c. Mirrors may be used to extend the beam or to establish a network of beams. Each mirror used shall not lower the rated maximum system range by more than 50%.
   d. Mirrors and photoelectric sources used in outdoor applications shall have self-heating capability to eliminate condensation and shall be housed in weatherproof enclosures.
6. Taunt-Wire:
   a. Housing for switch assembly shall be covered by a neoprene cap to retain the center bolt (lever arm), which functions as a lever to translate movement of the attached horizontal wire into contact closure. When the neoprene cap is firmly seated on the cup-shaped polycarbonate housing, it shall function as the fulcrum for the lever (bolt).
   b. Upper exposed end of the lever shall be threaded to accommodate clamping to the horizontal wire. The lower end of the lever, which is fashioned to serve as the movable electrical contact, shall be held suspended in a small cup-shaped contact that floats in a plastic putty material.
   c. Plastic putty used shall retain a degree of elasticity under varying temperature conditions and provide the sensor switch with a self-adjusting property. This provides the switch with a built-in compensating mechanism that ignores small, very slow changes in lever alignment (i.e. which may result from environmental changes such as extreme temperature variations and ground seepage due to weather conditions) and to react to fast changes only, as caused by manual deflection or cutting of the wires.
   d. Contractor shall provide metal slider strips having slots through which the barbed wires pass. Wires shall be prevented from leaving the slots by rivets. A slider strip shall be used to translate normal forces to the barbed wire and to the horizontal displacement of the sensor.
   e. Install one (1) slider strip pair, upper and lower, on every fence post except where sensor posts or anchor strips are installed.
   f. Separation between slider elements along the fence shall be 10 feet (3000 mm).
   g. Attach wires of sensor to existing, specially installed fence posts, called anchor posts, located equidistant on both sides of sensor posts and at ends of sensor zone run.
   h. Anchor strip shall be a strip of steel plate on which fastening plates are installed. Weld or otherwise attach the strip to anchor post and ends of tensed barbed wires wrapped around the fastening plates. Attempts to climb on fastening plates or on the attached barbed wires shall cause plates to break off, creating an alarm and making it impossible to defeat the system by climbing at the anchor post.
   i. The use of barbed wire as part of the IDS system shall be suitable for installation under a preload tension of approximately 392 N 88 pounds and be flexible enough for convenient manipulation during tensioning. Double-strand 15 1/2-gage barbed wire shall be the minimum acceptable.
7. Electromechanical Fence Sensors:
   a. The fence length shall be divided into 300 ft. (100 m) or zones.
   b. Sensors shall consist of individual electromechanical sensing units mounted every three-thousand and 10 ft. (3045 mm) on the fence fabric or posts and wired in series to a sensor zone control unit and associated power supply.

8. Electrostatic Field Sensors:
   a. Sensors shall be capable of following irregular contours and barrier bends without degrading sensitivity below the specified detection level.
   b. In no case shall a single sensor zone exceed 300 ft. (100 m) or be long enough to significantly degrade sensitivity.
   c. Adjacent zones shall provide continuous coverage to avoid a dead zone. Adjacent zones shall be designed to prevent crosstalk interference.
   d. Exterior components shall be housed in rugged corrosion-resistant enclosures, protected from environmental degradation and include tamper switches.
   e. Interfacing between exterior units shall be carried in underground cables.
   f. Exterior support hardware shall be stainless or galvanized to avoid tension degradation.
   g. Sensor and field wires shall be stainless steel. Wire spacing for various configurations shall be maintained constant throughout each zone and shall be uniform with respect to the ground and follow manufacturer's specifications.
   h. Signal processing equipment shall be separately mounted such that no desensitized zones are created within the zone of detection.
9. Microwave: Do not install microwave sensors where fluorescent lights may pose a problem due to radiated ionization from lights.

3.2 TESTS AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 23 00
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Install IP cameras, provided by the VA, that tie into the existing Milestone Video System (NVR) CCTV system on campus.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For labeling and signs, Section 10 14 00, SIGNAGE.

C. For connection of high voltage, Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

D. For power cables, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

E. For grounding of equipment, Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

F. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.

G. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

H. For perimeter lighting, Section 26 56 00, EXTERIOR LIGHTING.

I. For access control, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS (PACS).

J. For screening of personnel and shipments, Section 28 13 53, SECURITY ACCESS DETECTION.

K. For alarm systems, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).

L. For control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.

M. For emergency and interior communications, Section 28 26 00, ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS).

N. For Warranty of Construction see GENERAL CONDITIONS.

O. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for installing and the operation of the CCTV System as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, Shop Drawings, Product Data, and Samples, and Section 02 41 00, Demolition Drawings.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A system drawing for each applicable security system shall:
      a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
      b. Provide full detail of all system components wiring from point-to-point.
      c. Identify wire types utilized for connection, interconnection with associate security subsystems.
      d. Show device locations that correspond to the floor plans.
      e. All general and drawing specific notes shall be included with the system drawings.
   5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
      a. Device ID.
      b. Device Location (e.g. site, building, floor, room number, location, and description).

c. Mounting type (e.g. flush, wall, surface, etc.).
d. Power supply or circuit breaker and power panel number.
e. In addition, for the CCTV Systems, provide the camera ID, camera type (e.g. fixed or pan/tilt/zoom (P/T/Z), lens type (e.g. for fixed cameras only) and housing model number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:
1. 35 percent
2. 65 percent
3. 90 percent
4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.5 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):

330	Electrical Performance Standards for CCTV Cameras
375A	Electrical Performance Standards for CCTV Monitors

C. Institute of Electrical and Electronics Engineers (IEEE):

C62.41	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
802.3af	Power over Ethernet Standard

D. National Electrical Contractors Association (NECA):

303-2005	Installing Closed Circuit Television (CCTV) Systems

E. National Fire Protection Association (NFPA):

70-05	Article 780-National Electrical Code

F. Federal Information Processing Standard (FIPS):

140-2	Security Requirements for Cryptographic Modules

G. Underwriters Laboratories, Inc. (UL):

983-06	Standard for Surveillance Camera Units
3044-01	Standard for Surveillance Closed Circuit Television Equipment

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant CCTV System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. All equipment associated within the CCTV System shall be UL 3004 compliant and rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.

B. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 Hz or 60 Hz AC power system unless documented otherwise in subsequent sections listed within this specification. All equipment shall have a back-up source of power that will provide a minimum of 96 hours of run time in the event of a loss of primary power to the facility.

C. The system shall be designed, installed, and programmed in a manner that will allow for easy operation, programming, servicing, maintenance, testing, and upgrading of the system.

D. All CCTV System components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with NFPA 70, Chapter 5.

E. All equipment and materials for the system will be compatible to ensure correct operation.

2.2 EQUIPMENT ITEMS

A. CCTV system shall meet following requirements:

B. All Cameras will be EIA 330 and UL 983 compliant as well as:
   1. Will be charge coupled device (CCD) cameras and shall conform to National Television System Committee (NTSC) formatting.
   2. Fixed cameras shall be color and the primary choice for monitoring following the activities described below. Pan/Tilt/Zoom (P/T/Z) cameras shall be color and are to be utilized to compliment the fixed cameras.
   3. Shall be powered by either 12 volts direct current (VDC) or 24 VAC. Power supplies shall be Class 2 and UL compliant and have a back-up power source to ensure cameras are still operational in the event of loss of primary power to the CCTV System.
   4. Shall be rated for continuous operation under the following environmental conditions:
      a. Ambient temperatures of minus 10 degrees C (14 degrees F) to 55 degrees C (131 degrees F) utilizing equipment that will provide automatic heating and cooling.
      b. Humidity, wind gusts, ice loading, and seismic conditions specified or encountered for locations where CCTV cameras will be utilized.
   5. Will be home run to a monitoring and recording device via a controlling device such as a matrix switcher or network server and monitored on a 24 hour basis at a designated Access Control System and Database Management location.
   6. Each function and activity shall be addressed within the system by a unique twenty (20) character user defined name. The use of codes or mnemonics identifying the CCTV action shall not be accepted.

7. Shall come with built-in video motion detection that shall automatically monitor and process information from each camera. The camera motion detection shall detect motion within the camera's field of view and provide automatic visual, remote alarms, and motion-artifacts as a result of detected motion as follows:
   a. Motion-detection settings shall include adjustable object size and velocity, as well as a selectable detection area of 132 zones in a twelve (12) x eleven (11) grid.
   b. Sensors shall accept video signals from CCTV cameras and when synchronizing is required, it shall be in composite synchronization.
   c. Sensor processors shall detect motion by digitizing multiple pixels within each video scene and by comparing the gray scale of the pixels to a previously stored reference. The number of pixels digitized depends on the application. The designer of the system shall consider cost effectiveness as a factor since digitizing a large number of pixels could increase cost dramatically with little additional actual detection capability for a specific application.
   d. An alarm shall be initiated when the comparison varies by six (6) percent or more.
8. Appropriate signage shall be designed, provided, and posted that notifies people that an area is under camera surveillance.
9. Dummy or fake cameras will not be utilized at any time.
10. Shall be programmed to digitally flip from color to black and white at dusk and vise versa at dawn.
11. Will be fitted with auto-iris lenses to ensure the image is maintained in low light.
12. Lightning protection shall be IEEE C62.41 compliant and provided for all cameras. Either surge protectors or a lightning grid may be utilized. Ensure all lightning protection equipment is compliant with Article 780 of the National Electrical Code (NEC). The use of Fuses and Circuit Breakers as a means of lightning protection shall not be allowed.
13. If using the camera as part of a CCTV network a video encoder shall be used to convert the signal from National Television System(s) Committee (NTSC) to Moving Picture Experts Group (MPEG) format.
14. P/T/Z cameras shall be utilized in a manner that they compliment fixed cameras and shall not be used as a primary means of monitoring activity.
15. Fixed Color Cameras Technical Characteristics:

Imaging Device	1/3-inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)
Scanning System	NTSC 525 lines, 21 interlace
Synchronization System	AC line lock/internal
Horizontal Resolution	330 TV lines
Iris Control	Selectable on/off
Electronic Shutter Range	NTSC 1/60-1/100,000 second
Auto Iris Lens Type	DC/video drive (auto sensing)
Minimum Illumination	0.6 lux
Signal to Noise Ratio	>50 dB
Automatic Gain Control	On/off switchable
Backlight Compensation	On/off switchable
Auto White Balance	On/off switchable
Video Output	1 Vp-p, 75 ohms
Power Consumption	Less than 5 watts
Video Connector	BNC
Lens Mount	C/CS mount (adjustable)

   a. Cameras shall be Pelco IP 110 series cameras or equal.

16. Power over Ethernet (PoE) Cameras
    a. Shall be IEEE 802.3af compliant only be utilized as part of a CCTV Network and should not be integrated with standard analog or digital CCTV System equipment.
    b. Shall be utilized for interior and exterior purposes.
    c. A Category (CAT)-V cable will be the primary source for carrying signals up to 300 ft. (100 m) from a switch hub or network server. If any camera is installed greater than 300 ft. (100 m) from the controlling device then the following will be required:
        1) A local or remote 12 VDC or 24 VAC power source will be required from a Class 2, UL compliant power supply.
        2) A signal converter will be required to convert from a CAT-V cable over to a fiber optic or standard signal cable. The signal will need to be converted back to a CAT-V cable at the controlling device using a signal converter card.
    d. Shall:
        1) Be routed to a controlling device via a network switcher or direct connection to a network server.
        2) Be of hybrid design with both an Internet Protocol (IP) output and a monitor video output which produces a picture equivalent to an analog camera, and allows simultaneous output of both.
        3) Provide at a minimum 200,000 effective pixels with built-in complementary color filter for accurate color with no image lag or distortion.
        4) Be a programmable IP address that allows for installation of multiple units in the same Local Area Network (LAN) environment.
        5) Incorporate a minimum of Transmission Control Protocol (TCP)/IP, User Datagram Protocol (UDP), Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Internet Control Message Protocol (ICMP0, Address Resolution Protocol (ARP), Real-Time Transport Protocol (RTP), Dynamic Host Configuration Protocol (DHCP), Network Time Protocol (NTP), Simple Mail Transfer Protocol (SMTP), Internet Group Management Protocol (IGMP), and Differentiated Service Code Point (DSCP) protocols for various network applications.
    e. Technical Characteristics:

Video Standards	MPEG-4; M-JPEG
Video Data Rate	9.6 Kbps - 6 Mbps Constant & variable
Image Resolution	768x494 (NTSC)
Video Resolution	704 x 576/480 (4CIF: 25/30 IPS) 704 x 288/240 (2CIF: 25/30 IPS) 352 x 288/240 (CIF: 25/30 IPS) 176 x 144/120 (QCIF: 25/30 IPS)
Select Frame Rate	1-25/30 IPS (PAL/NTSC);Field/frame based coding
Network Protocols	RTP, Telnet, UDP, TCP, IP, HTTP, IGMP, ICMP
Software Update	Flash ROM, remote programmable
Configuration	Via web browser, built-in web server interfaces
Video Out	1x Analog composite: NTSC or PAL; BNC connector 75 Ohm
Sensitivity	1 0.65 lux (color) 0.26 lux (NightSense)
Minimum Illumination	0.30 lux (color)0.12 lux(NightSense)
Video Signal-to-Noise Ratio	50 dB

Video Signal Gain	21 dB, (max) Electronic Shutter Automatic, up to 1/150000 sec. (NTSC)
Alarm In	Automatic sensing (2500 - 9000 K)
Input Voltage	+5 V nominal, +40 VDC max VDC: 11-36 V (700 mA) VAC: 12-28 V (700 mA) PoE: IEEE 802.3af compilant

C. Lenses: Shall be utilized in a manner that provides maximum coverage of the area being monitored by the camera. The lenses shall:
   1. Be 1/3” to fit CCD fixed camera.
   2. Be all glass with coated optics.
   3. Have mounts that are compatible with the camera selected.
   4. Be packaged and supplied with the camera.
   5. Have a maximum f-stop of f/1.3 for fixed lenses, and a maximum f-stop of f/1.6 for variable focus lenses.
   6. Be equipped with an auto-iris mechanism.
   7. Have sufficient circle of illumination to cover the image sensor evenly.
   8. Not be used on a camera with an image format larger than the lens is designed to cover.
   9. Be provided with pre-set capability.

D. Two types of lenses shall be utilized for both interior and exterior fixed cameras:
   1. Manual Variable Focus
   2. Auto Iris Fixed

E. Manual Variable Focus:
   1. Shall be utilized in large areas that are being monitored by the camera. Examples of this are perimeter fence lines, vehicle entry points, parking areas, etc.
   2. Shall allow for setting virtually any angle of field, which maximizes surveillance effects.
   3. Technical Characteristics:

Image format	1/3 inch
Focal length	5–50mm
Iris range	F1.4 to close
Focus range	1m (3.3 ft)
Back focus distance	10.05 mm (0.4 in)
Angle view Wide (1/3 in)	53.4 x 40.1
Angle view Tele (1/3 in)	5.3 x 4.1
Iris control	manual
Focus ctrl	manual
Zoom ctrl	manual

F. Auto Iris Fixed
   1. Shall be utilized in areas where a small specific point of reference is to be monitored. Examples of this are doorways, elevators, cashier booths, etc.
   2. To determine the exact size of the fixed lens required, complete a focal length calculation using either a focal length calculator or a focal length chart provided by the product manufacturer.
   3. Technical Characteristics:

Image format	1/3 inch	1/3 inch	1/3 inch
Focal length	2.8 mm	4 mm	8 mm

Iris range	F1.2 – 200	F1.2 – 200	F1.2 - 200
Min. Object	0.3 m (1 ft)	0.3 m (1 ft)	0.3 m (1 ft)
Lens mount	CS-mount	CS-mount	CS-mount
Angle of view	94 X 72	64 X 49	33 x 25
Focus control	Manual	Manual	manual

G. Camera Housings and Mounts:
1. This section pertains to all interior and exterior housings, domes, and applicable wall, ceiling, corner, pole, and rooftop mounts associated with the housing. Housings and mounts shall be specified in accordance to the type of cameras used.
2. All cameras and lenses shall be enclosed in a tamper resistant housing. Any additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
3. The camera and lens contained inside the housing shall be installed on a camera mount. All additional mounting hardware required to install the camera housing at its specified location shall be provided along with the housing.
4. Shall be manufactured in a manner that are capable of supporting a maximum of three (3) cameras with housings, and meet environmental requirements for the geographical area the camera support equipment is being installed on or within.
5. Environmentally Sealed
   a. Shall:
      1) Be designed in manner that it provides a condensation free environment for correct camera operation.
      2) Operate in a 100 percent condensing humidity atmosphere.
      3) Be constructed in a manner that:
         a) Has a fill valve to allow for the introduction of nitrogen into the housing to eliminate existing atmospheric air and pressurize the housing to create moisture free conditions.
         b) Has an overpressure valve to prevent damage to the housing in the event of over pressurization.
         c) Is equipped with a humidity indicator that is visible to the eye to ensure correct atmospheric conditions at all times.
         d) The leak rate of the housing is not to be greater than 13.8kPa or 2 pounds per square inch at sea level within a 90 day period.
         e) It shall contain camera mounts or supports as needed to allow for correct positioning of the camera and lens.
         f) The housing and sunshield are to be white in color.
   b. All electrical and signal cables required for correct operations shall be supplied in a hardened carrier system from the controller to the camera.
   c. The mounting bracket shall be adjustable to allow for the housing weight of the camera and the housing unit it is placed in.
   d. Accessibility to the camera and mounts shall be taken into consideration for maintenance and service purposes.
6. Indoor Mounts
   a. Ceiling Mounts:
      1) This enclosure and mount shall be installed in a finished or suspended ceiling.
      2) The enclosure and mount shall be fastened to the finished ceiling, and shall not depend on the ceiling tile grid for complete support.
      3) Suspended ceiling mounts shall be low profile, and shall be suitable for replacement of 2 foot by 2 foot (610mm x 610mm) ceiling tiles.
   b. Wall Mounts:

1) The enclosure shall be installed in manner that it matches the existing décor and placed at a height that it will be unobtrusive, unable to cause personal harm, and prevents tampering and vandalism.
2) The mount shall contain a manual pan/tilt head that will provide 360 degrees of horizontal and vertical positioning from a horizontal position, and has a locking bar or screw to maintain its fixed position once it has been adjusted.

7. Interior Domes
   a. The interior dome shall be a pendant mount, pole mount, ceiling mount, surface mount, or corner mounted equipment.
   b. The lower portion of the dome that provides camera viewing shall be made of black opaque acrylic and shall have a light attenuation factor of no more that 1 f-stop.
   c. The housing shall be equipped with integral pan/tilt capabilities complete with wiring, wiring harness, connectors, receiver/driver, pan/tilt control system, pre-position cards, or any other hardware and equipment as needed to fully provide a fully functional pan/tilt dome.
   d. The pan/tilt mechanism shall be:
      1) Constructed of heavy duty bearings and hardened steel gears.
      2) Permanently lubricated to ensure smooth and consistent movement of all parts throughout the life of the product.
      3) Equipped with motors that are thermally or impedance protected against overload damage.
   e. Pan movements shall be 360 degrees and tilt movement shall no be less than +/- 90 degrees.
   f. Pan speed shall be a minimum of 10 degrees per second.
8. Exterior Domes
   a. The exterior dome shall meet all requirements outlined in the interior dome paragraph above.
   b. The housing shall be constructed to be dust and water tight, and fully operational in 100 percent condensing humidity.
9. Exterior Wall Mounts
   a. Shall have an adjustable head for mounting the camera.
   b. Shall be constructed of aluminum, stainless steel, or steel with a corrosion-resistant finish.
   c. The head shall be adjustable for not less than plus and minus 90 degrees of pan, and not less than plus and minus 45 degrees of tilt. If the bracket is to be used in conjunction with a pan/tilt, the bracket shall be supplied without the adjustable mounting head, and shall have a bolt-hole pattern to match the pan/tilt base.
   d. Shall be installed at a height that allows for maximum coverage of the area being monitored.
10. Explosion Proof Housing
    a. This housing shall meet or exceed all requirements of NEMA four (4) standards for hazardous locations.
    b. It shall be supplied with the mounting brackets for the specified camera and lens.

H. Controlling Equipment
   1. Shall be utilized to call up, operate, and program all cameras associated CCTV System components.
   2. Will have the ability to operate the cameras locally and remotely. A matrix switcher or a network server shall be utilized as the CCTV System controller.
   3. The controller shall be able to fit into a standard 19” (47.5 cm) equipment rack.

4. Control and programming keyboards shall be provided with its own type of switcher. All keyboards shall:
   a. Be located at each monitoring station.
   b. Be addressable for programming purposes.
   c. Provide interface between the operator and the CCTV System.
   d. Provide full control and programming of the switcher.
   e. Have the minimum following controls:
      1) programming
      2) switching
      3) lens function
      4) P/T/Z
      5) environmental housing
      6) annotation
5. Matrix Switcher: The matrix switcher shall meet the following minimum requirements:
   a. Take multiple camera inputs and route them to multiple monitoring stations.
   b. Allow for centralized user management controlling configurations.
   c. Provide live viewing of all cameras.
   d. Provide P/T/Z, focus, and iris control of all unitized cameras.
   e. Be expandable to allow for the addition of multiple cameras and monitoring stations over the life of the system visual identification system by utilizing input and output video and controller cards.
   f. Input cards shall allow for the addition of a minimum of four (4) camera inputs per card.
   g. Output cards shall allow for the addition of a minimum of eight (8) outputs per card.
   h. Have the ability to be programmed either locally or remotely.
   i. Remotely operate multiple cameras from multiple stations.
   j. Be able to fully interface with a digital video recorder (DVR) for recording of all events.
   k. Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
   l. Shall have an alarm interface that is compatible with all associated security subsystems. Alarm inputs shall be via either a relay or an EIA ANSI/EIA/TIA-232-F interface. The interface shall allow for a minimum of 24 alarm inputs and 12 alarm outputs.
   m. The switcher response time to an alarm input shall not be less than 200 milliseconds from the time an alarm is sensed until a picture is displayed on a monitor.
   n. The switcher shall have a built in buffer to allow for back-log of alarms. These alarms shall be viewable by an operator.
   o. Be addressable in the event multiple matrix switchers are connected to the SMS.
   p. Be configured, i.e. camera names, monitor names, sequences, alarms and alarm actions, etc. utilizing the configuration program and tools provided by the matrix manufacturer.
   q. The matrix switcher shall meet the following minimum input/output requirements:

Camera inputs	16
Video outputs	4
Keyboard/Controller Outputs	4
Alarm inputs	323

   r. The matrix switcher will have the following components and technical characteristics:
      1) Main Unit:

Functions	Monitor control Camera selection, tour sequence, group sequence, group preset, OSD display, Camera/Receiver control via coaxial or RS-485 cable communication, Recorder control

Alarm control	Alarm event, Alarm Acknowledge, Alarm reset, Alarm suspension, Alarm History Display, Timer event, and Camera event
RS-485 (Camera)Port	6-conductor modular jack x 12 (2- wire or 4-wire communication, With termination switches (MODE 1 to 4))
Extension Port	6-conductor modular jack x 2(With a (EXTENSION 1 IN, OUT) termination switch (TERM: ON, OFF))
Extension Port	37-pin D-sub connector x 2(EXTENSION IN 2 or 3)
Extension Port	37-pin D-sub connector x 2(EXTENSION OUT 2 or 3)

2) Input Board:

Camera Input	1 V [P-P]/75 Ohm (BNC), composite video signal 0.5 V [P-P]/75 Ohm data signal and 2.5 V [P-P]/75 Ohm (25 pin D sub connector x 4)
Alarm Input	N.O. (Normally Open contact) or N.C. (Normally Close contact) selectable x 32 (37 pin D sub connector)

3) Output Board:

Monitor Output	1 V [P-P]/75 Ohm (BNC)
Alarm Output	Open collector output x 32, Max. 24 VDC, 100 mA
Extension Port	6-conductor modular jack x 2
Serial Port	9-pin D-sub connector x 2

6. Network Server
   a. Allow for the transmission of live video, data, and audio over either an existing Ethernet network or a dedicated security system network, requiring an IP address or Internet Explorer 5.5 or higher, or shall work as an analog-to-Ethernet “bridge” controlling matrices, multiplexers, and pan/tilt/zoom cameras. The network shall operate in a box-to-box configuration allowing for encoded video to be decoded and displayed on an analog monitor.
   b. If a CCTV System network is going to be utilized as the primary means of monitoring, operating, and recording cameras then the following equipment shall be required as part of the system:
      1) System Server
      2) Computer Workstation
      3) Recording Device
      4) Encoder/Decoder
      5) Monitor
      6) Hub/Switch
      7) Router
      8) Encryptor
   c. Shall provide overall control, programming, monitoring, and recording of all cameras and associated devices within the CCTV System.
   d. All equipment on the network shall be IP addressable.
   e. The CCTV System network shall meet or exceed the following design and performance specifications:
      1) Two MPEG-4 video streams for a total of 40 images per second will be provided.
      2) PC Software that manages the installation and maintenance of all hardware transmitters and receivers on the network shall be provided.

3) Video Source that supports any NTSC video source to the computer network shall be addressed.
4) Receivers that could be used to display the video on a standard analog NTSC or PAL monitor will be addressed.
5) Shall be Johnson Controls or approved equal with Bacnet complaint protocol to intergrate with existing system on campus.

f. The system shall support the following network protocols:
1) Internet connections: RTP, Real Time Control Protocol (RTCP), UDP, IP, TCP, ICMP, HTTP, Simple Network Management Protocol (SNMP), IGMP, DHCP, and ARP.
2) Video Display: MPEG-4, M-JPEG in server push mode only.
3) Have the ability to adjust bandwidth, image quality and image rate.
4) Support image sizes of either 704 x 576 pixels or 352 x 288 pixels.
5) Have an audio coding format of G.711 or G.728.
6) Provide a video frame rate of at least 30 images per second.
7) Support LAN Interface Ethernet 10/100BaseT and be auto sensing.
8) Have a LAN Data Rate of 9.6 Kbps to 5.0 Mbps.
9) Utilize data interface RS-232/RS-422/RS-485.

g. All connections within the system shall be via CAT-V cable and RJ-45 jacks. If analog equipment is used as part of the system, then either an encoder or a decoder will be utilized to convert the analog signal to a digital one.

h. The CCTV network system shall conform to all VA agency wide security standards for administrator and operator use.

i. Server Technical Characteristics:

Hardware	Personal Computer
CPU	Pentium IV, 3.0 GHz or better
Hard Disk Interface	IDE or better
RAM	256 MB
OS	Windows XP Home/XP Professional
Graphic Card	NVIDIA GeForce 6600 NVIDIA Quadro FX 1400 ATI RADEON X600/X800 or better
Ethernet Card	100 Mb
Software	DirectX 9.0c
Free Memory	120 MB

j. Network Switch Technical Characteristics

Protocol and standard	IEEE802.3 IEEE802.3u IEEE802.3ab
Ports	24 10/100/1000M auto-negotiation RJ-45 ports with auto MDI/MDI-X
Network media	Cat 5 UTP for 1,000Mbps Cat 3 UTP for 10Mbps
Transmission method	store-and-forward
LED	indicator power, act/link, speed

k. Router Technical Characteristics

Network Standards	IEEE 802.3, 802.3u 10Base-T Ethernet (WAN) 100Base-T Ethernet (LAN) IEEE 802.3x Flow Control IEEE802.1p Priority Queue ANS/IEEE 802.3 NWay auto-negotiation

Protocol	CSMA/CD, TCP, IP, UDP, PPPoE, AND DHCP (client and server)
VPN Supported	PPTP, IPSec pass-through
Management	Browser
Ports	4 x 10/100Base-T Auto sensing RJ45 ports, and an auto uplink RJ45port(s) 1 x 10Base-T RJ45 port, WAN
LEDs	Power, WAN Activity, LAN Link (10/100), LAN Activity

l. Encryptor Technical Characteristics:

Cryptography	Standard - Triple DES 168-bit (ANSI 9.52) Rijndael - AES (128, 192, 256)
Performance	Throughput (end-to-end) @ 100 Mbps line speed: >188 Mbps full duplex (large frames) >200 kfps full duplex (small frames) Latency (end-to-end) @ 100 Mbps
Key Management	Automatic KEK/DEK Exchange Using Signed Diffie-Hellman Unit Authentication Using X.509 Certificates
Physical Interfaces	10BaseT or 10/100BaseT Ethernet (Host and Network Ports) 10BaseT Ethernet Management Port Back and Front-Panel Serial Control Port
Device Management	THALES Element Manager, Front Panel Viewer, and Certificate Manager 10Base T (RJ-45) or 9-pin Serial Control Port SNMP Network Monitoring
Security Features	Tamper Proof Cryptographic Envelope Tamper Evident Chassis Hardware Random Number Generator
Management	Channel Encrypted Using Same Algorithm as Data Traffic
Security Certifications	FIPS 140-2 Level 3 CAPS Baseline and Enhanced Grades Common Criteria EAL4 and EAL5 (under evaluation)
Regulatory	EN60950, FCC, UL, CE, EN 50082-1, and EN 55022

I. Recording Devices
1. All cameras on the CCTV System shall be recorded in real time using a Digital Video Recorder (DVR), Network Video Recorder (NVR), or a Time Lapse Video Recorder (VCR). The type of recording device utilized should be determined by the size and type of CCTV System designed and installed, and to what extent the system is to be utilized.
2. All recording devices shall be 19“(47.5 cm) rack-mountable.
3. All DVR’s and NVR’s that are viewable over an Intranet or Internet will be routed through an encryptor. Encryptors shall:
   a. Comply with FIPS PUB 140-2.
   b. Support TCP/IP.
   c. Directly interfaces to low-cost commercial routers.
   d. Provide packet-based crypto synchronization.
   e. Encrypt source and destination IP addresses.
   f. Support web browser based management requiring no additional software.
   g. Have a high data sustained throughput — 1.544 Mbps (T1) full duplex data rate.
   h. Provide for both bridging and routing network architecture support.
   i. Support Electronic Key Management System (EKMS) compatible.
   j. Have remote management ability.
   k. Automatically reconfigure when secure network or wide area network changes.

J. The CCTV cameras shall tie into the existing NVR serving the campus. Provide for expansion of the existing NVR as required for the addition of these cameras.

K. Wires and Cables
   1. Shall meet or exceed the manufactures recommendation for power and signal.
   2. Will be carried in an enclosed conduit system, utilizing electromagnetic tubing (EMT) to include the equivalent in flexible metal, rigid galvanized steel (RGS) to include the equivalent of liquid tight, polyvinylchloride (PVC) schedule 40 or 80.
   3. All conduits will be sized and installed per the NEC. All security system signal and power cables that traverse or originate in a high security office space will contained in either EMT or RGS conduit.
   4. All conduit, pull boxes, and junction boxes shall be clearly marked with colored permanent tape or paint that will allow it to be distinguished from all other conduit and infrastructure.
   5. Conduit fills shall not exceed 50 percent unless otherwise documented.
   6. A pull string shall be pulled along and provided with signal and power cables to assist in future installations.
   7. At all locations where there is a wall penetration or core drilling is conducted to allow for conduit to be installed, fire stopping materials shall be applied to that area
   8. High voltage and signal cables shall not share the same conduit and shall be kept separate up to the point of connection. High voltage for the security system shall be defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
   9. For all equipment that is carrying digital data between the Access Control System and Database Management or at a remote monitoring station, shall not be less that 20 AWG and stranded copper wire for each conductor. The cable or each individual conductor within the cable shall have a shield that provides 100% coverage. Cables with a single overall shield shall have a tinned copper shield drain wire.
   10. All cables and conductors, except fiber optic cables, that act as a control, communication, or signal lines shall include surge protection. Surge protection shall be furnished at the equipment end and additional triple electrode gas surge protectors rated for the application on each wire line circuit shall be installed within three (3) ft. (one (1) m.) of the building cable entrance. The inputs and outputs shall be tested in both normal and common mode using the following wave forms:
      a. A 10 microsecond rise time by 1000 microsecond pulse width waveform with a peak voltage of 1500 watts and peak current of 60 amperes.
      b. An 8 microsecond rise time by 20 microsecond pulse width wave form with a peak voltage of 1000 volts and peak current of 500 amperes.
   11. The surge suppression device shall not attenuate or reduce the video or sync signal under normal conditions. Fuses and relays shall not be used as a means of surge protection.
   12. Coaxial Cables
      a. All video signal cables for the CCTV System, with exception to the PoE cameras, shall be a coaxial cable and have a characteristic impedance of 75 ohms plus or minus 3 ohms.
      b. For runs up to 750 feet use of an RG-59/U is required. The RG-59/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
      c. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.

d. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U shall be shielded which provides a minimum of 95 percent coverage, with a stranded copper center conductor of a minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.

e. All runs greater than 2750 feet will be substituted with a fiber optic cable. If using fiber optics as a signal carrier then the following equipment will be utilized:
   1) Multimode fiber optic cable a minimum size of 62 microns
   2) Video transmitter, installed at the camera that utilizes 12 VDC or 24 VAC for power.
   3) Video receiver, installed at the switcher.

f. RG-59/U Technical Characteristics

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.145 in.
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	.242 in.
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.094 μH/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft
Nom. Conductor DC Resistance @ 20°C	12.2 Ohms/1000 ft
Nom. Outer Shield DC Resistance @ 20°C	2.4 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

g. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27
Conductor Diameter	.040 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.180 in.
Outer Shield Material	Trade Name Duofoil
Outer Shield Type	Tape/Braid
Outer Shield %Coverage	100 %
Outer Jacket Material	PVC
Overall Nominal Diameter	.274 in.
Nom. Characteristic Impedance	75 Ohms

Nom. Inductance	0.106 µH/ft
Nom. Capacitance	Conductor to Shield 16.2 pF/ft
Nom. Velocity of Propagation	82 %
Nom. Delay	1.24 ns/ft
Nom. Conductor DC Resistance	6.4 Ohms/1000 ft
Nominal Outer Shield DC Resistance @ 20°C	2.8 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

h. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27
Conductor Diameter	.064 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	.312 in.
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 %
Inner Jacket Material	PE – Polyethylene
Inner Jacket Diameter	.391 in.
Outer Shield Type	Braid
Outer Shield Material	BC - Bare Copper
Outer Shield %Coverage	95 %
Outer Jacket Material	Trade Name Belflex
Outer Jacket Material	PVC Blend
Overall Nominal Diameter	.520 in.
Operating Temperature Range	-35°C To +75°C
Non-UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.097 µH/ft
Nom. Capacitance	Conductor to Shield 17.3 pF/ft
Nom. Velocity of Propagation	78 %
Nom. Delay	1.30 ns/ft
Nom. Conductor DC Resistance	3.1 Ohms/1000 ft
Nom. Inner Shield DC Resistance	1.8 Ohms/1000 ft
Nom. Outer Shield DC Resistance	1.4 Ohms/1000 ft
Max. Operating Voltage Non-UL	300 V RMS

13. Signal Cables:
    a. Signal wiring for PoE cameras depends on the distance the camera is being installed from either a hub or the server.
    b. If the camera is up to 300 ft from a hub or the server, then use a shielded UTP category 5 (CAT-V) cable a with standard RJ-45 connector at each end. The cable with comply with the Power over Ethernet, IEEE802.3af, Standard.
    c. If the camera is over 300 ft from a hub or server then utilize a multimode fiber optic cable with a minimum size of 62 microns.
    d. Provide a separate cable for power.
    e. CAT-5 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8
AWG	24
Stranding	Solid
Conductor Material	BC - Bare Copper
Insulation Material	PO – Polyolefin
Overall Nominal Diameter	.230 in.
IEC Specification	11801 Category 5
TIA/EIA Specification	568-B.2 Category 5e
Max. Capacitance Unbalance	(pF/100 m) 150 pF/100 m
Nom. Velocity of Propagation	70 %
Max. Delay	(ns/100 m) 538 @ 100MHz
Max. Delay Skew	(ns/100m) 45 ns/100 m
Max. Conductor DC Resistance	9.38 Ohms/100
Max. DCR Unbalance@ 20°C	3 %
Max. Operating Voltage	UL 300 V RMS

f. Fiber Optic Cables Technical Characteristics:

Fiber Type	62.5 Micron
Number of Fibers	4
Core Diameter 6	2.5 +/- 2.5 microns
Core Non-Circularity	5% Maximum
Clad Diameter	125 +/- 2 microns
Clad Non-Circularity	1% Maximum
Core-clad Offset	1.5 Microns Maximum
Primary Coating Material	Acrylate
Primary Coating Diameter	245 +/- 10 microns
Secondary Coating Material	Engineering Thermoplastic
Secondary Coating Diameter	900 +/- 50 microns
Strength Member Material	Aramid Yarn
Outer Jacket Material	PVC
Outer Jacket Color	Orange
Overall Diameter	.200 in.
Numerical Aperture	.275
Maximum Gigabit Ethernet	300 meters
Maximum Gigabit Ethernet	550 meters

14. Power Cables
    a. Will be sized accordingly and shall comply with the NEC. High voltage power cables will be a minimum of three conductors, 14 AWG, stranded, and coated with a non-conductive polyvinylchloride (PVC) jacket. Low voltage cables will be a minimum of 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
    b. Will be utilized for all components of the CCTV System that require either a 110 VAC 60 Hz or 220 VAC 50 Hz input. Each feed will be connected to a dedicated circuit breaker at a power panel that is primarily for the security system.
    c. All equipment connected to AC power shall be protected from surges. Equipment protection shall withstand surge test waveforms described in IEEE C62.41. Fuses shall not be used as a means of surge protection.

d. Shall be rated for either 110 or 220 VAC, 50 or 60 Hz, and shall comply with VA Master Spec 26 05 21 Low Voltage Electrical Power Conductors and Cables (600 Volts and Below).

e. Low Voltage Power Cables

1) Shall be a minimum of 18 AWG, Stranded and have a polyvinylchloride outer jacket.

2) Cable size shall determined using a basic voltage over distance calculation and shall comply with the NEC's requirements for low voltage cables.

2.3 INSTALLATION KIT

A. General:

1. The kit shall be provided that, at a minimum, includes all 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, and/or cable tray, etc., required to accomplish a neat and secure installation. All wires shall terminate in a spade lug and barrier strip, wire wrap terminal or punch block. Unfinished or unlabeled wire connections shall not be allowed. All unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware shall be turned over to the Contracting Officer. The following sections outline the minimum required installation sub-kits to be used:
2. System Grounding:
   a. The grounding kit shall include all cable and installation hardware required. All head end equipment and power supplies shall be connected to earth ground via internal building wiring, according to the NEC.
   b. This includes, but is not limited to:
      1) Coaxial Cable Shields
      2) Control Cable Shields
      3) Data Cable Shields
      4) Equipment Racks
      5) Equipment Cabinets
      6) Conduits
      7) Cable Duct blocks
      8) Cable Trays
      9) Power Panels
      10) Grounding
      11) Connector Panels
3. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.
4. Wire and Cable: The wire and cable kit shall include all connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.
5. Conduit, Cable Duct, and Cable Tray: The kit shall include all 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, and/or cable tray installation in accordance with the NEC and this document.
6. Equipment Interface: The equipment kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface the systems with the identified sub-system(s) according to the OEM requirements and this document.

7. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to correctly label each subsystem according to the OEM requirements, as-installed drawings, and this document.
8. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be in accordance with NECA 303, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

B. Components shall be configured with appropriate “service points” to pinpoint system trouble in less than 30 minutes.

C. The Contractor shall install all system components including Government furnished equipment, and appurtenances in accordance with the manufacturer's instructions, documentation listed in Sections 1.4 and 1.5 of this document, and shall furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.

D. The CCTV System will be designed, engineered, installed, and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the system is a stand alone or a complete network.

E. For integration purposes, the CCTV System shall be integrated where appropriate with the following associated security subsystems:
   1. PACS:
      a. Provide 24 hour coverage of all entry points to the perimeter and agency buildings. As well as all emergency exits utilizing a fixed color camera.
      b. Record cameras on a 24 hours basis.
      c. Be programmed go into an alarm state when an emergency exit is opened, and notify the Access Control System and Database Management of an alarm event.
      d. For additional CCTV System requirements as they relate to the PACS, refer to Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEMS.
   2. IDS:
      a. Provide a recorded alarm event via a color camera that is connected to the IDS system by either direct hardwire or a security system computer network.
      b. Record cameras on a 24 hours basis.
      c. Be programmed to go into an alarm state when an IDS device is put into an alarm state, and notify the.
      d. For additional CCTV System requirements as they relate to the IDS, refer to Master Specification 28 16 11.
   3. Security Access Detection:
      a. Provide full coverage of all vehicle and lobby entrance screening areas utilizing a fixed color camera.
      b. Record cameras on a 24 hours basis.
      c. The CCTV System should have facial recognition software to assist in identifying individuals for current and future purposes.

d. For additional CCTV System requirements as they relate to the Security Access Detection, refer to Master Specification 28 13 53.

4. EPPS:
   a. Provide a recorded alarm event via a color camera that is connected to the EPPS system by either direct hardwire or a security system computer network.
   b. Record cameras on a 24 hours basis.
   c. Be programmed to go into an alarm state when an emergency call box or duress alarm/panic device is activated, and notify the Access Control System and Database Management of an alarm event.
   d. For additional CCTV System requirements as they relate to the EPPS, refer to Master Specification 28 26 00.

F. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.

G. For programming purposes refer to the manufacturers requirements for correct system operations. Ensure computers being utilized for system integration meet or exceed the minimum system requirements outlined on the systems software packages.

H. A complete CCTV System shall be comprised of, but not limited to, the following components:
   1. Cameras
   2. Lenses
   3. Video Display Equipment
   4. Camera Housings and Mounts
   5. Controlling Equipment
   6. Recording Devices
   7. Wiring and Cables

I. I. The Contractor shall visit the site and verify that site conditions are in agreement/compliance with the design package. The Contractor shall report all changes to the site or conditions that will affect performance of the system to the Contracting Officer in the form of a report. The Contractor shall not take any corrective action without written permission received from the Contracting Officer.

J. J. Existing Equipment
   1. 1. The Contractor shall connect to and utilize existing video equipment, video and control signal transmission lines, and devices as outlined in the design package. Video equipment and signal lines that are usable in their original configuration without modification may be reused with Contracting Officer approval.
   2. 2. The Contractor shall perform a field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into the CCTV System, and furnish a report to the Contracting Officer as part of the site survey report. For those items considered nonfunctioning, provide (with the report) specification sheets, or written functional requirements to support the findings and the estimated cost to correct the deficiency. As part of the report, the Contractor shall include a schedule for connection to all existing equipment.
   3. 3. The Contractor shall make written requests and obtain approval prior to disconnecting any signal lines and equipment, and creating equipment downtime. Such work shall proceed only after receiving Contracting Officer approval of these requests. If any device fails after the Contractor has commenced work on that device, signal or control line, the Contractor shall diagnose the failure and perform any necessary corrections to the equipment.
   4. The Contractor shall be held responsible for repair costs due to Contractor negligence, abuse, or incorrect installation of equipment.

5. The Contracting Officer shall be provided a full list of all equipment that is to be removed or replaced by the Contractor, to include description and serial/manufacturer numbers where possible. The Contractor shall dispose of all equipment that has been removed or replaced based upon approval of the Contracting Officer after reviewing the equipment removal list. In all areas where equipment is removed or replaced the Contractor shall repair those areas to match the current existing conditions.

K. Enclosure Penetrations: All enclosure penetrations shall be from the bottom of the enclosure unless the system design requires penetrations from other directions. Penetrations of interior enclosures involving transitions of conduit from interior to exterior, and all penetrations on exterior enclosures shall be sealed with rubber silicone sealant to preclude the entry of water and will comply with VA Master Specification 07 84 00, Firestopping. The conduit riser shall terminate in a hot-dipped galvanized metal cable terminator. The terminator shall be filled with an approved sealant as recommended by the cable manufacturer and in such a manner that the cable is not damaged.

L. Cold Galvanizing: All field welds and brazing on factory galvanized boxes, enclosures, and conduits shall be coated with a cold galvanized paint containing at least 95 percent zinc by weight.

M. Interconnection of Console Video Equipment: The Contractor shall connect signal paths between video equipment as specified by the OEM. Cables shall be as short as practicable for each signal path without causing strain at the connectors. Rack mounted equipment on slide mounts shall have cables of sufficient length to allow full extension of the slide rails from the rack.

N. Cameras:
1. Install the cameras with the focal length lens as indicated for each zone.
2. Connect power and signal lines to the camera.
3. Set cameras with fixed iris lenses to the f-stop to give full video level.
4. Aim camera to give field of view as needed to cover the alarm zone.
5. Aim fixed mounted cameras installed outdoors facing the rising or setting sun sufficiently below the horizon to preclude the camera looking directly at the sun.
6. Focus the lens to give a sharp picture (to include checking for day and night focus and image quality) over the entire field of view; and synchronize all cameras so the picture does not roll on the monitor when cameras are selected. Dome cameras shall have all preset positions defined and installed.

O. Monitors:
1. Install the monitors as shown and specified in design and construction documents.
2. Connect all signal inputs and outputs as shown and specified.
3. Terminate video input signals as required.
4. Connect the monitor to AC power.

P. Switcher:
1. Install the switcher as shown in the design and construction documents, and according to the OEM.
2. Connect all subassemblies as specified by the manufacturer and as shown.
3. Connect video signal inputs and outputs as shown and specified; terminate video inputs as required.
4. Connect alarm signal inputs and outputs as shown and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by the manufacturer and as shown.
5. Connect the switcher CPU and switcher subassemblies to AC power.

6. Load all software as specified and required for an operational CCTV System configured for the site and building requirements, including data bases, operational parameters, and system, command, and application programs.
7. Provide the original and 2 backup copies for all accepted software upon successful completion of the endurance test.
8. Program the video annotation for each camera.

Q. Video Recording Equipment:
1. Install the video recording equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video signal inputs and outputs as shown and specified.
3. Connect alarm signal inputs and outputs as shown and specified.
4. Connect video recording equipment to AC power.

R. Video Signal Equipment:
1. Install the video signal equipment as shown in the design and construction documents, and as specified by the OEM.
2. Connect video or signal inputs and outputs as shown and specified.
3. Terminate video inputs as required.
4. Connect alarm signal inputs and outputs as required.
5. Connect control signal inputs and outputs as required
6. Connect electrically powered equipment to AC power.

S. Camera Housings, Mounts, and Poles:
1. Install the camera housings and mounts as specified by the manufacturer and as shown, provide mounting hardware sized appropriately to secure each camera, housing and mount with maximum wind and ice loading encountered at the site.
2. Provide a foundation for each camera pole as specified and shown.
3. Provide a ground rod for each camera pole and connect the camera pole to the ground rod as specified in Division 26 of the VA Master Specification and the VA Electrical Manual 730.
4. Provide electrical and signal transmission cabling to the mount location via a hardened carrier system from the Access Control System and Database Management to the device.
5. Connect signal lines and AC power to the housing interfaces.
6. Connect pole wiring harness to camera.

T. System Start-Up
1. The Contractor shall not apply power to the CCTV System until the following items have been completed:
   a. CCTV System equipment items and have been set up in accordance with manufacturer's instructions.
   b. A visual inspection of the CCTV System has been conducted to ensure that defective equipment items have not been installed and that there are no loose connections.
   c. System wiring has been tested and verified as correctly connected as indicated.
   d. All system grounding and transient protection systems have been verified as installed and connected as indicated.
   e. Power supplies to be connected to the CCTV System have been verified as the correct voltage, phasing, and frequency as indicated.
2. Satisfaction of the above requirements shall not relieve the Contractor of responsibility for incorrect installation, defective equipment items, or collateral damage as a result of Contractor work efforts.

U. Supplemental Contractor Quality Control

1. The Contractor shall provide the services of technical representatives who are familiar with all components and installation procedures of the installed CCTV System; and are approved by the Contracting Officer.
2. The Contractor will be present on the job site during the preparatory and initial phases of quality control to provide technical assistance.
3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
4. The Contractor shall participate in the testing and validation of the system and shall provide certification that the system installed is fully operational as all construction document requirements have been fulfilled.

3.2 TESTING AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 26 00
ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install complete Duress-Panic Alarms, Emergency Phones/ Call-Boxes, and Intercom Systems, hereafter referred to as EPPS System.

1.2 RELATED WORK

A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.

B. For labeling and signs, Section 10 14 00, SIGNAGE.

C. For parking equipment requirements, Section 11 12 00, PARKING CONTROL EQUIPMENT.

D. For connections, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

E. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.

F. For other communication systems, Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.

G. For grounding of equipment, Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

H. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELCTRICAL SYSTEMS.

I. For cabling requirements, Section 27 15 00, COMMUNICATIONS HORIZONTAL CABLING.

J. For routing requirements, Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.

K. For integration with PACS, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEM (PACS).

L. For integration with IDS, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).

M. For security cameras, Section 28 23 00, VIDEO SURVEILLANCE.

N. For monitoring of equipment, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.

O. For Warranty of Construction see GENERAL CONDITIONS.

P. For General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.3 QUALITY ASSURANCE

A. The Contractor shall be responsible for providing, installing, and the operation of the EPPS System as shown. The Contractor shall also provide certification as required.

B. The security system shall be installed and tested to ensure all components are fully compatible as a system and can be integrated with all associated security subsystems, whether the security system is stand-alone or a part of a complete Information Technology (IT) computer network.

C. The Contractor or security sub-contractor shall be a licensed security Contractor as required within the state or jurisdiction of where the installation work is being conducted.

1.4 SUBMITTALS

A. Submit below items in conjunction with Master Specification Sections 01 33 23, SHOP DRAWING, PRODUCT DATA, AND SAMPLES, and Section 02 41 00, DEMOLITION.

B. Provide certificates of compliance with Section 1.3, Quality Assurance.

C. Provide a pre-installation and as-built design package in both electronic format and on paper, minimum size 48 x 48 inches (1220 x 1220 millimeters); drawing submittals shall be per the established project schedule.

D. Pre-installation design and as-built packages shall include, but not be limited to:
   1. Index Sheet that shall:
      a. Define each page of the design package to include facility name, building name, floor, and sheet number.
      b. Provide a list of all security abbreviations and symbols.
      c. Reference all general notes that are utilized within the design package.
      d. Specification and scope of work pages for all security systems that are applicable to the design package that will:
         1) Outline all general and job specific work required within the design package.
         2) Provide a device identification table outlining device Identification (ID) and use for all security systems equipment utilized in the design package.
   2. Drawing sheets that will be plotted on the individual floor plans or site plans shall:
      a. Include a title block as defined above.
      b. Define the drawings scale in both standard and metric measurements.
      c. Provide device identification and location.
      d. Address all signal and power conduit runs and sizes that are associated with the design of the electronic security system and other security elements (e.g., barriers, etc.).
      e. Identify all pull box and conduit locations, sizes, and fill capacities.
      f. Address all general and drawing specific notes for a particular drawing sheet.
   3. A riser drawing for each applicable security subsystem shall:
      a. Indicate the sequence of operation.
      b. Relationship of integrated components on one diagram.
      c. Include the number, size, identification, and maximum lengths of interconnecting wires.
      d. Wire/cable types shall be defined by a wire and cable schedule. The schedule shall utilize a lettering system that will correspond to the wire/cable it represents (example: A = 18 AWG/1 Pair Twisted, Unshielded). This schedule shall also provide the manufacturer's name and part number for the wire/cable being installed.
   4. A system drawing for each applicable security system shall:
      a. Identify how all equipment within the system, from main panel to device, shall be laid out and connected.
      b. Provide full detail of all system components wiring from point-to-point.
      c. Identify wire types utilized for connection, interconnection with associate security subsystems.
      d. Show device locations that correspond to the floor plans.
      e. All general and drawing specific notes shall be included with the system drawings.
   5. A schedule for all of the applicable security subsystems shall be included. All schedules shall provide the following information:
      a. Device ID.
      b. Device Location (e.g. site, building, floor, room number, location, and description).

c. Mounting type (e.g. flush, wall, surface, etc.).
d. Power supply or circuit breaker and power panel number.

6. Detail and elevation drawings for all devices that define how they were installed and mounted.

E. Pre-installation design packages shall be reviewed by the Contractor along with a VA representative to ensure all work has been clearly defined and completed. All reviews shall be conducted in accordance with the project schedule. There shall be four (4) stages to the review process:

1. 35 percent
2. 65 percent
3. 90 percent
4. 100 percent

F. Provide manufacturer security system product cut-sheets. Submit for approval at least 30 days prior to commencement of formal testing, a Security System Operational Test Plan. Include procedures for operational testing of each component and security subsystem, to include performance of an integrated system test.

G. Submit manufacture's certification of Underwriters Laboratories, Inc. (UL) listing as specified. Provide all maintenance and operating manuals per the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

1.5 PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplement, and errata) form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.

B. American National Standards Institute (ANSI):

ANSI S3.2-99	Method for measuring the Intelligibility of Speech over Communications Systems

C. Department of Justice American Disability Act (ADA)

28 CFR Part 36	ADA Standards for Accessible Design

D. National Fire Protection Association (NFPA):

70-05	National Electrical Code

E. National Electrical Manufactures Association (NEMA)

250-03	Enclosures for Electrical Equipment (1000 Volts Maximum)

F. Underwriters Laboratories, Inc. (UL):

305-00	Standard for Panic Hardware
444-02	Communications Cables
636-95	Standard for Holdup Alarm Units and Systems

G. Uniform Federal Accessibility Standards (UFAS), 1984

1.6 WARRANTY OF CONSTRUCTION.

A. Warrant EPPS System work subject to the Article "Warranty of Construction" of FAR clause 52.246-21.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. General:

1. All equipment shall be rated for continuous operation. Environmental conditions (i.e. temperature, humidity, wind, and seismic activity) shall be taken under consideration at each facility and site location prior to installation of the equipment.
2. All equipment shall operate on a 120 or 240 volts alternating current (VAC); 50 hertz (Hz) or 60 Hz Alternating Current (AC) power system unless documented otherwise in subsequent sections listed within this spec. All equipment shall have a battery back-up source of power that will provide 12 hours (hrs.) of run time in the event of a loss of primary power to the security systems until a backup generator comes on-line.
3. The EPPS systems shall be designed, installed, and programmed in a manner that will allow for easy of operation, programming, servicing, maintenance, testing, and upgrading of the system.
4. All EPPS components located in designated "HAZARDOUS ENVIRONMENT" areas where fire or explosion could occur due to the presence of natural gases or vapors, flammable liquids, combustible residue, or ignitable fibers or debris, shall be rated Class II, Division I, Group F, and installed in accordance with National Fire Protection Association (NFPA) 70, National Electrical Code Chapter 5.
5. The Contractor shall provide the Contracting Officer with written verification, that the type of wire/cable being provided is recommended and approved by the OEM. Cabling shall meet the interconnecting wiring requirements of NFPA 70, National Electrical Code. The Contractor is responsible for providing the correct protection cable duct and/or conduit and wiring.
6. When interfacing with other communications or security subsystems the Contractor shall utilize interfacing methods that are approved by the Contracting Officer. At a minimum, an acceptable interfacing method requires not only a physical and mechanical connection; but also a matching of signal, voltage, and processing levels with regard to signal quality and impedance. The interface point must adhere to all standards described herein.
7. Systems shall be scaleable, not vendor specific, and allow expansion as required.
8. Wireless systems shall use ultrasonic, infrared and radio frequency waves to link distributed transmitters and receivers. Specific characteristics of particular facility will determine best application. Contractor is responsible for determining best system using prediction program to determine where readable signals can be obtained and identify "dead spots".
9. All hardwired alarms, switches, and junction boxes shall be protected from tampering and include line supervision.
10. The installation and placement of intercom units and emergency-call boxes in strategic locations shall also require that signage be posted near these devices. The signage, in accordance with Section 10 14 00, SIGNAGE shall communicate the location of the device and its unique identification number, and brief instruction on how to access/use the device. The signage may appear on the device, on a pole or wall near the device location and shall be printed in a manner that is easily read during daylight and hours of darkness.

2.2 EQUIPMENT ITEMS

A. All systems shall be designed to provide continuous electrical supervision of the complete and entire system.

B. Noise filters and surge protectors shall be provided for all intercommunications equipment to ensure protection from primary AC power surges and to ensure noise interference is not induced into low voltage data circuits.

C. All alarm and initiating and signaling circuits shall be supervised for open circuits, short circuits, and system grounds. Main and Uninterrupted Power Supply (UPS) power circuits shall be supervised for any change in operating conditions (e.g. low battery, primary to back up battery, and UPS online). When an open, short or ground occurs in any system circuit, an audible and visual fault alarm signal shall be initiated at the master control station and all remote locations.

D. Control Unit: Shall consist of the components to constantly monitor and verify alarm activation; identify zone of activation and location of activation.

E. Audible Signal Device for Duress-Panic: Provides alarm activation and audible sound for alarms, as well as supervisory and trouble signals that shall be distinctive.

F. Assessment: This capability shall consist of electronic devices required to visually and audibly verify the validity of alarms. Assessment also includes providing indication of tampering, fail-safe, low battery, and power losses.

G. Alarm Monitoring and Reporting: Shall annunciate information to at least two (2) separate locations. The alarms shall maintain the capability to respond with local and remote visible and audible signals upon activation of an alarm. The alarms shall have the capability of operating in a silent mode, alerting personnel monitoring the system that the device has been activated.

H. The intercom and emergency call-box systems shall be provided with normally acceptable speech intelligibility, defined as a score of at least 70% in accordance with ANSI S3.2

I. Master Stations for Emergency Call Box and Security Intercoms:
   1. All master stations shall have a "call-in" switch to provide an audible and visual indication of incoming calls from remote stations. Individual visual indication shall identify the calling station and status, and remain actuated until a call is answered by a master station.
   2. Master stations shall be equipped with a handset with a switch for private conversations.
   3. Intercom master stations shall also have an all-call feature, and have the ability to receive video from a video intercom unit.
   4. Master stations shall have the capability to selectively communicate with any remote station by actuating assigned station number on a keypad or select button for that station.
   5. Master stations may be standalone or can be integrated with the Access Control System and Database Management. The Contractor will be responsible for the integration of the Master station with the Access Control System and Database Management in accordance with OEM instructions and Section 28 13 16, ACCESS CONTROL SYSTEM AMD DATABASE MANAGEMENT.

J. Duress-Panic Alarms:
   1. Housing shall be a rugged corrosion-resistant housing of stainless steel or Acrylonitrile Butadiene Styrene (ABS) molded plastic or similar material that is weather and dust proof.
   2. Actuating device shall include a minimum of a plunger button whose head is recessed from the face/front edge of the housing and be designed to avoid accidental activation using switch guard or multiple buttons (i.e., requires pressing two (2) buttons simultaneously)
   3. Wireless stationary devices will meet the same specifications as Personal Duress/Panic Alarms.
   4. Alarm switch/button shall lock-in upon activation until manually reset with key or manufacture provided device.
   5. The switch shall be a positive-acting, double-pole, and double-throw switch.

6. Duress/Panic alarms shall meet UL 305 Standard for Panic Alarms. To reduce the possibility of false alarms and ensure installation functionality UL 636 Standard for Holdup Alarms standards shall be met.
7. Alarms used for concealed application requires silent alarm notification to a monitoring station. They shall annunciate at the Access Control System and Database Management, monitored by a central station or direct connect to local police, depending on local ordinance requirements.
8. Shall be capable of being mounted for hand or foot use in a manner that is unable to be viewed by the public. Larger systems use a computer that intercepts and processes alarms and displays them on a monitor. The central computer can make an announcement over facility hand held radios, pagers or telephones, or at the Access Control System and Database Management so that the other security personnel can be immediately notified. These systems shall be hardwired.
9. Components:
   a. Transmitter
   b. Locator subsystem
   c. Receiver
   d. Software
10. Wiring will be four (4) conductor #18 American Wire Gauge (AWG).
11. Duress-Panic Alarm Technical Characteristics:

Temperature Range	0° to 110°F (-17.8°C to 43.3°C)
Nominal Voltage	12 V DC @ 6 mA
Current	Max 8 mA
Operational Voltage	7 V DC to 15 V DC
Operational life	Rated for 0,000 activations
Battery Activations	500
Actuator	Dual button plunger with activation lock
LED	Bi-color – on and activated

K. Personal Duress-Panic Alarm:
1. These systems are wireless only and can be worn as a belt clip, with a neck lanyard or with a wrist band. These alarms can be either active (manually operated) or passive mode (if detached from body, or body position changes to a prone position) alarm activates. They also provide identification of individual and location.
2. Components:
   a. Transmitter
   b. Repeaters (for wireless and increase distance)
   c. Locator subsystem
   d. Receiver
   e. Software
3. Wireless transmitters shall send a periodic check in signal to the main computer or processor. If the signal is not received according to a definable time window, a supervisory alert will be generated. Wireless devices shall report a low battery condition well in advance to the failure of the battery.
4. Shall consist of a compact lightweight transmitter enclosed in a durable fire-retardant ABS plastic case that can be easily worn.
5. Transmitters may use ultrasonic, radio frequency (RF), or infrared (IR) to transmit signals. Each has advantages and disadvantages. Selection of system shall be dependent on defined usage and range of communications required.

6. Sensors shall be adjustable to activate automatically when mounted on a belt and the user is in a horizontal position for longer than one (1) to fifteen (15) minutes. Adjustment capability shall not be accessible to personnel wearing the panic alarm device.
7. Radio frequencies for transmitter will comply with Federal Communication Commission (FCC) regulations.
8. Radio frequency transmitters will use frequency modulation signal hopping.
9. Personal Duress-Panic Alarm Technical Characteristics:

Temperature Range	0° to 110°F (-17.8°C to 43.3°C)
Nominal Voltage	12 V DC @ 6 mA
Current	Max 8 mA
Operational Voltage	7 V DC to 15 V DC
Battery Life	Regular battery 60 hour duration or Nickel-Metal Hydride (NiMH) rechargeable 12 hrs. 20 hr. per charge
Battery Lifespan	500 activations
Actuator	Plunger with activation lock
LED	Bi-color – on and activated
Passive Activation	Adjustable Prone position 1-15 minutes

L. Emergency Call Box Enclosures:
1. Consist of remote call stations, master station and a telephone Private Branch Exchange (PBX). They shall have two-way voice communications. Calls are directed to a pre-programmed extension. These systems are effective for a multi-facility environment or stand-alone facility with a parking structure or large parking lot. In addition, they may contain built-in CCTV system capabilities or can be integrated to work with standalone CCTV systems.
2. Emergency Call Boxes will be housed in an National Electric Manufactures Association (NEMA) 250 Enclosures for Electrical Equipment compliant enclosures. Call-box enclosure shall include blue light/or similar strobe mounted behind or on top of the call box: A blue light or color lit strobe shall be activated (e.g. to inform others visually that assistance is required) when the emergency switch/button/phone is pressed/taken off-hook and shall flash for the duration of a call.
3. The faceplate shall be constantly lit by ultra bright LEDs.
4. Enclosure and bracket system shall be designed to resist extreme weather conditions and constructed of weather resistant stainless steel.
5. Emergency Call Box Enclosure Technical Characteristics:

Construction	Minimum 11 gauge stainless steel Impact resistant polycarbonate window for lights
Mounting	Wall, pole or kiosk
Power	120 VAC: 44 Watts Maximum or 24 VDC: 18 Watts Maximum
Lighting	Strobe: 1.5 million candlepower 70 flashes per minute. Blue Light: 7 watt high efficiency 10,000 hour compact fluorescent. Faceplate Light: Ultra bright LEDs 100,000 hour lifetime.

M. Emergency Call Boxes:
1. Emergency Call Box shall be indoor/outdoor-rated, Uniform Federal Accessibility Standards (UFAS) and Americans with Disability Act (ADA) compliant, and provide hands-free usage. Phone shall also include cast metal raised letter and Braille signage for UFAS/ADA compliance.
2. Emergency Call Box shall include built-in auto-dialer that dials two (2) numbers: if first number doesn't answer, automatically dials a second number.
3. The System shall include auto-answer to allow for monitoring and initiating calls with an Emergency Phone.
4. Emergency Call Box shall use flush mount enclosure (FME,) shall include two (2) piece housing construction with full front lip to allow tight gasket seal between the speakerphone and enclosure. Screws shall be tamper free.
5. When activated the Emergency Call Box shall automatically place a call to the pre-programmed number(s). If the number is busy it should automatically call a second number.
6. The electronics enclosure shall be capable of using interchangeable faceplates: a single-button faceplate, a two-button faceplate, or a two-button faceplate with keypad.
7. The system shall use a “plain old telephone service” (POTS) line or analog PBX and shall be capable of integration with existing CCTV and Access Control System and Database Management via software at the SMS head-end.
8. Depending on distance and existing phone line capabilities, RF or use of wireless phone connections may be considered. The Contractor and Contracting Officer shall select appropriate system based on facility telecommunication system capabilities and desired system requirements.
9. Monitoring/Diagnostic capability at control and monitoring stations shall include the capability to automatically poll each Emergency Call Box, report incoming calls, identify location, and keep permanent records of all events with the use of a Windows based compatible software package and shall also meet the requirements of the Security Management System (SMS).
10. If speaker/handset stations are used, lifting the handset shall automatically cut out the loudspeaker in the station and all conversation shall be carried through the handset. Where noise does not exceed 55 dB, hands-free operations may be performed from distances up to 20 feet (ft.) (6.096 m). In higher noise environments only a talk-listen switch shall be utilized.
11. If system is a hardware type master station it shall be capable of:
    a. LED display of identification code for emergency phones;
    b. Indicate whether call was initiated by pushing button or by an auxiliary device;
    c. Include RJ11 ports for connection to telephone line and standard telephone; and
    d. Powered by 9 VDC, 500mA power supply that connects to 120 volt alternating current (VAC).
12. System shall include auto-answer to allow security to monitor and initiate calls with Emergency Call Box.
13. Contractor shall provide the capability to connect up to 8 phones on one (1) phone line while retaining ability to call each phone individually and without affecting performance. System shall also be able to create a closed system without need for any phone lines.
14. The System shall include the capability to record a message identifying the location of the caller.
15. It shall remotely be able to adjust speakerphone & microphone sensitivity.
16. Emergency Call Box Technical Characteristics:

Construction	12 gauge (2.8mm) #4 brushed stainless steel face plate
Operating Temperature	-4ºF to +149ºF (-20ºC to +65ºC)
Communication	2-way hands-free communication

Digital Capacity	Up to 18 digits, including pauses, for each of two (2) phone numbers
Dialing Speed	Minimum 10 tones per second
Power Source	Phone line powered (requires 20mA at 24 v off-hook)
Connection	Parallel tip and ring connected to RJ11 connector for quick installation
Memory	Erasable Programmable Read-only Memory (EPROM)
Circuit Protection	Lightening suppressed and full wave polarity guarded
Programming	Non-volatile EEPROM programming can be done from any telephone. No battery back-up needed
Wiring Requirements	1 twisted-shielded pair (gauge depends on distance)
Camera	Option for pin-hole color camera or Integration with existing CCTV
LED	Call confirmation
Activation	Sound or 1.5 in. minimum piezoelectric button
Labeling	"Push for Help" or "Emergency"

N. Strobes and Beacon:
   1. Used for visual recognition of device activation once an emergency phone or intercom is activated. They provide unit identification and quick location of the caller.
   2. Strobes and Beacons Technical Characteristics:

STROBE	
Input Voltage	10.5 – 28 VDC or VAC
Input Current	Average 1 amp
Input Current	Peak 3 amp
Intensity	1,000,000 candlepower
Control Circuit Output	2 mA max
Flash Rate	60 – 75 times per minute
BEACON	
Input Voltage	10.5 - 28 VAC or VDC
Input Current	@24.0 : 427 MA

O. Security Intercoms:
   1. Shall be utilized to assist in controlling entry to a site, parking lot, facility, main and alternate entries, loading dock areas. They are also used for emergencies. These systems shall have both two-way voice communications and video (CCTV) capabilities built in. Intercoms may also have key-pads that allow for specific call connections or may provide a directory. These systems consist of both remote and master stations. Intercom shall be externally powered for distances over 1,500 feet (457.2 meters) (m) from the master control unit.
   2. The Intercom shall be programmable from a remote location and have a three number dialing capability per activation button, or include a keypad for dialing authorized and published extensions.
   3. The Intercom shall have an internally mounted electronics enclosure and auxiliary power.
   4. The Contractor shall be responsible for integration of intercom with auxiliary output to electronic or magnetic door releases, as well as CCTV, as required.
   5. Security Intercom Technical Characteristics:

Construction	12 gauge (2.8mm) #4 brushed stainless steel face plate
Operating Temperature	-4ºF to +149ºF (-20ºC to +65ºC)
Communication	2-way hands-free communication
Digital Capacity	Up to 18 digits, including pauses, for each of two (2) phone numbers
Dialing Speed	Minimum 10 tones per second
Power Source	Phone line powered or PBX
Connection	Parallel tip and ring connected to RJ11 connector for quick installation
Memory	EPROM
Circuit Protection	Lightening suppressed and full wave polarity guarded
Programming	Non-volatile EEPROM programming can be done from any telephone. No battery back-up needed
Wiring Requirements	1 twisted-shielded pair (gauge depends on distance)
Camera	Option for pin-hole color camera or Integration with existing CCTV
LED	Call confirmation
Activation	1.5 in. (38.1mm) minimum piezoelectric button
Labeling	"Information" or "Help"

2.3 INSTALLATION KIT

A. General: A kit shall be provided that, at a minimum, includes all connectors and terminals, labeling systems, barrier strips, wiring blocks or wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, etc., required to accomplish a neat and secure installation. Unfinished or unlabeled wire connections will not be allowed. Contractor shall turn over to the Contracting Officer all unused and partially opened installation kit boxes, coaxial cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, and physical installation hardware. This is an acceptable alternate to the individual spare equipment requirement as long as the minimum spare items are provided in this count. The following installation sub-kits are required as a minimum:

B. System Grounding:
   1. The grounding kit shall include all cable in accordance with UL 444 Communications Cables, and installation hardware required. All grounding will be according to the NEC.
   2. This includes, but is not limited to:
      a. Coaxial Cable Shields
      b. Control Cable Shields
      c. Data Cable Shields
      d. Conduits
      e. Cable Duct
      f. Cable Trays
      g. Power Panels
      h. Connector Panels

C. Coaxial Cable: The coaxial cable kit shall include all coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, etc., required to accomplish a neat and secure installation.

D. Wire And Cable: The wire and cable kit shall include all connectors and terminals, barrier straps, wiring blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels etc., required to accomplish a neat and orderly installation.

E. Equipment Interface: The equipment interface kit shall include any item or quantity of equipment, cable, mounting hardware and materials needed to interface Systems and Subsystems according to the OEM requirements and this specification.

F. Labels: The labeling kit shall include any item or quantity of labels, tools, stencils, and materials needed to label each subsystem according to the OEM requirements, as-installed drawings, and this specification.

G. Documentation: The documentation kit shall include any item or quantity of items, computer discs, as installed drawings, equipment, maintenance, and operation manuals, and OEM materials needed to correctly provide the system documentation as required by this document and explained herein.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System installation shall be installed in accordance with NFPA 731 Standards for the Installation of Electric Premises Security Systems and appropriate installation manual for each type of subsystem designed, engineered, and installed.

B. The location and type of duress, intercom, or call-box to be installed will be in accordance with physical security requirements unique to each VA facility.

C. For EPPS systems (i.e. use current panic/duress and emergency call boxes) that can operate through existing VA facility telephone system lines, software programming and hardware, refer to Section 27 51 23, INTERCOMMUNICATIONS AND PROGRAM SYSTEMS to integrate additional EPPS equipment.

D. Concealed duress/panic devices shall be mounted in such a way that their location is only known by the person having knowledge of the activating device location. No wiring shall be exposed to identify the location of the activation device.

E. Floor mounted duress alarms shall be attached to millwork on floor. When mounted under millwork, wiring shall be routed in millwork to conduit system via flexible conduit.

F. Hard-wired switches shall be wired to individual alarm points within the Advanced Processing Controller (apC).

G. Wall and post mounted stations shall be mounted to meet UFAS/ADA requirements and use tamper proof bolts and screws. Testing will be finished before installation of fasteners.

H. Cleaning: Subsequent to installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacture instructions.

I. Provisions shall be made for systems in high-noise areas or areas with electrical interference environments.

J. Adjustment/Alignment/Synchronization: Contractor shall prepare for system activation by following manufacturer's recommended procedures for adjustment, alignment, or programming. Prepare each component in accordance with appropriate provisions of the component's installation, operations, and maintenance instructions.

3.2 TESTS AND TRAINING

A. All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

END OF SECTION

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring as shown on the drawings and specified.

B. Fire alarm systems shall comply with requirements of NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Contracting Officer or his authorized representative. Installers shall have a minimum of two years experience installing fire alarm systems.

C. Fire alarm signals:
   1. Building shall have a general evacuation fire alarm signal in accordance with ASA S3.41 to notify all occupants in the respective building to evacuate.

D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit located in the security office telephone operator’s office and fire department.

E. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

1.2 SCOPE

A. All existing fire alarm equipment, wiring, devices and sub-systems that are not shown to be reused shall be removed. All existing fire alarm conduit not reused shall be removed.

B. A new fire alarm system shall be designed and installed in accordance with the specifications and drawings. Device location and wiring runs shown on the drawings are for reference only unless specifically dimensioned. Actual locations shall be in accordance with NFPA 72 and this specification.
   1. What buildings are involved in the project; list the specific buildings?
   2. What interface is there with door magnets?
   3. What interface is there with the elevator (shut down and recall; speakers in cars)?
   4. What interface is there with HVAC systems for fan shut down?
   5. What interface is there with Kitchen Hood suppression systems?
   6. What interface is there with fire sprinkler systems?
   7. What interface is there with dry pipe sprinkler systems?
   8. What interface is there with preaction/deluge systems?
   9. What interface is there with a fire pump?

10. What interface is there with temperature switches for storage tanks and dry pipe valve rooms?
11. What interface is there with door locking systems?
12. What interface is there with electric eyes (they could open doors upon detection of smoke)?
13. What interface is there with fire department?
14. What interface is there with the pagers or hand radio system?
15. What interface is there with the emergency generators?
16. Where is the fire command station?
17. Are two way fire phones to be provided, where?

C. Existing fire alarm bells, chimes, door holders, 120VAC duct smoke detectors, valve tamper switches and waterflow/pressure switches may be reused only as specifically indicated on the drawings and provided the equipment:
1. Meets this specification section
2. Is UL listed or FM approved
3. Is compatible with new equipment being installed
4. Is verified as operable through contractor testing and inspection
5. Is warranted as new by the contractor.

D. Existing 120 VAC duct smoke detectors, waterflow/pressure switches, and valve tamper switches reused by the Contractor shall be equipped with an addressable interface device compatible with the new equipment being installed.

E. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.

F. Basic Performance:
1. Alarm and trouble signals from each building fire alarm control panel shall be digitally encoded by UL listed electronic devices onto a multiplexed communication system.
2. Response time between alarm initiation (contact closure) and recording at the main fire alarm control unit (appearance on alphanumeric read out) shall not exceed five (5) seconds.
3. The signaling line circuits (SLC) between building fire alarm control units shall be wired Style 7 in accordance with NFPA 72. Isolation shall be provided so that no more than one building can be lost due to a short circuit fault.
4. Initiating device circuits (IDC) shall be wired Style C in accordance with NFPA 72.
5. Signaling line circuits (SLC) within buildings shall be wired Style 4 in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet of floor space or 3 floors whichever is less.
6. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

1.3 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS: Restoration of existing surfaces.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Procedures for submittals.

C. Section 07 84 00, FIRESTOPPING: Fire proofing wall penetrations.

D. Section 09 91 00, PAINTING: Painting for equipment and existing surfaces.

E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.

F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.

G. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW: Cables/wiring.

1.4 SUBMITTALS

A. General: Submit 4 copies and 1 reproducible in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

B. Drawings:
   1. Prepare drawings using and include all contractors information. Layering shall be by VA criteria as provided by the Contracting Officer's Technical Representative (COTR). Bid drawing files on AutoCAD will be provided to the Contractor at the pre-construction meeting. The contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
   2. Floor plans: Provide locations of all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
   3. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, elevator control interface, HVAC shutdown interface, fire extinguishing system interface, and all other fire safety interfaces. Show wiring Styles on the riser diagram for all circuits. Provide diagrams both on a per building and campus wide basis.
   4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.
   5. Two weeks prior to final inspection, the Contractor shall deliver to the COTR one (1) set of reproducible, as-built drawings, two blueline copies and one (1) set of the as-built drawing computer files (using AutoCAD Release 14 or later). As built drawings (floor plans) shall show all new and existing conduit used for the fire alarm system.

C. Manuals:
   1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.
      a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
      b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
      c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.

d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturer's installation limitations including but not limited to circuit length limitations.
e. Complete listing of all digitized voice messages.
f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.
g. Include information indicating who will provide emergency service and perform post contract maintenance.
h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VAMC and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.

2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manual to the COTR.
   a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.
   b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
   c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
   d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
   e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.

D. Certifications:
1. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer’s representative who makes the certification.
2. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
3. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

1.5 WARRANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of five (5) years from the date of acceptance of the entire installation by the Contracting Officer.

1.6 GUARANTY PERIOD SERVICES

A. Complete inspection, testing, maintenance and repair service for the fire alarm system shall be provided by a factory trained authorized representative of the manufacturer of the major equipment for a period of five years from the date of acceptance of the entire installation by the Contracting Officer.

B. Contractor shall provide all necessary test equipment, parts and labor to perform required inspection, testing, maintenance and repair.

C. All inspection, testing, maintenance and permanent records required by NFPA 72, and recommended by the equipment manufacturer shall be provided by the contractor. Work shall include operation of sprinkler system alarm and supervisory devices as well as all reused existing equipment connected to the fire alarm system. It shall include all interfaced equipment including but not limited to elevators, HVAC shutdown, and extinguishing systems.

D. Maintenance and testing shall be performed in accordance with NFPA 72. A computerized preventive maintenance schedule shall be provided and shall describe the protocol for preventive maintenance of equipment. The schedule shall include a systematic examination, adjustment and cleaning of all equipment.

E. Non included Work: Repair service shall not include the performance of any work due to improper use, accidents, or negligence for which the contractor is not responsible.

F. Service and emergency personnel shall report to the Engineering Office or their authorized representative upon arrival at the hospital and again upon the completion of the required work. A copy of the work ticket containing a complete description of the work performed and parts replaced shall be provided to the VA Contracting Officer or his authorized representative.

G. Emergency Service:
   1. Warranty Period Service: Service other than the preventative maintenance, inspection, and testing required by NFPA 72 shall be considered emergency call-back service and covered under the warranty of the installation during the first year of the warranty period, unless the required service is a result of abuse or misuse by the Government. Written notification shall not be required for emergency warranty period service and the contractor shall respond as outlined in the following sections on Normal and Overtime Emergency Call-Back Service. Warranty period service can be required during normal or overtime emergency call-back service time periods at the discretion of the Contracting Officer or his authorized representative.
   2. Normal and overtime emergency call-back service shall consist of an on-site response within two hours of notification of a system trouble.
   3. Normal emergency call-back service times are between the hours of 7:30 a.m. and 4:00 p.m., Monday through Friday, exclusive of federal holidays. Service performed during all other times shall be considered to be overtime emergency call-back service. The cost of all normal emergency call-back service for years 2 through 5 shall be included in the cost of this contract.

4. Overtime emergency call-back service shall be provided for the system when requested by the Government. The cost of the first 40 manhours per year of overtime call-back service during years 2 through 5 of this contract shall be provided under this contract. Payment for overtime emergency call-back service in excess of the 40 man hours per year requirement will be handled through separate purchase orders. The method of calculating overtime emergency call-back hours is based on actual time spent on site and does not include travel time.

H. The contractor shall maintain a log at each fire alarm control unit. The log shall list the date and time of all examinations and trouble calls, condition of the system, and name of the technician. Each trouble call shall be fully described, including the nature of the trouble, necessary correction performed, and parts replaced.

1.7 APPLICABLE PUBLICATIONS

A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only.

B. National Fire Protection Association (NFPA):

70 2005	National Electrical Code (NEC).
72-2002	National Fire Alarm Code.
90A-2002	Installation of Air Conditioning and Ventilating Systems.
101-2003	Life Safety Code

C. Underwriters Laboratories, Inc. (UL):
2000-2000.....Fire Protection Equipment Directory

D. Factory Mutual Research Corp (FM): Approval Guide, 2005 Edition

E. American National Standards Institute (ANSI):
S3.41-1996 Audible Emergency Evacuation Signal

F. International Code Council, International Building Code (IBC) 2003 Edition

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS, GENERAL

A. FA equipment shall be Johnson Controls IFC series and be able to tie into existing Johnson Controls FACP in building 6 on campus.

B. All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system. The authorized representative of the manufacturer of the major equipment shall certify that the installation complies with all manufacturer's requirements and that satisfactory total system operation has been achieved.

2.2 CONDUIT, BOXES, AND WIRE

A. Conduit shall be in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and as follows:
1. All new and reused conduit shall be installed in accordance with NFPA 70.
2. Conduit fill shall not exceed 40 percent of interior cross sectional area.
3. All new conduit shall be 19 mm (3/4 inch) minimum.

B. Wire:
   1. All existing wiring shall be removed and new wiring installed in a conduit or raceway.
   2. Wiring shall be in accordance with NEC article 760, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.
   3. Addressable circuits and wiring used for the multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer in writing.
   4. Any fire alarm system wiring that extends outside of a building shall have additional power surge protection to protect equipment from physical damage and false signals due to lightning, voltage and current induced transients. Protection devices shall be shown on the submittal drawings and shall be UL listed or in accordance with written manufacturer's requirements.
   5. All wire or cable used in underground conduits including those in concrete shall be listed for wet locations.

C. Terminal Boxes, Junction Boxes, and Cabinets:
   1. Shall be galvanized steel in accordance with UL requirements.
   2. All new and reused boxes shall be sized and installed in accordance with NFPA 70.
   3. New and existing covers shall be repainted red in accordance with Section 09 91 00, PAINTING and shall be identified with white markings as "FA" for junction boxes and as "FIRE ALARM SYSTEM" for cabinets and terminal boxes. Lettering shall be a minimum of 19 mm (3/4 inch) high.
   4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
   5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the COTR.

2.3 FIRE ALARM CONTROL UNIT

A. General:
   1. Each building shall be provided with a fire alarm control unit and shall operate as a supervised zoned fire alarm system.
   2. Each power source shall be supervised from the other source for loss of power.
   3. All circuits shall be monitored for integrity.
   4. Visually and audibly annunciate any trouble condition including, but not limited to main power failure, grounds and system wiring derangement.
   5. Transmit digital alarm information to the main fire alarm control unit.

B. Enclosure:
   1. The control unit shall be housed in a cabinet suitable for both recessed and surface mounting. Cabinet and front shall be corrosion protected, given a rust resistant prime coat, and manufacturer's standard finish.
   2. Cabinet shall contain all necessary relays, terminals, lamps, and legend plates to provide control for the system.

C. Operator terminal at main control unit:
   1. Operator terminal shall consist of the central processing unit, display screen, keyboard and printer.

2. Display screen shall have a minimum 15-inch diagonal non-glare screen capable of displaying 24 lines of 80 characters each.
3. Keyboard shall consist of 60 alpha numeric and 12 user/functional control keys.
4. Printer shall be the automatic type, printing the date, time and location for all alarm, supervisory, and trouble conditions.

D. Power Supply:
1. The control unit shall derive its normal power from a 120 volt, 60 Hz dedicated supply connected to the emergency power system. Standby power shall be provided by a 24 volt DC battery as hereinafter specified. The normal power shall be transformed, rectified, coordinated, and interfaced with the standby battery and charger.
2. The door holder power shall be arranged so that momentary or sustained loss of main operating power shall not cause the release of any door.
3. Power supply for smoke detectors shall be taken from the fire alarm control unit.
4. Provide protectors to protect the fire alarm equipment from damage due to lightning or voltage and current transients.
5. Provide new separate and direct ground lines to the outside to protect the equipment from unwanted grounds.

E. Circuit Supervision: Each alarm initiating device circuit, signaling line circuit, and notification appliance circuit, shall be supervised against the occurrence of a break or ground fault condition in the field wiring. These conditions shall cause a trouble signal to sound in the control unit until manually silenced by an off switch.

F. Supervisory Devices: All sprinkler system valves, standpipe control valves, post indicator valves (PIV), and main gate valves shall be supervised for off normal position. Closing a valve shall sound a supervisory signal at the control unit until silenced by an off switch. The specific location of all closed valves shall be identified at the control unit. Valve operation shall not cause an alarm signal. Low air pressure switches and duct detectors shall be monitored as supervisory signals. The power supply to the elevator shunt trip breaker shall be monitored by the fire alarm system as a supervisory signal.

G. Trouble signals:
1. Arrange the trouble signals for automatic reset (non latching).
2. System trouble switch off and on lamps shall be visible through the control unit door.

H. Function Switches: Provide the following switches in addition to any other switches required for the system:
1. Remote Alarm Transmission By-pass Switch: Shall prevent transmission of all signals to the main fire alarm control unit when in the "off" position. A system trouble signal shall be energized when switch is in the off position.
2. Alarm Off Switch: Shall disconnect power to alarm notification circuits on the local building alarm system. A system trouble signal shall be activated when switch is in the off position.
3. Trouble Silence Switch: Shall silence the trouble signal whenever the trouble silence switch is operated. This switch shall not reset the trouble signal.
4. Reset Switch: Shall reset the system after an alarm, provided the initiating device has been reset. The system shall lock in alarm until reset.
5. Lamp Test Switch: A test switch or other approved convenient means shall be provided to test the indicator lamps.
6. Drill Switch: Shall activate all notification devices without tripping the remote alarm transmitter. This switch is required only for general evacuation systems specified herein.

7. Door Holder By-Pass Switch: Shall prevent doors from releasing during fire alarm tests. A system trouble alarm shall be energized when switch is in the abnormal position.
8. Elevator recall By-Pass Switch: Shall prevent the elevators from recalling upon operation of any of the devices installed to perform that function. A system trouble alarm shall be energized when the switch is in the abnormal position.
9. HVAC/Smoke Damper By-Pass: Provide a means to disable HVAC fans from shutting down and/or smoke dampers from closing upon operation of an initiating device designed to interconnect with these devices.

I. Remote Transmissions:
1. Provide capability and equipment for transmission of alarm, supervisory and trouble signals to the main fire alarm control unit.
2. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

J. Remote Control Capability: Each building fire alarm control unit shall be installed and programmed so that each must be reset locally after an alarm, before the main fire alarm control unit can be reset. After the local building fire alarm control unit has been reset, then the all system acknowledge, reset, silence or disabling functions can be operated by the main fire alarm control unit

K. System Expansion: Design the control units and enclosures so that the system can be expanded in the future (to include the addition of twenty percent more alarm initiating, alarm notification and door holder circuits) without disruption or replacement of the existing control unit and secondary power supply.

L. Interface module: provide interface module to communicate alarms and trouble notifications to campus FA system. Interface module shall tie – into FA system panel located in Building 6.

2.4 STANDBY POWER SUPPLY

A. Uninterrupted Power Supply (UPS):
1. The UPS system shall be comprised of a static inverter, a precision battery float charger, and sealed maintenance free batteries.
2. Under normal operating conditions, the load shall be filtered through a ferroresonant transformer.
3. When normal AC power fails, the inverter shall supply AC power to the transformer from the battery source. There shall be no break in output of the system during transfer of the system from normal to battery supply or back to normal.
4. Batteries shall be sealed, gel cell type.
5. UPS system shall be sized to operate the central processor, CRT, printer, and all other directly connected equipment for five minutes upon a normal AC power failure.

B. Batteries:
1. Battery shall be of the sealed, maintenance free type, 24-volt nominal.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty four hours plus five minutes of alarm to an end voltage of 1.14 volts per cell, upon a normal AC power failure.
3. Battery racks shall be steel with an alkali resistant finish. Batteries shall be secured in seismic areas 2B, 3, or 4 as defined by the Uniform Building Code.

C. Battery Charger:

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120 volt, 60 hertz emergency power source.
2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
3. Shall have protection to prevent discharge through the charger.
4. Shall have protection for overloads and short circuits on both AC and DC sides.
5. A trouble condition shall actuate the fire alarm trouble signal.
6. Charger shall have automatic AC line voltage regulation, automatic current limiting features, and adjustable voltage controls.

2.5 ANNUNCIATION

A. Annunciator, Alphanumeric Type (System):
   1. Shall be a supervised, LCD display containing a minimum of two lines of 40 characters for alarm annunciation in clear English text.
   2. Message shall identify building number, floor, zone, etc on the first line and device description and status (pull station, smoke detector, waterflow alarm or trouble condition) on the second line.
   3. The initial alarm received shall be indicated as such.
   4. A selector switch shall be provided for viewing subsequent alarm messages.
   5. The display shall be UL listed for fire alarm application.
   6. Annunciators shall display information for all buildings connected to the system. Local building annunciators, for general evacuation system buildings, shall be permitted when shown on the drawings and approved by the COTR.

B. Printers:
   1. System printers shall be high reliability digital input devices, UL approved, for fire alarm applications. The printers shall operate at a minimum speed of 30 characters per second. The printer shall be continually supervised.
   2. Printers shall be programmable to either alarm only or event logging output.
      a. Alarm printers shall provide a permanent (printed) record of all alarm information that occurs within the fire alarm system. Alarm information shall include the date, time, building number, floor, zone, device type, device address, and condition.
      b. Event logging printers shall provide a permanent (printed) record of every change of status that occurs within the fire alarm system. Status information shall include date, time, building number, floor, zone, device type, device address and change of status (alarm, trouble, supervisory, reset/return to normal).
   3. System printers shall provide tractor drive feed pins for conventional fan fold 213 mm x 275 mm (8-1/2" x 11") paper.
   4. The printers shall provide a printing and non-printing self test feature.
   5. Power supply for printers shall be taken from and coordinated with the building emergency service.
   6. Each printer shall be provided with a stand for the printer and paper.
   7. Spare paper and ribbons for printers shall be stocked and maintained as part of the five (5) year guarantee period services in addition to the one installed after the approval of the final acceptance test.

2.6 ALARM NOTIFICATION APPLIANCES

A. Bells:
   1. Shall be electric, single stroke or vibrating, heavy duty, under dome, solenoid type.

2. Unless otherwise shown on the drawings, shall be 150 mm (6 inches) diameter and have a minimum nominal rating of 80 dBA at 3000 mm (10 feet).
3. Mount on removable adapter plates on outlet boxes.
4. Bells located outdoors shall be weatherproof type with metal housing and protective grille.
5. Each bell circuit shall have a minimum of twenty percent spare capacity.

B. Speakers:
1. Shall operate on either 25 VRMS or 70.7 VRMS with field selectable output taps from 0.5 to 2.0W and originally installed at the one half watt tap. Speakers shall provide a minimum sound output of 80 dBA at ten feet with the one half watt tap.
2. Frequency response shall be a minimum of 400 HZ to 4000 HZ.
3. 100 mm (4 inches) or 200 mm (8 inches) cone type speakers ceiling mounted with white colored baffles in areas with suspended ceilings and wall mounted in areas without ceilings.

C. Strobes:
1. Xenon flash tube type minimum 15 candela in toilet rooms and 75 candela in all other areas with a flash rate of 1 HZ. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA 72).
2. Backplate shall be red with 13 mm (1/2 inch) permanent red letters. Lettering to read "Fire", be oriented on the wall or ceiling properly, and be visible from all viewing directions.
3. Each strobe circuit shall have a minimum of twenty (20) percent spare capacity.
4. Strobes may be combined with the audible notification appliances specified herein.

D. Fire Alarm Horns:
1. Shall be electric, utilizing solid state electronic technology operating on a nominal 24 VDC.
2. Shall be a minimum nominal rating of 80 dBA at ten feet.
3. Mount on removable adapter plates on conduit boxes.
4. Horns located outdoors shall be of weatherproof type with metal housing and protective grille.
5. Each horn circuit shall have a minimum of twenty (20) percent spare capacity.

2.7 ALARM INITIATING DEVICES

A. Manual Fire Alarm Stations:
1. Shall be non breakglass, address reporting type.
2. Station front shall be constructed of a durable material such as cast or extruded metal or high impact plastic. Stations shall be semi flush type.
3. Stations shall be of single action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
4. Operating handles shall be constructed of a durable material. On operation, the lever shall lock in alarm position and remain so until reset. A key shall be required to gain front access for resetting, or conducting tests and drills.
5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.
6. Stations identified as key operated only shall have a single standardized lock and key separate from the control equipment.

B. Smoke Detectors:
1. Smoke detectors shall be UL listed for use with the fire alarm control unit being furnished.
2. Smoke detectors shall be addressable type complying with applicable UL Standards for system type detectors. Smoke detectors shall be installed in accordance with the manufacturer's recommendations and NFPA 72.

3. Detectors shall have an indication lamp to denote an alarm condition. Provide remote indicator lamps and identification plates where detectors are concealed from view. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position.
4. All spot type and duct type detectors installed shall be of the photoelectric type.
5. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensitivity of any photoelectric detector shall be factory set at 3.0 plus or minus 0.25 percent obscuration per foot.
6. Detectors shall provide a visual trouble indication if they drift out of sensitivity range or fail internal diagnostics. Detectors shall also provide visual indication of sensitivity level upon testing. Detectors, along with the fire alarm control units shall be UL listed for testing the sensitivity of the detectors.

C. Heat Detectors:
1. Heat detectors shall be of the addressable restorable rate compensated fixed temperature spot type.
2. Detectors shall have a minimum smooth ceiling rating of 2500 square feet.
3. Ordinary temperature (135 degrees F) heat detectors shall be utilized in elevator shafts and elevator mechanical rooms. Intermediate temperature rated (200 degrees F) heat detectors shall be utilized in all other areas.
4. Provide a remote indicator lamp, key test station and identification nameplate (e.g. “Heat Detector - Elevator P-) for each elevator group. Locate key test station in plain view on elevator machine room wall.

D. Water Flow and Pressure Switches:
1. Wet pipe water flow switches and dry pipe alarm pressure switches for sprinkler systems shall be connected to the fire alarm system by way of an address reporting interface device.
2. All new water flow switches shall be of a single manufacturer and series and non accumulative retard type. See Section 21 12 00, FIRE-SUPPRESSION STANDPIPES and Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches added. Connect all switches shown on the approved shop drawings.
3. All new switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds. Timing shall be recorded and documented during testing.

E. Extinguishing System Connections:
1. Kitchen Range Hood and Duct Suppression Systems:
   a. Each suppression system shall be equipped with a micro-switch connected to the building fire alarm control unit. Discharge of a suppression system shall automatically send a alarm signal to the building fire detection and alarm system for annunciation.
   b. Operation of this suppression system shall also automatically shut off all sources of fuel and heat to all equipment requiring protection under the same hood.
2. Each gaseous suppression system shall be monitored for system alarm and system trouble conditions via addressable interface devices.

2.8 SUPERVISORY DEVICES

A. Duct Smoke Detectors:
1. Duct smoke detectors shall be provided and connected by way of an address reporting interface device. Detectors shall be provided with an approved duct housing mounted exterior to the duct, and shall have perforated sampling tubes extending across the full width of the duct (wall to wall). Detector placement shall be such that there is uniform airflow in the cross section of the duct.

2. Interlocking with fans shall be provided in accordance with NFPA 90A and as specified hereinafter under Part 3.2, "TYPICAL OPERATION".
3. Provide remote indicator lamps, key test stations and identification nameplates (e.g. "DUCT SMOKE DETECTOR AHU-X") for all duct detectors. Locate key test stations in plain view on walls or ceilings so that they can be observed and operated from a normal standing position.

B. Sprinkler and Standpipe System Supervisory Switches:
1. Each sprinkler system water supply control valve, riser valve or zone control valve, and each standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valve shall be equipped with a supervisory switch.
3. Valve supervisory switches shall be connected to the fire alarm system by way of address reporting interface device.
4. The mechanism shall be contained in a weatherproof die cast aluminum housing that shall provide a 19 mm (3/4 inch) tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed or if the unit is removed from its mounting.
6. Where dry pipe sprinkler systems are installed, high and low air pressure switches shall be provided and monitored by way of an address reporting interface devices.

2.9 ADDRESS REPORTING INTERFACE DEVICE

A. Shall have unique addresses that reports directly to the building fire alarm panel.

B. Shall be configurable to monitor normally open or normally closed devices for both alarm and trouble conditions.

C. Shall have terminal designations clearly differentiating between the circuit to which they are reporting from and the device that they are monitoring.

D. Shall be UL listed for fire alarm use and compatibility with the panel to which they are connected.

E. Shall be mounted in weatherproof housings if mounted exterior to a building.

2.10 SMOKE BARRIER DOOR CONTROL

A. Electromagnetic Door Holders:
1. New Door Holders shall be standard wall mounted electromagnetic type. In locations where doors do not come in contact with the wall when in the full open position, an extension post shall be added to the door bracket.
2. Operation shall be by 24 volt DC supplied from a battery located at the fire alarm control unit. Door holders shall be coordinated as to voltage, ampere drain, and voltage drop with the battery, battery charger, wiring and fire alarm system for operation as specified.

B. A maximum of twelve door holders shall be provided for each circuit. Door holders shall be wired to allow releasing doors by smoke zone.

C. Door holder control circuits shall be electrically supervised.

D. Smoke detectors shall not be incorporated as an integral part of door holders.

2.11 UTILITY LOCKS AND KEYS:

A. All key operated test switches, control units, annunciator panels and lockable cabinets shall be provided with a single standardized utility lock and key.

B. Key-operated manual fire alarm stations shall have a single standardized lock and key separate from the control equipment.

C. All keys shall be delivered to the COTR.

2.12 SPARE AND REPLACEMENT PARTS

A. Provide spare and replacement parts as follows:
   1. Manual pull stations - 5
   2. Key operated manual pull stations - 3
   3. Heat detectors - 2 of each type
   4. Fire alarm strobes - 5
   5. Fire alarm bells - 5
   6. Fire alarm speakers - 5
   7. Smoke detectors - 20
   8. Duct smoke detectors with all appurtenances - 1
   9. Sprinkler system water flow switch - 1 of each size
   10. Sprinkler system water pressure switch - 1 of each type
   11. Sprinkler valve tamper switch - 1 of each type
   12. Control equipment utility locksets - 5
   13. Control equipment keys - 25
   14. 2.5 oz containers aerosol smoke - 12
   15. Printer paper - 3 boxes
   16. Printer replacement ribbons - 3
   17. Monitor modules - 3
   18. Control modules - 3
   19. Fire alarm SLC cable (same as installed) – 152 m (500 feet)

B. Keys for key-operated manual pull stations shall be provided 30 days prior to actual installation.

C. Spare and replacement parts shall be in original packaging and submitted to the COTR.

D. Furnish and install a storage cabinet of sufficient size and suitable for storing spare equipment. Doors shall include a pad locking device. Padlock to be provided by the VA. Location of cabinet to be determined by the COTR.

E. Provide to the VA, all hardware, software, programming tools, license and documentation necessary to permanently modify the fire alarm system on site. The minimum level of modification includes addition and deletion of devices, circuits, zones and changes to system description, system operation, and digitized evacuation and instructional messages.

2.13 INSTRUCTION CHART

A. Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame with a backplate. Install the frame in a conspicuous location observable from each control unit where operations are performed. The card shall show those steps to be taken by an operator when a signal is received under all conditions, normal, alarm, supervisory, and trouble. Provide an additional copy with the binder for the input output matrix for the sequence of operation. The instructions shall be approved by the COTR before being posted.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS , Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW), and all penetrations of smoke and fire barriers shall be protected as required by Section 07 84 00, FIRESTOPPING.

B. All new conduits, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. All existing accessible fire alarm conduit not reused shall be removed.

C. All new or reused exposed conduit shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.

D. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Restoration, and be re painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.

E. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations to be approved by the COTR.

F. Speakers shall be ceiling mounted and fully recessed in areas with suspended ceilings. Speakers shall be wall mounted and recessed in finished areas without suspended ceilings. Speakers may be surface mounted in unfinished areas.

G. Strobes shall be flush wall mounted 2,000 mm (80 inches) above the floor or 150 mm (6 inches) below ceiling, whichever is lower. Locate and mount to maintain a minimum 900 mm (36 inches) clearance from side obstructions.

H. Manual pull stations shall be installed not less than 1050 mm (42 inches) or more than 1200 mm (48 inches) from finished floor to bottom of device and within 1500 mm (60 inches) of a stairway or an exit door.

I. Where possible, locate water flow and pressure switches a minimum of 300 mm (12 inches) from a fitting that changes the direction of the flow and a minimum of 900 mm (36 inches) from a valve.

J. Mount valve tamper switches so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one fifth of the distance from its normal position.

K. Connect combination closer-holders installed under Section 08 71 00, DOOR HARDWARE.

3.2 TYPICAL OPERATION

A. Activation of any manual pull station, water flow or pressure switch, heat detector, kitchen hood suppression system, gaseous suppression system, or smoke detector shall cause the following operations to occur:

1. Operate the emergency voice communication system in Buildings. For sprinkler protected buildings, flash strobes continuously only in the zone of alarm. For buildings without sprinkler protection throughout, flash strobes continuously only on the floor of alarm.
2. Continuously sound a temporal pattern general alarm and flash all strobes in the building in alarm until reset at the local fire alarm control unit in Building.
3. Release only the magnetic door holders on the floor from which alarm was initiated after the alert signal.
4. Transmit a separate alarm signal, via the main fire alarm control unit to the fire department.
5. Unlock the electrically locked exit doors within the zone of alarm.

B. Heat detectors in elevator machine rooms shall, in addition to the above functions, disconnect all power to all elevators served by that machine room after a time delay. The time delay shall be programmed within the fire alarm system programming and be equal to the time it takes for the car to travel from the highest to the lowest level, plus 10 seconds.

C. Smoke detectors in the primary elevator lobbies of Buildings shall, in addition to the above functions, return all elevators in the bank to the secondary floor.

D. Smoke detectors in the remaining elevator lobbies, elevator machine room, or top of hoistway shall, in addition to the above functions, return all elevators in the bank to the primary floor.

E. Operation of a smoke detector at a corridor door used for automatic closing shall also release only the magnetic door holders on that floor.

F. Operation of duct smoke detectors shall cause a system supervisory condition and shut down the ventilation system and close the associated smoke dampers as appropriate.

G. Operation of any sprinkler or standpipe system valve supervisory switch, high/low air pressure switch, or fire pump alarm switch shall cause a system supervisory condition.

3.3 TESTS

A. Provide the service of a NICET level III, competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the COTR.

B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the COTR. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meets all contract requirements. After the system has passed the initial test and been approved by the COTR, the contractor may request a final inspection.
1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
3. Run water through all flow switches. Check time delay on water flow switches. Submit a report listing all water flow switch operations and their retard time in seconds.
4. Open each alarm initiating and notification circuit to see if trouble signal actuates.
5. Ground each alarm initiation and notification circuit and verify response of trouble signals.

3.4 FINAL INSPECTION AND ACCEPTANCE

A. Prior to final acceptance a minimum 30 day "burn in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn in" period and where the last 14 days is without a system or equipment malfunction.

B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a VA representative.

3.5 INSTRUCTION

A. The manufacturer's authorized representative shall provide instruction and training to the VA as follows:

1. Six one-hour sessions to engineering staff, security police and central attendant personnel for simple operation of the system. Two sessions at the start of installation, two sessions at the completion of installation and two sessions 3 months after the completion of installation.
2. Four two hour sessions to engineering staff for detailed operation of the system. Two sessions at the completion of installation and two sessions 3 months after the completion of installation.
3. Three eight-hour sessions to electrical technicians for maintaining, programming, modifying, and repairing the system at the completion of installation and one eight-hour refresher session 3 months after the completion of installation.

B. The Contractor and/or the Systems Manufacturer's representative shall provide a typewritten "Sequence of Operation" including a trouble shooting guide of the entire system for submittal to the VA. The sequence of operation will be shown for each input in the system in a matrix format and provided in a loose leaf binder. When reading the sequence of operation, the reader will be able to quickly and easily determine what output will occur upon activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72.

C. Furnish the services of a competent instructor for instructing personnel in the programming requirements necessary for system expansion. Such programming shall include addition or deletion of devices, zones, indicating circuits and printer/display text.

END OF SECTION

SECTION 31 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 are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the Department of Veterans Affairs will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 GENERAL REQUIREMENTS.

B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

A. This Section includes requirements for commissioning the site utility systems, subsystems and equipment. This Section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

B. The commissioning activities have been developed to support the VA requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

C. The commissioning activities have been developed to support the United States Green Building Council (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Contract Documents developed with the approval of the VA.
   1. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” prerequisite of “Fundamental Building Systems Commissioning”.
   2. Commissioning activities and documentation for the LEED™ section on “Energy and Atmosphere” requirements for the “Enhanced Building System Commissioning” credit.
   3. Activities and documentation for the LEED™ section on “Measurement and Verification” requirements for the Measurement and Verification credit.

D. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more specifics regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

B. The following Site Utility systems will be commissioned:
   1. Sanitary Sewage Lift Stations (Lift station sump or tank level controls, pump alternator, alarms and alarm panel, pumps and motors).
   2. Steam Condensate Pump Stations (Condensate receivers and transfer pumps, motors, controls, pump alternator, alarms and instrumentation, and safeties).
   3. Storm Drainage Pump Systems (Sump level controls, pump alternator, alarms and alarm panel, pumps and motors).

1.6 SUBMITTALS

A. The commissioning process requires review of selected Submittals. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the Resident Engineer prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE-FUNCTIONAL CHECKLISTS

A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.2 CONTRACTORS TESTS

A. Contractor tests as required by other sections of Division 31 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.3 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:

A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the 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.

3.4 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. The instruction shall be scheduled in coordination with the 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 OF SECTION

SECTION 31 20 00
EARTH MOVING

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.
   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 D 1557.
   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, proofrolling, or similar methods.
   3. Existing Subgrade (Footings Only): Same as paragraph 1, but no fill or backfill. If materials differ from // reference borings and // design requirements, excavate to acceptable strata subject to Resident Engineer's 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 D2922.

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 Resident Engineer. 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 Resident Engineer based on the determination by the Contractor’s soils testing agency/geotechinical engineer 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 springline 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 contaminates as defined and determined by the Resident Engineer or the Contractor’s testing agency/geotechinical engineer.

1.3 **RELATED WORK:**

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

B. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

C. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

D. Site preparation: and Section 02 41 00, DEMOLITION

E. Paving sub-grade requirements: Section 32 12 16, ASHPALT PAVING.

F. Soil and Rock Profiling: Section 01 00 00, GENERAL REQUIREMENTS, SOIL AND ROCK PROFILING.

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. Classified Excavation: Removal and disposal of all material except that material not defined as Rock.

C. 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. Blasting: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be removed with conventional methods may not be performed by blasting.
   5. 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 ROCK EXCAVATION:

A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by California Registered Professional Land Surveyor or California 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.

1.6 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 Resident Engineer:
   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 D 1557 for each on site or borrow soil material proposed for fill, backfill, engineered fill, or structural fill.
      c. Test reports for compliance with ASTM D 2940 requirements for sub-base 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.

1.7 APPLICABLE PUBLICATIONS:

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

B. American Association of State Highway and Transportation Officials (AASHTO):
T99-01(2004)…….. Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 inch) Drop
T180-01(2004)…… 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):
D448-03a…….. Standard Classification for Sizes of Aggregate for Road and Bridge Construction
D698-00ae1 ……..Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft3 (600 kN m/m3))
D1556-00…….. Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-02e1 ……..Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2700 kN m/m3))
D2167-94 (2001)….. Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2487-06…….. Standard Classification of Soil for Engineering Purposes (Unified Soil Classification System)
D2922-05……..Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D2940-03……..Standard Specifications for Graded Aggregate Material for Bases or Sub-bases for Highways or Airports.

D. Society of Automotive Engineers (SAE):
J732-92…….Specification Definitions - Loaders
J1179-02…….Hydraulic 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 75 mm (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-µm (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-µm (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, crushed stone or gravel graded from 25 mm (1 inch) to 4.75 mm (No. 4), per ASTM D 2940.
   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 D 2940.

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 the site.

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 Resident Engineer. Remove materials from the site. Trees and shrubs, shown to be transplanted, shall be dug with a ball of earth and burlapped in accordance with latest issue of, "American Standard for Nursery Stock" of the American Association of Nurserymen, Inc. Transplant trees and shrubs to a permanent or temporary position within two hours after digging. Maintain trees and shrubs held in temporary locations by watering as necessary and feeding semiannually with liquid fertilizer with a minimum analysis of 5 percent nitrogen, 10 percent phosphorus, and 5 percent potash. Maintain plants moved to permanent positions as specified for plants in temporary locations until conclusion of contract. // 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 Resident Engineer. 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 the site.

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 are approximate. From a site survey that measured spot elevations and subsequently generated existing contours and spot elevations. 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 Resident Engineer of any differences between existing elevations shown on plans and those encountered on site by Surveyor/Engineer described above. Notify Resident Engineer 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. No burning of materials is permitted onsite.

3.2 EXCAVATION:

A. Shoring, Sheeting and Bracing: Shore, brace, or slope, its angle of repose or to an angle considered acceptable by the Resident Engineer, 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.

2. Construction of the support of excavation system shall not interfere with the permanent structure and may begin only after a review by the Resident Engineer.
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 provide a concrete fill support under disturbed foundations, as directed by Resident Engineer, at no additional cost to the Government. Do not remove shoring until permanent work in excavation has been inspected and approved by Resident Engineer.

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 Resident Engineer. Approval by the Resident Engineer is also required before placement of the permanent work on all subgrades.

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 Resident Engineer.

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. Proofrolling shall consist of at least two complete passes with one pass being in a direction perpendicular to preceding one. Remove any areas that deflect, rut, or pump excessively during proofrolling, or that fail to consolidate after successive passes to suitable soils and replaced with compacted fill. 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.

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 undisturbed earth unless a mechanical support is shown.

d. Length of open trench in advance of piping laying shall not be greater than is authorized by Resident Engineer.

2. Sanitary and storm sewer trenches:
   a. Trench width below a point 150 mm (6 inches) above top of pipe shall be 600 mm (24 inches) maximum for pipe up to and including 300 mm (12 inches) diameter, and four-thirds diameter of pipe plus 200 mm (8 inches) for pipe larger than 300 mm (12 inches). Width of trench above that level shall be as necessary for sheeting and bracing and proper performance of the work.
   b. Bed bottom quadrant of pipe on undisturbed soil or granular fill.
      1) Undisturbed: Bell holes shall be no larger than necessary for jointing. Backfill up to a point 300 mm (12 inches) above top of pipe shall be clean earth placed and tamped by hand.
      2) Granular Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one sixth of pipe diameter below pipe to 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
   c. Place and compact as specified remainder of backfill using acceptable excavated materials. Do not use unsuitable materials.
   d. Use granular fill for bedding where rock or rocky materials are excavated.

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 Resident Engineer as unsuitable, and replace with acceptable material. If there is a question as to whether material is unsuitable or not, the contractor shall obtain samples of the material, under the direction of the Resident Engineer, and the materials shall be examined by an independent testing laboratory for soil classification to determine whether it is unsuitable or not. Testing of the soil shall be performed by the Contractor's Testing Agency/ Geotechnical Engineers. 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 25 mm (1 inch).
      3) Pavements: Plus or minus 13 mm (1 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:

A. Design of the underpinning system is the responsibility of the Contractor and is subject to review and approval by the Resident Engineer. Underpinning of existing building foundations, as indicated on structural drawings, or where excavation undermines existing foundations, shall be accomplished in the following manner:
   1. Make general excavation for new construction, where new foundations are to be below existing foundations, to elevation of new foundations (or sized stone subbase), maintaining a 45 degree sloped berm.
   2. For underpinning pits, underpin existing wall foundations by excavating 1200 mm (4 feet) wide pits to depth shown on drawings skipping 3 sections at any one time so as to maintain support for wall at all times.
   3. Underpin intervening sections one at a time; no adjacent sections shall be underpinned until concrete in adjacent sections shall have reached 20 MPa (2500 psi) strength and have been dry packed with non-shrink grout to obtain positive bearing. Sheet and brace underpinning pits if soil will not stand on a vertical cut during this operation, or as required for safety of workmen. Repack any voids behind sheeting to prevent sloughing which could cause settlement of existing foundations. Contractor performing this portion of work shall have been prequalified by Resident Engineer as having previously performed successfully this type of work or will demonstrate his capability for successfully performing this work. It shall be sole responsibility of the Contractor to guard against objectionable movement or settlement and to preserve integrity of existing structures.
   4. The tip elevation of the underpinning pits shall be a minimum of 900 mm (3 feet) below the adjacent excavation elevation.
   5. Subgrades at the tip of the underpinning pit shall be clean, dry, and free of debris and shall be observed by the Resident Engineer prior to concrete placement.
   6. Concrete shall not be free fall greater than 3000 mm (10 feet) into the pit.

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 Resident Engineer.

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 Resident Engineer. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. 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 D1557 .
      b. Curbs, curbs and gutters, ASTM D1557
      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 D1557.
      d. Landscaped areas, top 400 mm (16 inches), ASTM D1557 .
      e. Landscaped areas, below 400 mm (16 inches) of finished grade, ASTM D1557 .
   2. Natural Ground (Cut or Existing)
      a. Curbs, curbs and gutters, top 150 mm (6 inches), ASTM D1557 .
      b. Under sidewalks, top 150 mm (6 inches), ASTM D1557 .

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 Resident Engineer 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 // the site property.

B. Disposal: Transport surplus satisfactory soil to legal, offsite location. Stockpile or spreading soil is allowed if directed by Resident Engineer.

C. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.

D. Place excess excavated materials suitable for fill and/or backfill on site where directed.

E. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.

F. Segregate all excavated contaminated soil designated by the Resident Engineer 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 CLEAN UP:

A. 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 Property.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies performance of dewatering required to lower and control ground water table levels and hydrostatic pressures to permit excavation, backfill, and construction to be performed in the dry. Control of surface water shall be considered as part of the work under this specification.

1.2 SUMMARY:

A. The work to be completed by the Contractor includes, but is not necessarily limited to the following:
   1. Implementation of the Erosion and Sedimentation Control Plan.
   2. Dewater excavations, including seepage and precipitation.

B. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for care of water and erosion control. Excavation work shall not begin before the Erosion and Sedimentation Control Plan is in place.

1.3 REQUIREMENT:

A. Dewatering system shall be of sufficient size and capacity necessary to lower and maintain ground water table to an elevation at least 300 mm (1 foot) below lowest foundation subgrade or bottom of pipe trench and to allow material to be excavated in a reasonably dry condition. Materials to be removed shall be sufficiently dry to permit excavation to grades shown and to stabilize excavation slopes where sheeting is not required. Operate dewatering system continuously until backfill work has been completed.

B. Reduce hydrostatic head below any excavation to the extent that water level in the construction area is a minimum of 300 mm (1 foot) below prevailing excavation surface.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain stability of sides and bottom of excavation.

E. Construction operations are performed in the dry.

F. Control of surface and subsurface water is part of dewatering requirements. Maintain adequate control so that:
   1. The stability of excavated and constructed slopes are not adversely affected by saturated soil, including water entering prepared subbase and subgrades where underlying materials are not free draining or are subject to swelling or freeze-thaw action.
   2. Erosion is controlled.
   3. Flooding of excavations or damage to structures does not occur.
   4. Surface water drains away from excavations.
   5. Excavations are protected from becoming wet from surface water, or insure excavations are dry before additional work is undertaken.

G. Permitting Requirements: The contractor shall comply with and obtain the required State and County permits where the work is performed.

1.4 RELATED WORK:

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

B. Safety Requirements: Section 01 00 00, GENERAL REQUIREMENTS

C. Submittal requirements as specified in Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

D. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

E. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article 1.12, PHYSICAL DATA.

F. Excavation, backfilling, site grade and utilities: Section 31 20 00, EARTH MOVING.

1.5 SUBMITTALS:

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

B. Drawings and Design Data:
   1. Submit drawings and data showing the method to be employed in dewatering excavated areas 30 days before commencement of excavation.
   2. Material shall include: location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey the water from site to adequate disposal.
   3. Include a written report outlining control procedures to be adopted if dewatering problem arises.
   4. Materials submitted shall be in a format acceptable for inclusion in required permit applications to any and all regulatory agencies for which permits for discharge water from the dewatering system are required due to the discharge reaching regulated bodies of water.

C. Inspection Reports.

D. All required permits.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Install a dewatering system to lower and control ground surface water in order to permit excavation, construction of structure, and placement of backfill materials to be performed under dry conditions. Make the dewatering system adequate to pre-drain the water-bearing strata above and below the bottom of structure foundations, utilities and other excavations.

B. In addition, reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, to extent that water levels in construction area are a minimum of 300 mm (1 foot) below prevailing excavation surface at all times.

3.2 3.2 OPERATION:

A. Prior to any excavation below the ground water table, place system into operation to lower water table as required and operate it continuously 24 hours a day, 7 days a week until utilities and structures have been satisfactorily constructed, which includes the placement of backfill materials and dewatering is no longer required.

B. Place an adequate weight of backfill material to prevent buoyancy prior to discontinuing operation of the system.

3.3 WATER DISPOSAL:

A. Dispose of water removed from the excavations in such a manner as:
   1. Will not endanger portions of work under construction or completed.
   2. Will cause no inconvenience to Government or to others working near site.
   3. Will comply with the stipulations of required permits for disposal of water.
   4. Will Control Runoff: The Contractor shall be responsible for control of runoff in all work areas including but not limited to: excavations, access roads, parking areas, laydown, and staging areas. The Contractor shall provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. All water shall be removed from the immediate work areas and shall be disposed of in accordance with applicable permits.

B. Excavation Dewatering:
   1. The Contractor shall be responsible for providing all facilities required to divert, collect, control, and remove water from all construction work areas and excavations.
   2. Drainage features shall have sufficient capacity to avoid flooding of work areas.
   3. Drainage features shall be so arranged and altered as required to avoid degradation of the final excavated surface(s).
   4. The Contractor shall utilize all necessary erosion and sediment control measures as described herein to avoid construction related degradation of the natural water quality.

C. Dewatering equipment shall be provided to remove and dispose of all surface and ground water entering excavations, trenches, or other parts of the work during construction. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

3.4 STANDBY EQUIPMENT:

A. Provide complete standby equipment, installed and available for immediate operation, as may be required to adequately maintain de-watering on a continuous basis and in the event that all or any part of the system may become inadequate or fail.

3.5 CORRECTIVE ACTION:

A. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system (loosening of the foundation strata, or instability of slopes, or damage to foundations or structures), perform work necessary for reinstatement of foundation soil and damaged structure resulting from such inadequacy or failure by Contractor, at no additional cost to Government.

3.6 DAMAGES:

A. Immediately repair damages to adjacent facilities caused by dewatering operations.

3.7 REMOVAL:

A. Insure compliance with all conditions of regulating permits and provide such information to the Resident Engineer. Obtain written approval from Resident Engineer before discontinuing operation of dewatering system.

END OF SECTION

SECTION 31 23 23.33
FLOWABLE FILL

PART 1 - GENERAL

1.1 **INTRODUCTION:**

A. Flowable fill refers to a cementitious slurry consisting of a mixture of fine aggregate or filler, water, and cementitious material(s), which is used as a fill or backfill in lieu of compacted earth. This mixture is capable of filling all voids in irregular excavations and hard to reach places (such as under undercuts of existing slabs), is self-leveling, and hardens in a matter of a few hours without the need for compaction in layers. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.

B. Flowable fill materials will be used as only as a structural fill replacement on VA projects. Unless otherwise noted, flowable fill installed as a substitution for structural earth fill, shall not be designed to be removed by the use of hand tools. The materials and mix design for the flowable fill should be designed to produce the compressive strength indicated for the placed location, as indicated in Section 1.4.

1.2 **DESCRIPTION:**

A. Furnish and place flowable fill in a fluid condition, that sets within the required time and, after curing, obtains the desired strength properties as evidenced by the laboratory testing of the specific mix design, at locations shown on the plans or as directed by the Resident Engineer, in writing. This section specifies flowable fill for use as structural fill to and to be excavatable using hand tools.

1.3 **RELATED WORK:**

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

B. Earthwork, excavation and backfill and compaction requirements: Section 31 20 00, EARTH MOVING.

1.4 **DEFINITIONS:**

A. Flowable fill - Ready-mix Controlled Low Strength Material used as an alternative to compacted soil, and is also known as controlled density fill, and several other names, some of which are trademark names of material suppliers. Flowable fill (Controlled Low Strength Material) differs from portland cement concrete as it contains a low cementitious content to reduce strength development for possible future removal. Unless specifically approved otherwise, by the Resident Engineer, flowable fill shall be designed as a permanent material, not designed for future removal. Design strength for this permanent type flowable fill shall be a compressive strength of 2.1 MPa (300 psi) minimum at 28 days. Chemical admixtures may also be used in flowable fill to modify performance properties of strength, flow, set and permeability.

B. Excavatable Flowable fill – flowable fill designed with a compressive strength that will allow excavation as either machine tool excavatable at compressive strength of 1.5 MPa (200 psi) maximum at 1 year, or hand tool excavatable at compressive strength of 0.7 MPa (100 psi) maximum at 1 year.

1.5 **SUBMITTALS:**

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

B. Flowable fill Mix Design: Provide flowable fill mix design containing cement and water. At the contractor's option, it may also contain fly ash, aggregate, or chemical admixtures in any proportions such that the final product meets the strength and flow consistency, and shrinkage requirements included in this specifications.

1. Test and Performance - Submit the following data:
   a. Flowable fill shall have a minimum strength of 2.1 MPa (300 psi) according to ASTM C 39 at 28 days after placement.
   b. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per ft.) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   c. Flowable fill shall have a unit weight of 1500 - 1900 kg/m3 (90 - 115 lbs/feet 3) measured at the point of placement after a 60 minute ready-mix truck ride.

C. Provide documentation that the admixture supplier has experience of at least one year, with the products being provided and any equipment required to obtain desired performance of the product.

D. Manufacturer's Certificates: Provide Resident Engineer with a certification that the materials incorporated in the flowable fill, following achievement of the required strength, do not represent a threat to groundwater quality.

1.6 **APPLICABLE PUBLICATIONS:**

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

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

D4832-02	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
C618-03	Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Concrete. (Use Fly Ash conforming to the chemical and physical requirements for mineral admixture, Class F listed, including Table 2 (except for Footnote A). Waive the loss on ignition requirement.)
C403/C403M-05	Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
C150-99 Rev.A-04	Standard Specification for Portland Cement
C33-03	Standard Specification for Concrete Aggregates
C494/C494M-04	Standard Specification for Chemical Admixtures for Concrete
C940 RevA-98	Standard Specification for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced – Aggregate Concrete in the Laboratory

C. American Concrete Institute (ACI):

SP-150-94 Controlled Low-Strength Materials

1.7 **QUALITY ASSURANCE:**

A. Manufacturer: Flowable fill shall be manufactured by a ready-mix concrete producer with a minimum of 1 year experience in the production of similar products.

B. Materials: For each type of material required for the work of this Section, provide primary materials that are the products of one manufacturer. If not otherwise specified here, materials shall comply with recommendations of ACI 229, "Controlled Low Strength Materials."

C. Pre-Approval Procedures: The use of flowable fill during any part of the project shall be restricted to those incidences where, due to field conditions, the Contractor has made the Resident Engineer aware of the conditions for which he recommends the use of the flowable, and the Resident Engineer has confirmed those conditions and approved the use of the flowable fill, in advance. During the submittal process, the contractor shall prepare and submit various flowable fill mix designs corresponding to required conditions or if the contractor desires to use flowable fill due to economics. Approval for the strength of the flowable fill shall be obtained from the Resident Engineer when the contractor desires, or is required, to use flowable fill at specific location(s) within the project. Prior to commencement of field operations the contractor shall establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.8 **DELIVERY, STORAGE, AND HANDLING:**

A. Deliver and handle all products and equipment required, in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

1.9 **PROJECT CONDITIONS:**

A. Perform installation of flowable fill only when approved by the Resident Engineer, and when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.

PART 2 - PRODUCTS

2.1 **2.1 MATERIALS:**

A. Provide flowable fill containing, at a minimum, cementitious materials and water. Cementitious materials shall be portland cement, pozzolanic materials, or other self-cementing materials, or combinations thereof, at the contractor's option,and following approval by the Resident Engineer. The flowable fill mix design may also contain, fine aggregate or filler, and/or chemical admixtures in any proportions such that the final product meets the strength, flow consistency and shrinkage requirements included in this specification, as approved by the Resident Engineer.

B. Portland Cement: ASTM C150 Type 2.

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

D. Air-Entraining Admixture: ASTM C260.

E. Chemical Admixtures: ASTM C494.

F. Aggregate: ASTM C33.

2.2 **FLOWABLE FILL MIXTURE:**

A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.

B. Flowable fill shall have a minimum strength of 2.1 MPa (300 psi) according to ASTM C39 at 28 days after placement.

C. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 10.4 mm per m (1/8 inch per foot) of flowable fill depth (for mixes containing high fly ash content). Measurement of a Final Bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.

D. Flowable fill shall have a unit weight of 1500 - 1900 kg/m3(90 - 115 lbs/feet3) measured at the point of placement after a 60 minute ready-mix truck ride..

E. Flowable fill shall have an in-place yield of at least 98% of design yield for permanent type and a maximum of 110% of design yield for removable types at 1 year .

F. Provide equipment as recommended by the Manufacturer and comply with manufacturer's recommendations for the addition of additives, whether at the production plant or prior to placement at the site.

PART 3 - EXECUTION

3.1 **EXAMINATION:**

A. Examine conditions of substrates and other conditions under which work is to be performed and notify Resident Engineer, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 **3.2 APPLICATION OF FLOWABLE FILL:**

A. Secure tanks, pipes and other members to be encased in flowable fill. Insure that there are no exposed metallic pipes, conduits, or other items that will be in contact with the flowable fill after placement. If so, replace with non-metallic materials or apply manufacturers recommended coating to protect metallic objects before placing the flowable fill. Replacement or protection of metallic objects is subject to the approval of the Resident Engineer.

3.3 **PROTECTION AND CURING:**

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

END OF SECTION

SECTION 32 05 03
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section shall cover site work concrete constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown. Construction shall include the following:

B. Curb, combination curb and gutter and wheel stop.

C. Pedestrian Pavement: Walks grade slabs crossings, wheelchair curb ramps, terraces and steps.

D. Vehicular Pavement: Service courts, and driveways.

1.2 RELATED WORK

A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Subgrade Preparation: Section 31 20 00, EARTH MOVING.

C. Concrete Materials, Quality, Mixing, Design and Other Requirements: Section 03 30 00, CAST-IN-PLACE-CONCRETE.

D. Metal Components of Steps (Nosing and Railing): Section 05 50 00, METAL FABRICATIONS.

1.3 DESIGN REQUIREMENTS

A. Design all elements with the latest published version of applicable codes.

1.4 WEATHER LIMITATIONS

A. Placement of concrete shall be as specified under Article 3.8, COLD WEATHER and Article 3.7, HOT WEATHER of Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.5 SELECT SUBBASE MATERIAL JOB-MIX

A. The Contractor shall retain and reimburse a testing laboratory to design a select subbase material mixture and submit a job-mix formula to the Resident Engineer, in writing, for approval. The formula shall include the source of materials, gradation, plasticity index, liquid limit, and laboratory compaction curves indicating maximum density at optimum moisture.

1.6 SUBMITTALS

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

B. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified.
   1. Expansion joint filler
   2. Hot poured sealing compound
   3. Reinforcement
   4. Curing materials

C. Data and Test Reports: Select subbase material.
   1. Job-mix formula.
   2. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in referenced publications.

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. Refer to the latest edition of all referenced Standards and codes.

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

M031MM031-07-UL .....Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (ASTM A615/A615M-09)

M055MM055-09-UL .....Steel Welded Wire Reinforcement, Plain, for Concrete (ASTM A185)

M147-65-UL .....Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses (R 2004)

M148-05-UL .....Liquid Membrane-Forming Compounds for Curing Concrete (ASTM C309)

M171-05-UL .....Sheet Materials for Curing Concrete (ASTM C171)

M182-05-UL .....Burlap Cloth Made from Jute or Kenaf and Cotton Mats

M213-01-UL .....Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Type) (ASTM D1751)

M233-86-UL .....Boiled Linseed Oil Mixer for Treatment of Portland Cement Concrete

T099-09-UL .....Moisture-Density Relations of Soils Using a 2.5 kg. (5.5 lb) Rammer and a 305 mm (12 in.) Drop

T180-09-UL .....Moisture-Density Relations of Soils Using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop

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

C94/C94M-09 .....Ready-Mixed Concrete

C143/C143M-09 .....Slump of Hydraulic Cement Concrete

PART 2 - PRODUCTS

2.1 GENERAL

A. Concrete shall be Type C, air-entrained as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, with the following exceptions:

TYPE	MAXIMUM SLUMP*
Curb & Gutter	75 mm (3")
Pedestrian Pavement	75 mm (3")
Vehicular Pavement	50 mm (2") (Machine Finished) 100 mm (4") (Hand Finished)
Equipment Pad	75 to 100 mm (3" to 4")
* For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.	

2.2 REINFORCEMENT

A. The type, amount, and locations of steel reinforcement shall be as shown on the drawings and in the specifications.

B. Welded wire-fabric shall conform to AASHTO M55.

C. Dowels shall be plain steel bars conforming to AASHTO M31. Tie bars shall be deformed steel bars conforming to AASHTO M31.

2.3 SELECT SUBBASE (WHERE REQUIRED)

A. Subbase material shall consist of select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials conforming to AASHTO M147, Grading E or F.

B. Materials meeting other gradations than that noted will be acceptable whenever the gradations are within a tolerance of three to five percent, plus or minus, of the single gradation established by the job-mix formula.

C. Subbase material shall produce a compacted, dense-graded course, meeting the density requirement specified herein.

2.4 FORMS

A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.

B. Do not use forms if they vary from a straight line more than 3 mm (1/8 inch) in any 3000 mm (ten foot) long section, in either a horizontal or vertical direction.

C. Wood forms should be at least 50 mm (2 inches) thick (nominal). Wood forms shall also be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

2.5 CONCRETE CURING MATERIALS

A. Concrete curing materials shall conform to one of the following:
   1. Burlap conforming to AASHTO M182 having a weight of 233 grams (seven ounces) or more per square meter (yard) when dry.
   2. Impervious Sheeting conforming to AASHTO M171.
   3. Liquid Membrane Curing Compound conforming to AASHTO M148 (ASTM C309), Type 1 and shall be free of paraffin or petroleum.

2.6 EXPANSION JOINT FILLERS

A. Material shall conform to AASHTO M213.

PART 3 - EXECUTION

3.1 SUBGRADE PENETRATION

A. Prepare, construct, and finish the subgrade as specified in Section 31 20 00, EARTH MOVING.

B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

3.2 SELECT SUBBASE (WHERE REQUIRED)

A. Mixing: Proportion the select subbase by weight or by volume in quantities so that the final approved job-mixed formula gradation, liquid limit, and plasticity index requirements will be met after subbase course has been placed and compacted. Add water in approved quantities, measured by weight or volume, in such a manner to produce a uniform blend.

B. Placing:
   1. Place the mixed material on the prepared subgrade in a uniform layer to the required contour and grades, and to a loose depth not to exceed 200 mm (8 inches), and that when compacted, will produce a layer of the designated thickness.
   2. When the designated compacted thickness exceeds 150 mm (6 inches), place the material in layers of equal thickness. Remove unsatisfactory areas and replace with satisfactory mixture, or mix the material in the area.
   3. In no case will the addition of thin layers of material be added to the top layer in order to meet grade.
   4. If the elevation of the top layer is 13 mm (1/2 inch) or more below the grade, excavate the top layer and replace with new material to a depth of at least 75 mm (3 inches) in compacted thickness.

C. Compaction:
   1. Perform compaction with approved equipment (hand or mechanical) well suited to the material being compacted.
   2. Moisten or aerate the material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used.
   3. Compact each layer to at least 95 percent or 100 percent of maximum density as determined by AASHTO T180 or AASHTO T99 respectively.

D. Smoothness Test and Thickness Control:

E. Test the completed subbase for grade and cross section with a straight edge.
   1. The surface of each layer shall not show any deviations in excess of 10 mm (3/8 inch).

2. The completed thickness shall be within 13 mm (1/2 inch) of the thickness as shown.

F. Protection:
1. Maintain the finished subbase in a smooth and compacted condition until the concrete has been placed.
2. When Contractor's subsequent operations or adverse weather disturbs the approved compacted subbase, excavate, and reconstruct it with new material meeting the requirements herein specified, at no additional cost to the VA.

3.3 SETTING FORMS

A. Base Support:
1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.

B. Form Setting:
1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.
2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.
3. Forms shall conform to line and grade with an allowable tolerance of 3 mm (1/8 inch) when checked with a straightedge and shall not deviate from true line by more than 6 mm (1/4 inch) at any point.
4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
5. Clean and oil forms each time they are used.

C. The Contractor’s California Registered Professional Land Surveyor shall establish and control the alignment and the grade elevations of the forms or concrete slipforming machine operations.
1. Make necessary corrections to forms immediately before placing concrete.
2. When any form has been disturbed or any subgrade or subbase has become unstable, reset and recheck the form before placing concrete.

3.4 EQUIPMENT

A. The Resident Engineer shall approve equipment and tools necessary for handling materials and performing all parts of the work prior to commencement of work.

B. Maintain equipment and tools in satisfactory working condition at all times.

3.5 PLACING REINFORCEMENT

A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement.

B. Before the concrete is placed, the Resident Engineer shall approve the reinforcement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown.

3.6 PLACING CONCRETE - GENERAL

A. Obtain approval of the Resident Engineer before placing concrete.

B. Remove debris and other foreign material from between the forms before placing concrete. Obtain approval of the Resident Engineer before placing concrete.

C. Before the concrete is placed, uniformly moisten the subgrade, base, or subbase appropriately, avoiding puddles of water.

D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.

E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.

F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.

G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.

3.7 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENT, AND EQUIPMENT PADS

A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.

B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.

C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.

D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.

E. Finish the surface to grade with a wood or metal float.

F. All Concrete pads and pavements shall be constructed with sufficient slope to drain properly.

3.8 PLACING CONCRETE FOR VEHICULAR PAVEMENT

A. Deposit concrete into the forms as close as possible to its final position.

B. Place concrete rapidly and continuously between construction joints.

C. Strike off concrete and thoroughly consolidate by a finishing machine, vibrating screed, or by hand-finishing.

D. Finish the surface to the elevation and crown as shown.

E. Deposit concrete as near the joints as possible without disturbing them but do not dump onto a joint assembly. Do not place adjacent lanes without approval by the Resident Engineer.

3.9 CONCRETE FINISHING - GENERAL

A. The sequence of operations, unless otherwise indicated, shall be as follows:
   1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
   2. Maintain finishing equipment and tools in a clean and approved condition.

3.10 CONCRETE FINISHING CURB

A. Round the edges of the gutter and top of the curb with an edging tool to a radius of 6mm (1/4 inch) or as otherwise detailed.

B. Float the surfaces and finish with a smooth wood or metal float until true to grade and section and uniform in textures.

C. Finish the surfaces, while still wet, with a bristle type brush with longitudinal strokes.

D. Immediately after removing the front curb form, rub the face of the curb with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Brush the surface, while still wet, in the same manner as the gutter and curb top.

E. Except at grade changes or curves, finished surfaces shall not vary more than 3 mm (1/8 inch) for gutter and 6 mm (1/4 inch) for top and face of curb, when tested with a 3000 mm (10 foot) straightedge.

F. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.

G. Correct any depressions which will not drain.

H. Visible surfaces and edges of finished curb, and combination curb and gutter shall be free of blemishes, form marks, and tool marks, and shall be uniform in color, shape, and appearance.

3.11 CONCRETE FINISHING PEDESTRIAN PAVEMENT

A. Walks, Grade Slabs, Wheelchair Curb Ramps, Terraces:
   1. Finish the surfaces to grade and cross section with a metal float, trowled smooth and finished with a broom moistened with clear water.
   2. Brooming shall be transverse to the line of traffic.
   3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.
   4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 2 mm (1/16 inch) in depth.
   5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks. The finished surface of the pavement shall not vary more than 5 mm (3/16 inch) when tested with a 3000 mm (10 foot) straightedge.
   6. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).
   7. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.

B. Steps: The method of finishing the steps and the sidewalls is similar to above except as herein noted.
   1. Remove the riser forms one at a time, starting with the top riser.
   2. After removing the riser form, rub the face of the riser with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Use an outside edger to round the corner of the tread; use an inside edger to finish the corner at the bottom of the riser.
   3. Give the risers and sidewall a final brush finish. The treads shall have a final finish with a stiff brush to provide a non-slip surface.

4. The texture of the completed steps shall present a neat and uniform appearance and shall not deviate from a straightedge test more than 5 mm (3/16 inch).

3.12 CONCRETE FINISHING FOR VEHICULAR PAVEMENT

A. Accomplish longitudinal floating with a longitudinal float not less than 3000 mm (10 feet) long and 150 mm (6 inches) wide, properly stiffened to prevent flexing and warping. Operate the float from foot bridges in a sawing motion parallel to the direction in which the pavement is being laid from one side of the pavement to the other, and advancing not more than half the length of the float.

B. After the longitudinal floating is completed, but while the concrete is still plastic, eliminate minor irregularities in the pavement surfaces by means of metal floats, 1500 mm (5 feet) in length, and straightedges, 3000 mm (10 feet) in length. Make the final finish with the straightedges, which shall be used to float the entire pavement surface.

C. Test the surface for trueness with a 3000 mm (10 foot) straightedge held in successive positions parallel and at right angles to the direction in which the pavement is being laid and the entire area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one half the length of the straightedge. Correct all irregularities and refinish the surface.

D. The finished surface of the pavement shall not vary more than 6 mm (1/4 inch) in both longitudinal and transverse directions when tested with a 3000 mm (10 foot) straightedge.

E. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).

F. When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, give the surface of the pavement a broomed finish with an approved fiber broom not less than 450 mm (18 inches) wide. Pull the broom gently over the surface of the pavement from edge to edge. Brooming shall be transverse to the line of traffic and so executed that the corrugations thus produced will be uniform in character and width, and not more than 3 mm (1/8 inch) in depth. Carefully finish the edge of the pavement along forms and at the joints with an edging tool. The brooming shall eliminate the flat surface left by the surface face of the edger.

G. The finish surfaces of new and existing abutting pavements shall coincide at their juncture.

3.13 CONCRETE FINISHING EQUIPMENT PADS

A. After the surface has been struck off and screeded to the proper elevation, give it a smooth dense float finish, free from depressions or irregularities.

B. Carefully finish all slab edges with an edger having a radius as shown in the Drawings.

C. After removing the forms, rub the faces of the pad with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. The finish surface of the pad shall not vary more than 3 mm (1/8 inch) when tested with a 3000 mm (10 foot) straightedge.

D. Correct irregularities exceeding the above.

3.14 JOINTS - GENERAL

A. Place joints, where shown, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.

B. Joints shall be straight and continuous from edge to edge of the pavement.

3.15 CONTRACTION JOINTS

A. Cut joints to depth as shown with a grooving tool or jointer of a radius as shown or by sawing with a blade producing the required width and depth.

B. Construct joints in curbs by inserting 3 mm (1/8 inch) steel plates conforming to the cross sections of the curb.

C. Plates shall remain in place until concrete has set sufficiently to hold its shape and shall then be removed.

D. Finish edges of all joints with an edging tool having the radius as shown.

E. Score pedestrian pavement with a standard grooving tool or jointer.

3.16 EXPANSION JOINTS

A. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.

B. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.

C. Anchor with approved devices to prevent displacing during placing and finishing operations.

D. Round the edges of joints with an edging tool.

E. Form expansion joints as follows:
   1. Without dowels, about structures and features that project through, into, or against any site work concrete construction.
   2. Using joint filler of the type, thickness, and width as shown.
   3. Installed in such a manner as to form a complete, uniform separation between the structure and the site work concrete item.

3.17 CONSTRUCTION JOINTS

A. Locate longitudinal, transverse, and construction joints between slabs of vehicular pavement as shown.

B. Place transverse construction joints of the type shown, where indicated and whenever the placing of concrete is suspended for more than 30 minutes.

C. Use a butt-type joint with dowels in curb if the joint occurs at the location of a planned joint.

D. Use keyed joints with tiebars if the joint occurs in the middle third of the normal curb joint interval.

3.18 FORM REMOVAL

A. Forms shall remain in place at least 12 hours after the concrete has been placed. Remove forms without injuring the concrete.

B. Do not use bars or heavy tools against the concrete in removing the forms. Promptly repair any concrete found defective after form removal.

3.19 CURING OF CONCRETE

A. Cure concrete by one of the following methods appropriate to the weather conditions and local construction practices, against loss of moisture, and rapid temperature changes for at least seven days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready to install before actual concrete placement begins. Provide protection as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement and employ another method of curing as directed by the Resident Engineer.

B. Burlap Mat: Provide a minimum of two layers kept saturated with water for the curing period. Mats shall overlap each other at least 150 mm (6 inches).

C. Impervious Sheeting: Use waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Polyethylene shall be at lease 0.1 mm (4 mils) in thickness. Wet the entire exposed concrete surface with a fine spray of water and then cover with the sheeting material. Sheets shall overlap each other at least 300 mm (12 inches). Securely anchor sheeting.

D. Liquid Membrane Curing:
   1. Apply pigmented membrane-forming curing compound in two coats at right angles to each other at a rate of 5 m^2/L (200 square feet per gallon) for both coats.
   2. Do not allow the concrete to dry before the application of the membrane.
   3. Cure joints designated to be sealed by inserting moistened paper or fiber rope or covering with waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint.
   4. Immediately re-spray any area covered with curing compound and damaged during the curing period.

3.20 CLEANING

A. After completion of the curing period:
   1. Remove the curing material (other than liquid membrane).
   2. Sweep the concrete clean.
   3. After removal of all foreign matter from the joints, seal joints as herein specified.
   4. Clean the entire concrete of all debris and construction equipment as soon as curing and sealing of joints has been completed.

3.21 PROTECTION

A. The contractor shall protect the concrete against all damage prior to final acceptance by the Government. Remove concrete containing excessive cracking, fractures, spalling, or other defects and reconstruct the entire section between regularly scheduled joints, when directed by the Resident Engineer, and at no additional cost to the Government. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the Resident Engineer.

3.22 FINAL CLEAN-UP

A. Remove all debris, rubbish and excess material from the Station.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work shall cover the composition, mixing, construction upon the prepared subgrade, and the protection of hot asphalt concrete pavement. The hot asphalt concrete pavement shall consist of an aggregate or asphalt base course and asphalt surface course constructed in conformity with the lines, grades, thickness, and cross sections as shown. Each course shall be constructed to the depth, section, or elevation required by the drawings and shall be rolled, finished, and approved before the placement of the next course.

1.2 RELATED WORK

A. Laboratory and field testing requirements: Section 01 45 29, TESTING LABORATORY SERVICES.

B. Subgrade Preparation: Paragraph 3.3 and Section 31 20 00, EARTH MOVING.

C. Pavement Markings: Section 32 17 23, PAVEMENT MARKINGS.

1.3 INSPECTION OF PLANT AND EQUIPMENT

A. The Resident Engineer shall have access at all times to all parts of the material producing plants for checking the mixing operations and materials and the adequacy of the equipment in use.

1.4 ALIGNMENT AND GRADE CONTROL

A. The Contractor's Registered Professional Land Surveyor shall establish and control the pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on the Drawings.

1.5 SUBMITTALS

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

B. Data and Test Reports:
   1. Aggregate Base Course: Sources, gradation, liquid limit, plasticity index, percentage of wear, and other tests required by State Highway Department.
   2. Asphalt Base/Surface Course: Aggregate source, gradation, soundness loss, percentage of wear, and other tests required by State Highway Department.
   3. Job-mix formula.

C. Certifications:
   1. Asphalt prime and tack coat material certificate of conformance to State Highway Department requirements.
   2. Asphalt cement certificate of conformance to State Highway Department requirements.
   3. Job-mix certification - Submit plant mix certification that mix equals or exceeds the State Highway Specification.

D. One copy of State Highway Department Specifications.

E. Provide MSDS (Material Safety Data Sheets) for all chemicals used on ground.

PART 2 - PRODUCTS

2.1 GENERAL

A. Aggregate base and asphalt concrete materials shall conform to the requirements of the following and other appropriate sections of the latest version of the State Highway Material Specifications, including amendments, addenda and errata. Where the term "Engineer" or "Commission" is referenced in the State Highway Specifications, it shall mean the VA Resident Engineer or VA Contracting Officer.

2.2 AGGREGATES

A. Provide aggregates consisting of crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.

B. Subbase aggregate (where required) maximum size: 38mm(1-1/2").

C. Base aggregate maximum size:
   1. Base course over 152mm(6") thick: 38mm(1-1/2");
   2. Other base courses: 19mm(3/4").

D. Asphaltic base course:
   1. Maximum particle size not to exceed 25.4mm(1”).
   2. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

E. Aggregates for asphaltic concrete paving: Provide a mixture of sand, mineral aggregate, and liquid asphalt mixed in such proportions that the percentage by weight will be within:

Sieve Sizes	Percentage Passing
19mm(3/4")	100
9.5mm(3/8")	67 to 85
6.4mm(1/4")	50 to 65
2.4mm(No. 8 mesh)	37 to 50
600µm(No. 30 mesh)	15 to 25
75µm(No. 200 mesh)	3 to 8

plus 50/60 penetration liquid asphalt at 5 percent to 6-1/2 percent of the combined dry aggregates.

2.3 ASPHALTS

A. Comply with provisions of Asphalt Institute Specification SS2:
   1. Asphalt cement: Penetration grade 50/60
   2. Prime coat: Cut-back type, grade MC-250
   3. Tack coat: Uniformly emulsified, grade SS-1H

2.4 SEALER

A. Provide a sealer consisting of suitable fibrated chemical type asphalt base binders and fillers having a container consistency suitable for troweling after thorough stirring, and containing no clay or other deleterious substance.

B. Where conflicts arise between this specification and the requirements in the latest version of the State Highway Specifications, the State Specifications shall control.

PART 3 - EXECUTION

3.1 GENERAL

A. The Asphalt Concrete Paving equipment, weather limitations, job-mix formula, mixing, construction methods, compaction, finishing, tolerance, and protection shall conform to the requirements of the appropriate sections of the State Highway Specifications for the type of material specified.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

A. Provide hot plant-mixed asphaltic concrete paving materials.
   1. Temperature leaving the plant: 143 degrees C(290 degrees F) minimum, 160 degrees C(320 degrees F) maximum.
   2. Temperature at time of placing: 138 degrees C(280 degrees F) minimum.

3.3 SUBGRADE

A. Shape to line and grade and compact with self-propelled rollers.

B. All depressions that develop under rolling shall be filled with acceptable material and the area re-rolled.

C. Soft areas shall be removed and filled with acceptable materials and the area re-rolled.

D. Should the subgrade become rutted or displaced prior to the placing of the subbase, it shall be reworked to bring to line and grade.

E. Proof-roll the subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by VA Resident Engineer or VA Contracting Officer. If pumping, pushing, or other movement is observed, rework the area to provide a stable and compacted subgrade.

3.4 BASE COURSES

A. Subbase (when required)
   1. Spread and compact to the thickness shown on the drawings.
   2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.
   3. After completion of the subbase rolling there shall be no hauling over the subbase other than the delivery of material for the top course.

B. Base
   1. Spread and compact to the thickness shown on the drawings.
   2. Rolling shall begin at the sides and continue toward the center and shall continue until there is no movement ahead of the roller.

3. After completion of the base rolling there shall be no hauling over the base other than the delivery of material for the top course.

C. Thickness tolerance: Provide the compacted thicknesses shown on the Drawings within a tolerance of minus 0.0mm (0.0") to plus 12.7mm (0.5").

D. Smoothness tolerance: Provide the lines and grades shown on the Drawings within a tolerance of 5mm in 3m (3/16 inch in ten feet).

E. Moisture content: Use only the amount of moisture needed to achieve the specified compaction.

3.5 PLACEMENT OF ASPHALTIC CONCRETE PAVING

A. Remove all loose materials from the compacted base.

B. Apply the specified prime coat, and tack coat where required, and allow to dry in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

C. Receipt of asphaltic concrete materials:
   1. Do not accept material unless it is covered with a tarpaulin until unloaded, and unless the material has a temperature of not less than 130 degrees C(280 degrees F).
   2. Do not commence placement of asphaltic concrete materials when the atmospheric temperature is below 10 degrees C (50 degrees F), not during fog, rain, or other unsuitable conditions.

D. Spreading:
   1. Spread material in a manner that requires the least handling.
   2. Where thickness of finished paving will be 76mm (3") or less, spread in one layer.

E. Rolling:
   1. After the material has been spread to the proper depth, roll until the surface is hard, smooth, unyielding, and true to the thickness and elevations shown own the drawings.
   2. Roll in at least two directions until no roller marks are visible.
   3. Finished paving smoothness tolerance:
      a. No depressions which will retain standing water.
      b. No deviation greater than 3mm in 1.8m (1/8" in six feet).

3.6 APPLICATION OF SEAL COAT

A. Prepare the surfaces, mix the seal coat material, and apply in accordance with the manufacturer's recommendations as approved by the Architect or Engineer.

B. Apply one coat of the specified sealer.

C. Achieve a finished surface seal which, when dry and thoroughly set, is smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

3.7 PROTECTION

A. Protect the asphaltic concrete paved areas from traffic until the sealer is set and cured and does not pick up under foot or wheeled traffic.

3.8 FINAL CLEAN-UP

A. Remove all debris, rubbish, and excess material from the work area.

END OF SECTION

SECTION 32 84 00

PLANTING IRRIGATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. An automatically-controlled irrigation system, complete, including piping, backflow preventer, sprinkler heads, valves, controls, control wiring, fittings, electrical connections and necessary accessories.

1.2 RELATED WORK

A. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.

C. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

D. Division 26, ELECTRICAL.

E. Section 32 90 00, PLANTING

1.3 QUALITY ASSURANCE

A. Criteria:

1. Manufacturer regularly and presently manufactures the item submitted as one of their principal products.

2. There is a permanent service organization, maintained or trained by the manufacturer, which will render satisfactory service within eight hours of receipt of notification that service is requested.

3. Installer, or supplier of a service, has technical qualifications, experience, and trained personnel and facilities to perform the specified work.

B. Products Criteria:

1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units are products of one manufacturer.

2. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

   a. All components of an assembled unit need not be products of the same manufacturer but component parts which are alike are the product of a single manufacturer.

   b. Components are compatible with each other and with the total assembly for the intended service.

3. Nameplates: Nameplate bearing manufacturer's name or identification trademark 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.

C. System Requirements:

1. Full and complete coverage is required. Contractor shall, at no additional cost to the Government, make necessary adjustments to layout required to achieve full coverage of irrigated areas without overthrow on roadways, sidewalks, window wells, or buildings and to protect trees from close high spray velocity.

2. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown. Lines are to be common trenched wherever possible.

3. Locations of remote control valves is schematic. Remote control valves shall be grouped wherever possible and aligned at a set dimension back of curb along roads.

4. Irrigation lines and control wire shall run through designated utility lanes or beside roadways where possible.

5. Connect new system to existing mains.

D. Maintenance and Operating Instructions: Prior to final acceptance, verbal instructions, for a period of not less than 4 hours, shall be provided to the operating personnel. Provide manuals as specified in Section 01 00 00, GENERAL REQUIREMENTS.

E. Completely program controller according to approved irrigation schedule.

F. Follow manufacturer's instructions for installation.

G. As-Built Record Drawings: Maintain a complete set of as-built drawings which shall be corrected daily to show changes in locations of all pipe, valves, pumps and related irrigation equipment. Valves shall be shown with dimensions to reference points.

H. Controller Chart:

1. Prepare a map diagram showing location of all valves, lateral lines, and route of the control wires. Identify all valves as to size, station, number and type of irrigation. "As-built" drawings must be approved before charts are prepared.

2. Provide one controller chart showing the area covered by controller for each automatic controller supplied at the maximum size controller door will allow. Chart shall be a reduced drawing of the actual "as-built" system. If controller sequence is not legible when the drawing is reduced to door size, the drawing shall be enlarged to a size that is readable and placed folded, in a sealed plastic container, inside the controller door.

3. Chart shall be a blackline print with a different color used to show area of coverage for each station. Charts must be completed and approved prior to final inspection of the irrigation system.

1.4 SUBMITTALS

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

B. Manufacturers' Literature and Data:
1. Piping.
2. Jointing materials.
3. Valves.
4. Backflow preventer and enclosure.
5. Wiring and connectors.
6. Automatic control equipment.
7. Sprinkler heads.
8. Rain sensor.
9. Quick couplers.

10. Valve boxes.

C. Name and address of a permanent service organization maintained or trained by the manufacturers that will render satisfactory service within eight hours of receipt of notification that service is requested.

D. Reproducible "as-built" drawings.

E. After "as-built" drawings have been approved, submit print of controller chart.

1.5 APPLICABLE PUBLICATIONS

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

B. Federal Specifications (Fed. Spec.):
A-A-60005 Frames, Covers, Gratings, Steps, Sump And Catch Basin, Manhole

C. American National Standard Institute (ANSI):
B40.100-05 Gauges-Pressure Indicating Dial Type-Elastic Element

D. American Society of Sanitary Engineers (ASSE):
1013-2009 Reduced Pressure Principle Backflow Preventers

E. American Society for Testing and Materials (ASTM):
B61-08 Steam or Valve Bronze Castings

B62-09 Composition Bronze or Ounce Metal Castings

D1785-06 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120

D2241-05 Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)

D2464-06 Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2466-06 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

D2564-04 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems

D2855-96(R2002) Making Solvent Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

F477-08 Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F. American Water Works Association (AWWA):

C110/A21.10-08 Ductile-Iron and Gray-Iron Fittings, 3-Inch Through 48-Inch for Water

C111/A21.11-06 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

C115/A21.15-05 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

C151/A21.51-09 Ductile-Iron Pipe, Centrifugally Cast, for Water

C504-06 Rubber Seated Butterfly Valves

C600-05 Installation of Ductile-Iron Water Mains and Their Appurtenances

C900-07 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 4in. Through 12in.

G. Manufacturers Standardization Society (MSS):

SP-70-06 Gray Iron Gate Valves, Flanged and Thread Ends

PART 2 - PRODUCTS

2.1 PIPING

A. Irrigation Mains: Provide one of the following materials.

1. Polyvinyl Chloride (PVC) Pressure Pipe, AWWA C900, SCH 40 PVC, working pressure 1025 kPa (150 psi).

B. Irrigation Laterals: Polyvinyl Chloride, ASTM D2241, SCH 40 PVC, solvent welded.

C. Threaded Pipe: Polyvinyl Chloride, ASTM D1785, PVC 1120, Schedule 80, for threaded connections, risers and swing joints.

D. Above Grade and in Concrete Pit: AWWA C115, flanged joints and fittings working pressure 1025 kPa (150 psi).

E. Fittings:
1. Irrigation Laterals: PVC, schedule 40, solvent welded socket type, ASTM D2466.
2. Threaded Pipe: PVC, schedule 80, ASTM D2464.
3. Swing Joints: Threaded fittings with elastomeric seals that allow 360 degree rotation, and designed for minimum 1375 kPa (200 psig) working pressure, may be used in lieu of standard threaded fittings.

F. Jointing Materials:

1. Irrigation Mains: Rubber gaskets, AWWA C111.
2. Irrigation Laterals: Solvent cement, ASTM D2564.

2.2 VALVES (EXCEPT REMOTE CONTROL VALVES)

A. Underground Shut-Off Valves: Provide One of the Following:

1. Gate valves 50 mm (2 inches) and larger: Iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 1025 kPa (150 psi) minimum working pressure. AWWA C504.

2. Butterfly valves 80 mm (3 inches) and larger: cast iron body with stainless steel shaft, ductile iron valve disc and resilient rubber coated, 1025 kPa (150 psi) minimum pressure. AWWA C504.

3. Ball valves (for isolation valves 1-1/2” and smaller): Full-port ball valves with bronze body, PTFE seats, and 90 degree on/off handle. Ball valves to have NPT female end connections.

B. Operations:

1. Underground: furnish valves with 50 mm (2 inch) nut for T-Handle socket wrench operation.

2. Above ground and in pits: MSS SP-70, with handwheels.

3. All butterfly valves 150 mm (6 inches) and above shall have enclosed gear drive operators.

4. Ends of valves shall accommodate the type of pipe installed.

C. Check: Swing.

1. Smaller than 100 mm (4 inches): Bronze body and bonnet, ASTM B61 or B62, 850 kPa (125 pound) WSP.

2. One hundred mm (4 inches) and larger: Iron body, bronze trim, vertical or horizontal installation, flange connection, 1375 kPa (200 pound) WOG.

D. Pressure Reducing Valve: Cast steel body with renewable seats, with stainless steel trim. Flow passages and all parts designed to withstand high velocity applications, flange connected.

2.3 VALVE BOX

A. Gate and Butterfly Valve: Valve boxes shall be precast concrete (from Rigid Cast Iron Forms) with compressive strength of the concrete in excess of 30 Mpa (4000 psi). Box shall be of such length to be adapted to depth of cover required over pipe at valve location. Mark box cover to differentiate between irrigation system and domestic water supply system and set flush with finished grade. Provide 1 "T" handle socket wrenches of 15 mm (5/8 inch) round stock with sufficient length to extend 600 mm (2 feet) above top of deepest valve box cover.

B. Remote Control Valves: When in pavement, valve boxes shall be precast concrete (from Rigid Cast Iron Forms) with compressive strength of the concrete in excess of 30 MPa (4000 psi). In planter areas, valve boxes shall be HDPE structural foam Type A, Class III, green in color. Box shall be minimum 475 mm (19 inches) long by 350 mm (14 inches) deep with key-lockable hinged cast iron cover.

1. After installation, label boxes with two 80 mm (3 inch) size stencils designated controller and circuit numbers with permanent white epoxy paint. Numbers shall be placed at center of valve cover and shall face nearest main road or service road.

2. Furnish one 750 mm (30 inch) long valve adjustment keys.

2.4 BACKFLOW PREVENTER

A Provide reduced pressure principle backflow preventer in each new connection to existing water distribution system, ASSE 1013. Febco 825Y BV-1", in Strongbox SBBC-30 CR, tan color.

2.5 AUTOMATIC CONTROL EQUIPMENT—INDEPENDENT ELECTRIC CONTROLLER WITH FLOW SENSING

A. Overall control concept: The electric automatic control system shall consist of one controller which operates individual remote control valves in accordance with timing schedules programmed into the independent unit. The location of the controller is shown on the drawings. Toro Sentinel Series, Model DDAK24WS36NS-TRS-TFS-SHHR or approved equal.

B. 4 independent programs.

C. Seven (7) day calendar, odd/even day or day interval options of one (1) to thirty (30) days.

D. Exclude a day option to allow for the selection of specific day(s) not to water.

E. Three hundred sixty-five (365) day clock/calendar.

F. Station run times of one (1) minute to ten (10) hours in one (1) minute increments.

G. 16 total start times.

H. Start time stacking within each program.

I. Season adjust setting from ten (10) to two hundred (200) percent in ten (10) percent increments.

J. Rain delay setting from one (1) to seven (7) days

K. Automatic, semi-automatic, and manual and timed-manual operation.

L. 10 position programming dial and LCD display.

M. Lightning surge protection.

N. Self-diagnostic circuit breakers that identify and override electrical malfunction of valves.

O. Non-volatile memory to retain power during power failures of any duration.

P. Battery backup to maintain accurate time for up to ninety (90) days.

Q. Sensor hook-up with sensor override switch on faceplate.

R. Weather-resistant, locking metal cabinet with heavy duty internal transformer.

S. Wireless rain sensor, Toro model 53770- Wireless RainSensor, or approved equal.

2.6 REMOTE CONTROL VALVES:

A. Each sprinkler section shall be automatically operated by a remote control valve installed underground and operated by a 24-volt AC electric solenoid Valves shall be globe type of heavy duty construction and shall have manual shut-off and flow control adjustment and provide for manual operation. Install valves with unions on each side to allow for easy removal. Valves shall have a minimum of 1025 kPa (150 psi) working pressure.

B. Valves shall be of all brass construction furnished as straight or angle pattern type, or valve body shall be cast-iron with brass bonnet, trim and renewable seat and have two inlet tappings (furnished with one plugged) to allow installation as either a straight or angle pattern valve.

C. Valves shall be diaphragm type designed to operate in water containing sand and debris and shall have a self cleaning type contamination filter to filter all water leading to the solenoid actuator and the diaphragm chamber. Valve shall incorporate a non-adjustable type opening and closing speed control for protection against surge pressures, or valves shall operate by means of a slow acting direct drive thermal hydraulic motor without ports, screens or diaphragms

D. Valves shall be completely serviceable from the top without removing valve body from the system. Furnish one 750 mm (30 inch) long adjustment keys. Valves to operate at no more than 50 kPa (7 psi) pressure loss at manufacturers maximum recommended flow rate.

2.7 SPRINKLER HEADS

A. Shall be of make, type and performance as indicated on drawings. The entire internal assembly including filter screen, to be capable of removal from the top without removing the sprinkler case from the riser.

B. Rotary Pop-up Sprinklers: To be gear-driven.

1. Full Circle Sprinklers: To be a dual or tri-nozzle combination type with positive drive by means of a water-driven gear assembly. Sprinkler head to rotate uniformly and to be driven by means of a train of gears. Sprinklers to be equipped with an integral anti-drain valve to be self-closing at pressures of 3.0m (10 feet) of head or less. Gears and pinions shall be assembled on stainless steel spindles in a water-lubricated sandproof gear case. An inlet screen shall prevent debris from entering the sprinkler and shall be removable with the internal assembly. Sprinklers outer case shall be constructed of corrosion resistant, impact resistant, heavy-duty ABS.

2. Part circle sprinklers to be variable arc type as required with same type drive used for full circle heads.

C. Shrub Spray Heads: Nozzle shall be pop-up or fixed spray type of standard, undersize or oversize configuration as noted on plans. The sprinkler body, stem, nozzle and screen shall be constructed of heavy-duty, ultraviolet resistant plastic. It shall have a heavy duty stainless steel retract spring and a ratcheting system for alignment of the pattern. The sprinkler shall have a soft elastomer pressure-activated comolded wiper seal for cleaning debris from the pop-up stem. The sprinkler shall have a plastic or brass nozzle with an adjusting screw capable of regulating the radius and flow. The sprinkler shall be capable of housing protective, nonclogging filter screens or pressure compensating screens (PCS) under the nozzle.

2.8 QUICK COUPLERS

A. Shall have all parts contained in a two-piece unit and shall consist of a coupler water seal valve assembly and a removable upper body to allow the spring and key track to be serviced without shut down of the main.

B. Metal parts shall be brass.

C. Lids shall be lockable vinyl covered and have springs for positive closure on key removal.

D. Furnish two hose swivels and operating keys for each size coupler to the Resident Engineer.

2.9 LOW VOLTAGE CONTROL VALVE WIRE

A. Wire: Solid copper wire, Underwriters Laboratories Inc. approved for direct burial in ground. Size of wire shall be in accordance with manufacturer's recommendations, but in no case less than No. 14.

2.10 SPLICING MATERIALS: EPOXY WATERPROOF SEALING PACKET. LOW VOLTAGE CONTROLLER CABLE

A. Multi-strand cable, Underwriters Laboratories Inc. approved for direct burial in ground. Size and type of wire shall be in accordance with manufacturer’s recommendations.

2.11 SLEEVE MATERIAL

A. PVC-1120-5DR 17, Schedule 40.

2.12 WARNING TAPE

A. Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape, detectable type blue with black letters (if potable water), or purple with black letters (if reclaimed or untreated well water), and imprinted with “CAUTION BURIED IRRIGATION WATER LINE BELOW”.”

B. Tracer Wires

1. No. 14, Green, Type TW plastic-coated copper tracer wire shall be installed with non-metallic irrigation main lines.

PART 3 - EXECUTION

3.1 PIPE LAYING - GENERAL

A. Do not lay pipe on unstable material, in wet trench or when, in the opinion of Resident Engineer, trench or weather conditions are unsuitable for the work.

B. Concrete thrust block shall be installed where the irrigation main changes direction as at ells and tees and where the irrigation main terminates. Pressure tests shall not be made for a period of 36 hours following the completion of pouring of the thrust blocks. Concrete thrust blocks for supply mains shall be sized and placed in strict accordance with the pipe manufacturer's specifications and shall be of an adequate size and so placed as to take all thrust created by the maximum internal water pressure.

C. Allow a minimum of 80 mm (3 inches) between parallel pipes in the same trench.

D. Hold pipe securely in place while joint is being made.

E. Do not work over, or walk on, pipe in trenches until covered by layers of earth well tamped in place to a depth of 300 mm (12 inches) over pipe.

F. Full length of each section of pipe shall rest upon the pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipe on wood blocking.

G. Install sprinkler lines to avoid heating trenches, electric ducts, storm and sanitary sewer lines, and existing water and gas mains, all of which have right of way.

H. Clean interior of pipe of foreign matter before installation. Keep pipe clean during laying operations by means of plugs or other methods. When work is not in progress, securely close open ends of pipe and fittings to prevent water, earth, or other substances from entering.

I. Each sprinkler section shall drain to waste valves placed at lowest points in the system. Waste valves shall discharge to drainage pits composed of 3 foot long vertical sections of 600 mm (24

inch) diameter sewer pipe placed under the lawn areas. Fill pipe with gravel and cover with 50 mm (2 inch) precast concrete cover before backfilling. Waste valves may also discharge to storm sewers, where available.

J. Minimum cover over water mains shall be 750 mm (30 inches). Control valves shall never be less than 80 mm (3 inches) below finished grade. Cover laterals to minimum depth of 600mm (24 inches).

K. Existing sidewalks and curbs shall not be cut during trenching and installation of pipe. Install pipe under sidewalks and curbs by jacking, auger boring, or by tunneling. Repair or replace any concrete that cracks, due to settling, during the warranty period.

L. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.

M. Warning tape shall be continuously placed 300 mm (12 inches) above sprinkler system water mains and laterals.

3.2 LAYING PLASTIC PIPE

A. Shall be snaked in trench at least 1 meter to 100 meters (1 foot per 100 feet) to allow for thermal construction and expansion and to reduce strain on connections.

B. Joints

1. Solvent Welded Socket Type: ASTM D2855.

2. Threaded Type: Apply liquid teflon thread lubricant of teflon thread type. After joint is made hand tight (hard), a strap wrench should be used to make up to two additional full turns.

3. Elastomeric Gasket: ASTM F477.

a. Immediately before joining two lengths of PVC pipe, the inside of the bell or coupling, the outside of the spigot and the elastomeric gasket shall be thoroughly cleaned to remove all foreign material.

b. Lubrication of the joint and rubber gasket shall be done in accordance with the pipe manufacturer's specifications.

c. Care shall be taken that only the correct elastomeric gasket, compatible with the annular groove of the bell, is used. Insertion of the elastomeric gasket in the annular groove of the bell or coupling shall be in accordance with the manufacturer's recommendations. Pipe that is not furnished with a depth mark shall be marked before assembly to assure that the spigot end is inserted to the full depth of the joint.

d. The spigot and bell or coupling shall be aligned and pushed until the reference line on the spigot is flush with the end of the bell or coupling. Pushing shall be done in a smooth, steady motion.

3.3 INSTALLATION OF SPRINKLERS AND QUICK COUPLERS

A. Sprinkler heads and quick couplers shall be placed on temporary nipples extending at least 80 mm (3 inches) above finished grade. After turf is established, remove temporary nipples, ensuring that no dirt or foreign matter enters outlet, and install sprinkler heads and quick couplers at ground surface as detailed.

B. Place part-circle rotary sprinkler heads no more than 150 mm (6 inches) from edge, of and flush with top of adjacent walks, header boards, curbs, and mowing aprons, or paved areas at time of installation.

C. Install all shrub sprays, sprinklers and quick couplers on swing joints as detailed on plans.

D. Set shrub heads 200 mm (8 inches) above grade and 300 mm (1 foot) from edge of curb or pavement. Place adjacent to walls. Stake heads prior to backfilling trenches. Stakes to be parallel to riser.

E. Install sprinklers and quick coupling valves on a swing joint assembly.

3.4 INSTALLATION OF CONTROL WIRING

A. Wiring from master controllers to satellites and stub-cuts for future extension shall be located in trench with new mains or in separate trench at back of curb, unless cross-country route is shown. Locate in trench with mains when possible on cross-country routes.

B. Wiring bundles located with piping shall be set with top of the bundle below top of the pipe. No two wires in any bundle shall be of the same color. Wires shall be bundled, and tied or taped at 4.5 m (15 foot) intervals. A numbered tag shall be provided at each end of a wire, i.e., at valve, at field located controllers and at master controller. The number at each end of wire to be the same.

C. Splicing shall be held to a minimum. A pullbox shall be provided at each splice. No splices will be allowed between field located controllers and remote control valves.

D. Provide 300 mm (12 inch) expansion loops in wiring at each wire connection or change in wire direction. Provide 600 mm (24 inch) loop at remote control valves.

E. Power wiring for the operation of irrigation system shall not be run in same conduit as control wiring.

3.5 TRACER WIRE INSTALLATION

A. Tracer wire shall be installed on bottom of trench, adjacent to vertical pipe projections, carefully installed to avoid stress from backfilling, and shall be continuous throughout length of pipe with spliced joints soldered and covered with insulation type tape.

B. Tracer wire shall follow main line pipe and branch lines and terminate in yard box with gate valve controlling these main irrigation lines. Provide sufficient length of wire to reach finish grade, bend back end of wire to make a loop and attach a Dymo-Tape type plastic label with designation "Tracer Wire."

C. Record locations of tracer wires and their terminations on project record documents.

3.6 SETTING OF VALVES

A. No valves shall be set under roads, pavement or walks.

B. Clean interior of valves of foreign matter before installation.

C. Where pressure control valves are installed adjacent to remote control valve, they shall be housed in the same valve box.

D. Set valve box cover flush with finished grade.

3.7 SLEEVING

A. Furnish and install where pipe and control wires pass under walks, paving, walls, and other similar areas.

B. Sleeving to be twice line size or greater to accommodate retrieval for repair of wiring or piping and shall extend 300 mm (12 inches) beyond edges of paving or construction.

C. Bed sleeves with a minimum of 100 mm (4 inches) of sand backfill above top of pipe.

3.8 TEST AND FLUSHING

A. Pressure Test: Pressure test lines before joint areas are backfilled. Backfill a minimum of 300 mm (12 inches) over the pipe to maintain pipe stability during test period. Test piping at hydraulic pressure of 1025 kPa (150 psi) for two hours. Maximum loss shall be 3 L/25 mm pipe diameter/300 m (0.8 gallons/inch pipe diameter/1000-feet). Locate pump at low point in line and

apply pressure gradually. Install pressure gage shut-off valve and safety blow-off valve between pressure source and piping. Inspect each joint and repair leaks. Line shall be retested until satisfactory.

B. Flushing: After testing, flush system with a minimum of 150 percent of operating flow passing through each pipe beginning with larger mains and continuing through smaller mains in sequence. Flush lines before installing sprinkler heads and quick couplers.

C. Operation Test: Upon completion of the final adjustment of the sprinkler heads to permanent level at ground surface, test each sprinkler section by the pan test and visual test to indicate a uniform distribution within any one sprinkler head area and over the entire area. Operate the entire installation to demonstrate the complete and successful operation of all equipment.

END OF SECTION

SECTION 32 90 00
PLANTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work consists of furnishing and installing all planting materials required for landscaping hereinafter specified in locations as shown.

1.2 EQUIPMENT

A. Maintain all equipment, tools and machinery while on the project in sufficient quantities and capacity for proper execution of the work.

1.3 RELATED WORK

A. Section 31 20 00, EARTH MOVING, Stripping Topsoil and Stock Piling.

B. Section 01 45 29, TESTING LABORATORY SERVICES, Topsoil Testing.

C. Section 31 20 00, EARTH MOVING, Topsoil Materials.

D. Section 32 84 00, PLANTING IRRIGATION.

E. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.4 SUBMITTALS

A. Samples: Submit the following samples in a one gallon resealable (ziplock) freezer bag for approval before work is started:

Inert Mulch	0.5 kg (1 pound) of each type to be used.
Organic Mulch	0.25 kg (0.5 pound) of each type to be used.

B. Certificates of Conformance or Compliance: Before delivery, notarized certificates attesting that the following materials meet the requirements specified shall be submitted to the Resident Engineer for approval:

1. Plant Materials (Department of Agriculture certification by State Nursery Inspector declaring material to be free from insects and disease).
2. Fertilizers
3. Soil conditioners
4. Seed

C. Manufacturer's Literature and Data:

1. Edging
2. Pre-emergent herbicide

D. Soil laboratory testing results and any soil amendment recommendations from the Contractor.

1.5 DELIVERY AND STORAGE

A. Delivery:

1. Notify the Resident Engineer of the delivery schedule in advance so the plant material may be inspected upon arrival at the job site. Remove unacceptable plant material from the job site immediately.
2. Protect plants during delivery to prevent damage to root balls or desiccation of leaves. Protect trees during transport by tying in the branches and covering all exposed branches. Transporting all plant material in a closed vehicle such as a box truck is preferred.
3. The use of equipment such as "tree spades" is permitted provided the plant balls are sized in accordance with ANSI Z60.1 and tops are protected from damage.
4. Deliver fertilizer and soil conditioners to the site in the original, unopened containers bearing the manufacturer's warranteed chemical analysis, name, trade name or trademark, and in conformance to state and federal law. In lieu of containers, fertilizer and soil conditioners may be furnished in bulk and a certificate indicating the above information shall accompany each delivery.

B. Storage:

1. Keep seed, lime, and fertilizer in dry storage away from contaminants.
2. Store plants not installed on the day of arrival at the site as follows:
   a. Shade and protect plants from the wind when stored outside.
   b. Keep plants, including those in containers, in a moist condition until planted, by watering with fine mist spray.

1.6 PLANTING AND TURF INSTALLATION SEASONS AND CONDITIONS

A. No work shall be done when the ground is too wet or in an otherwise unsuitable condition for planting. Special conditions may exist that warrants a variance in the specified planting dates or conditions. Submit a written request to the Resident Engineer stating the special conditions and proposal variance.

1.7 PLANT AND TURF ESTABLISHMENT PERIOD

A. The Establishment Period for plants and turf shall begin after the approval of the Resident Engineer, and continue until the date that the Government accepts the project or phase for

beneficial use and occupancy. During the Plant and Turf Establishment Period the Contractor shall:

1. Water all plants and turf to maintain an adequate supply of moisture within the root zone. An adequate supply of moisture is the equivalent of 25 mm (1 inch) of absorbed water per week either through natural rainfall or augmented by periodic watering. Apply water at a moderate rate so as not to displace the mulch or flood the plants and turf.
2. Prune plants and replace mulch as required.
3. Replace and restore stakes, guy wires, and eroded plant saucers as required.
4. In plant beds and saucers, remove grass, weeds, and other undesired vegetation, including the root growth, before they reach a height of 75 mm (3 inches).
5. Remove plants that die during this period and replace each plant with one of the same size and species.

1.8 PLANT AND TURF WARRANTY

A. All work shall be in accordance with the terms of the Paragraph, "Warranty" of FAR clause 52.246-21, including the following supplements:

1. A One Year Plant Warranty will begin on the date that the Government accepts the project or phase for beneficial use and occupancy. The Contractor shall have completed, located, and installed all plants and turf according to the plans and specifications. All plants are expected to be living and in a healthy condition at the time of final inspection.
2. The Contractor will replace any dead plant material immediately. A one year warranty for the plants that were replaced, will begin on the day the work is completed.
3. Replacement of relocated plants that the Contractor did not supply is not required unless they die from improper handling and care during transplanting. Loss through Contractor negligence requires replacement in kind and size.
4. The Government will reinspect all plants at the end of the One Year Warranty. The Contractor will replace any dead, missing, or defective plant material immediately. The Warranty will end on the date of this inspection provided the Contractor has complied with the work required by this specification. The Contractor shall also comply with the following requirements:
   a. Replace dead, missing or defective plant material prior to final inspection.
   b. Mulch and weed plant beds and saucers. Just prior to this inspection, treat these areas to a second application of approved pre-emergent herbicide.
   c. From plants having been installed for one year, remove stakes.

d. Complete remedial measures directed by the Resident Engineer to ensure plant and turf survival.

e. Repair damage caused while making plant replacements.

1.9 APPLICABLE PUBLICATIONS

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

B. American National Standards Institute (ANSI) Publications:

ANSI Z60.1-04Nursery Stock

ANSI Z133.1-06 Tree Care Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush- Safety Requirements

C. Hortus Third, A Concise Dictionary of Plants Cultivated in the U.S. and Canada.

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

C136-06 Sieve Analysis of Fine and Coarse Aggregates

C516-02 Vermiculite Loose Fill Thermal Insulation

C549-06 Perlite Loose Fill Insulation

D977-05 Emulsified Asphalt (AASTHO M140)

D2028-97 (Rev. 2004) Cutback Asphalt (Rapid-curing Type)

D2103-05 Polyethylene Film and Sheeting

PART 2 - PRODUCTS

2.1 GENERAL

A. All plant material will conform to the varieties specified or shown in the plant list and be true to botanical name as listed in Hortus Third.

2.2 PLANTS

A. Plants shall be in accordance with ANSI Z60.1, except as otherwise stated in the specifications or shown on the plans. Where the drawings or specifications are in conflict with ANSI Z60.1, the drawings and specification shall prevail.

B. Provide well-branched and formed planting stock, sound, vigorous, and free from disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems. Provide trees, deciduous and evergreen, that are single trunked with a single leader, unless otherwise indicated, display no weak crotches. Provide symmetrically developed deciduous trees and shrubs of uniform habit of growth, with straight boles or stems and free from

objectionable disfigurements, and evergreen trees and shrubs with well developed symmetrical tops with typical spread of branches for each particular species or variety. Provide ground cover and vine plants with the number and length of runners for the size specified, and the proper age for the grade of plants specified. Provide vines and ground cover plants well established in removable containers, integral containers, or formed homogeneous soil sections. Plants shall have been grown under climatic conditions similar to those in the locality of the project.

C. The minimum acceptable sizes of all plants, measured before pruning with branches in normal position, shall conform to the measurements designated. Plants larger in size than specified may be used with the approval of the Resident Engineer, with no change in the contract price. When larger plants are used, increase the ball of earth or spread of roots in accordance with ANSI Z60.1.

D. Provide nursery grown plant material conforming to the requirements and recommendations of ANSI Z60.1.

E. Container grown plants shall have sufficient root growth to hold the earth intact when removed from containers, but shall not be root bound.

F. Make substitutions only when a plant (or its alternates as specified) is not obtainable and the Resident Engineer authorizes a change order providing for use of the nearest equivalent obtainable size or variety of plant having the same essential characteristics with an equitable adjustment of the contract price.

G. When existing plants are to be relocated, ball sizes shall conform to requirements for collected plants in ANSI Z60.1, and plants shall be dug, handled, and replanted in accordance with applicable sections of these specifications.

2.3 LABELS

A. Each plant, or group and bundles or containers of the same species, variety, and size of plant, shall be legibly tagged with a durable, waterproof and weather-resistant label indicating the correct plant name and size specified in the plant list. Labels shall be securely attached and not be removed.

2.4 TOPSOIL

A. Topsoil shall be a well-graded soil of good uniform quality. It shall be a natural, friable soil representative of productive soils in the vicinity. Topsoil shall be free of admixture of subsoil, foreign matter, objects larger than 25 mm (one inch) in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth and shall have a pH value of not less than 5.0 nor more than 7.5.

B. Obtain material from stockpiles established under Section 31 20 00, EARTH MOVING, subparagraph, Stripping Topsoil, that meet the general requirements as stated above. Amend topsoil not meeting the pH range specified by the addition of pH Adjusters.

C. If sufficient topsoil is not available on the site to meet the depth as specified herein, the Contractor shall furnish additional topsoil. At least 10 days prior to topsoil delivery, notify the Resident Engineer of the source(s) from which topsoil is to be furnished. Obtain topsoil from well drained areas. Additional topsoil shall meet the general requirements as stated above and comply with the requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES. Amend topsoil not meeting the pH range specified by the addition of pH adjusters.

2.5 LIME

A. Lime shall be agricultural limestone containing not less than 90 percent calcium and magnesium carbonates. Lime must be ground to such a fineness that not less than 90% must pass No. 8 mesh and not less than 25% must pass No. 100 mesh. Moisture is not to exceed 10%.

2.6 SOIL CONDITIONERS

A. Peat shall be a natural product of peat moss derived from a fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Peat shall be shredded and granulated to pass through a 13 mm (1/2inch) mesh screen and conditioned in storage piles for at least six months after excavation.

B. Coarse Sand

Coarse concrete sand, ASTM C-33 Fine Aggregate, shall be clean, sharp, free of limestone, shale and slate particles and of toxic materials.

C. Perlite shall conform to ASTM C549.

D. Vermiculite shall be horticultural grade and free of any toxic materials and conform to ASTM C516.

E. Pine Bark shall be horticultural-grade milled pine bark, with 80 percent of the material by volume sized between 0.1 and 15.0 mm.(.004in. and .59in.).

1. Pine bark shall be aged sufficiently to break down all woody material. Pine bark shall be screened
2. pH shall range between 4.0 and 7.0.
3. Submit manufacturer’s literature for approval.

F. Organic Material shall be commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.

G. Fertilizer: Agricultural fertilizer of a formula indicated by the soil test. Fertilizers shall be organic, slow-release compositions whenever applicable

2.7 PLANTING SOIL MIXTURE

A. The planting soil mixture shall be determined by the soil test results.

2.8 BIOSTIMULANTS

A. Biostimulants shall contain soil conditioners, VAM fungi, and endomycorrhizal and ectomycorrhizal fungi spores and soil bacteria appropriate for existing soil conditions.

2.9 PLANT FERTILIZER

A. Provide plant fertilizer that is commercial grade and uniform in composition and conforms to applicable state and federal regulations.

B. For new plant material, provide packet, table, or pellet forms of slow release fertilizers, bearing the manufacturer's warranteed statement of analysis. Slow release fertilizers shall be implemented as determined by the soil test results.

2.10 MEMBRANES

A. Polyethylene shall conform to ASTM D2103 and shall be 0.1 mm (four mils) thick and clear in color.

B. Landscape Fabric shall be a woven needle-punched polypropylene weighing 113 grams per square meter (4.8 oz. per sq. yd.) And a 950 liter per minute flow rate per sq. meter. (90 gal. per minute flow rate per sq. ft.)

2.11 MULCH

A. Mulch shall be free from deleterious materials and shall be stored as to prevent inclusion of foreign material.

B. Inert mulch materials shall be stone and shall range in size from 25 mm (one inch) to 65 mm (2-1/2 inches) in accordance with ASTM C 136.

C. Organic mulch materials shall be recycled wood chips:

1. Straw for lawn seed bed mulch shall be stalks from oats, wheat, rye, barley, or rice that are free from noxious weeds, mold or other objectionable material. Straw shall be in an air-dry condition and suitable for placing with blower equipment.

2. Wood cellulose fiber for use with hydraulic application of grass seed and fertilizer shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of the application of materials. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus three percent at the time of

manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that:

a. After addition and agitation in slurry tanks with fertilizers, grass seeds, water, and other approved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry.

b. When hydraulically sprayed on the ground, the material will form a blotter like cover impregnated uniformly with grass seed.

c. The cover will allow the absorption of moisture and allow rainfall or applied water to percolate to the underlaying soil.

2.12 STAKES

A. Provide stakes for tree support of rough sawn wood, free from knots, rot, cross grain, or other defects that would impair the strength. Stakes shall be a minimum of 50 mm by 50 mm (2 inches by 2 inches), or 65 mm (2-1/2 inches) in diameter, by 2400 mm (8 feet) long and pointed at one end Galvanized steel pipe 32 mm (1 ¼ in.) x 3000 mm (10’) with cap, primed with 2 coats flat black exterior enamel.

B. Tree Ties: Black plastic "Standard Tree Ties," Worldwide Tree Ties, Cupertino, CA; Black rubber "Gro-Strait", Gro-Strait, Walnut Creek, CA; or accepted equal. Provide ties without wires. Length of tie as required to adequately support tree while secured directly to stakes.

2.13 WATER

A. Water shall not contain elements toxic to plant life. It shall be obtained as specified in Section 01 00 00, GENERAL REQUIREMENTS.

2.14 ANTIDESICCANT

A. Antidesiccant shall be an emulsion specifically manufactured for agricultural use that will provide a protective film over plant surfaces permeable enough to permit transpiration.

2.15 HERBICIDES

A. All herbicides shall be properly labeled and registered with the U.S. Department of Agriculture. Keep all herbicides in the original labeled containers indicating the analysis and method of use.

PART 3 - EXECUTION

3.1 LAYOUT

A. Stake plant material locations and bed outlines on project site for approval by the Resident Engineer before any plant pits or beds are dug. The Resident Engineer may approve adjustments to plant material locations to meet field conditions.

3.2 EXCAVATION FOR PLANTING

A. Prior to excavating for plant pits and bed, verify the location of any underground utilities. Damage to utility lines will be repaired at the Contractor's expense. Where lawns have been established prior to planting operation, cover the surrounding turf before excavations are made in a manner that will protect turf areas. Barricade existing trees, shrubbery, and beds that are to be preserved in a manner that will effectively protect them during the project construction.

B. Remove rocks and other underground obstructions to a depth necessary to permit proper planting according to plans and specifications. Where underground utilities, construction, or solid rock ledges are encountered, the Resident Engineer may select other locations for plant material.

C. Dig plant pits by any approved method so that they have vertical sides and flat bottoms. When pits are dug with an auger and the sides of the pits become glazed, scarify the glazed surface. Size the plant pits as shown, otherwise, the minimum allowable dimensions of plant pits shall be regardless of width, 150 mm (6 inches) deeper for shrubs and 225 mm (9 inches) deeper for trees than the depth of ball or root spread; for ball or root spread up to 600 mm (2 feet), pit diameters shall be twice the ball or root spread; for ball or root spread from 600 to 1200 mm (2 to 4 feet), pit diameters shall be 600 mm (2 feet) greater; for ball or root spread over 1200 mm (4 feet), pit diameters shall be 1-1/2 times the ball or root spread.

D. Where ground cover and planting beds occur in existing turf areas, remove turf to a depth that will ensure the removal of the entire root system, with additional bed preparation as specified in the next paragraph.

E. Where existing soil is to be used in place, till new ground cover and plant beds to a depth of 100 mm (4 inches). Spread soil amendment uniformly over the bed to depth of 50 mm (2 inches) and thoroughly incorporate it into the existing soil to a depth of 100 mm (4 inches) using a roto-tiller or similar type of equipment to obtain a uniform and well pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till the soil down to a depth necessary to support the growth of new planting. During tillage operations, remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to a smooth and even surface conforming to established grades.

F. In areas of new grading where existing soil is being replaced for the construction of new ground cover and plant beds, remove 100 mm (4 inches) of existing soil and replace with topsoil. Plant beds shall be brought to a smooth and even surface conforming to established grades. Till 50 mm (2 inches) of soil amendment into the topsoil as specified.

G. Using topsoil, form earth saucers or water basins for watering around plants. Basins are to be 2” high for shrubs and 4” high for trees.

H. Treat plant saucers, shrub, and ground cover bed areas, prior to mulching, with an approved pre-emergent herbicide. Plant ground cover in areas to receive erosion control material through the material after material is in place.

3.3 SETTING PLANTS

A. Handle balled and burlapped and container-grown plants only by the ball or container. Remove container-grown plants in such a way to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around the roots or ball. Set plants so that the root crown is 1” higher than the surrounding grade. Plant ground cover plants after the mulch is in place. Avoid contaminating the mulch with the planting soil. Add slow release packet, tablet or pellet fertilizer as each plant is installed as per manufacturer's recommendation for method of installation and quantity.

B. Backfill container-grown plants with planting soil mixture as specified to approximately half the depth of the ball and then tamp and water. Tamp and water remainder of backfill Planting Soil Mixture; then form earth saucers or water basins around isolated plants with topsoil.

3.4 STAKING

A. Stake plants as shown on the drawings and as specified.

B. Drive stakes vertically into the ground to a depth of 800 to 900 mm (2-1/2 to 3 feet) in such a manner as not to injure the ball or roots, unless otherwise shown on the drawings.

C. Remove stakes after one year.

3.5 EDGING PLANT BEDS

A. Uniformly edge beds using a sharp tool to provide a clear cut division line between the planted area and the adjacent lawn.

B. Install metal edging materials in accordance with manufacturer's recommendations and as shown on the plans.

3.6 MULCHING PLANTS

A. Mulch within 48 hours after planting and applying a pre-emergent herbicide. Do not mulch in ground cover areas that shall have organic material placed before planting.

B. Placing Organic Material: Spread a mulch of recycled wood chips to a uniform minimum thickness of 75 mm (3 inches).

C. Keep mulch out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.

3.7 FINISH GRADING

A. Correct irregularities in finished surfaces to eliminate depressions. Protect finished areas from damage by vehicular or pedestrian traffic.

3.8 RESTORATION AND CLEAN-UP

A. Where existing or new turf areas have been damaged or scarred during planting and construction operations, restore disturbed area to their original condition. Keep at least one paved pedestrian access route and one paved vehicular access route to each building clean at all times. In areas where planting and turf work have been completed, clear the area of all debris, spoil piles, and containers. Clear all other paved areas when work in adjacent areas is completed. Remove all debris, rubbish and excess material from the station.

END OF SECTION

SECTION 33 10 00

WATER UTILITIES

PART 1 - PART 1 - GENERAL

1.1 DESCRIPTION:

A. Underground water distribution system complete, ready for operation, including all appurtenant structures, and connections to both new building service lines and to existing water supply.

1.2 RELATED WORK:

A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.

B. Excavation, trench widths, pipe bedding, backfill, shoring, sheeting, bracing: Section 31 20 00, EARTH MOVING.

C. Concrete: Section 03 30 00, CAST-IN-PLACE CONCRETE.

D. Protection of materials and equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

E. Fire protection system connection and supervisory switch for post indicator valve: Section 21 12 00, FIRE-SUPPRESSION STANDPIPES.

F. Fire protection system connection, Section 21 10 00, WATER-BASED FIRE-SUPPRESSION SYSTEMS.

1.3 DEFINITIONS:

A. Water Distribution: Pipelines and appurtenances which are part of the distribution system. The distribution system comprises the network of piping located throughout building areas and other areas of water use, including hydrants, valves, and other appurtenances used to supply water for domestic and fire-fighting/fire protection purposes.

B. Water Service Line: Pipe line connecting building piping to water distribution lines.

1.4 QUALITY ASSURANCE:

A. Products Criteria:
   1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be product of one manufacturer.
   2. Nameplate: Nameplate bearing manufacturer's name or identifiable trademark 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.

B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Water lines and the extension, and/or modifications to Public Utility systems.

C. Comply with all rules and regulations of Federal, State, and Local // Health Department // Department of Environmental Quality // having jurisdiction over the design, construction, and operation of potable water systems.

D. All material surfaces in contact with potable water shall comply with NSF 61.

1.5 SUBMITTALS:

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

B. Manufacturers' Literature and Data (Submit all items as one package):

C. (Ductile Iron Pipe and Polyvinyl Chloride (PVC) shall be in accordance with AWWA C600 and C605 respectively; and shall be provided to Resident Engineer for approval.)
   1. Piping.
   2. Gaskets.
   3. Valves.
   4. Fire hydrants.
   5. Street washer.
   6. Meter.
   7. Vaults, frames and covers.
   8. Steps.
   9. Post indicator.
   10. Valve boxes.
   11. Corporation and curb stops.
   12. Curb stop boxes.
   13. Joint restraint.
   14. Disinfection products.
   15. Link/sleeve seals.

D. Testing Certifications:
   1. Certification of Backflow Devices.
   2. Hydrostatic Testing.
   3. Certification of Disinfection, including free chlorine residuals, and bacteriological examinations.

1.6 APPLICABLE PUBLICATIONS:

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

B. American National Standards Institute (ANSI/ASME):

B16.1-98.....Cast Iron Pipe Flanges and Flanged Fittings

B16.18.....Cast Bronze Solder Joint Pressure Fittings

B16.26-88.....Cast Copper Alloy Fittings for Flared Copper Tubes

B40.100-98.....Pressure Gauges and Gauge Attachments

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

A123-97 .....Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

A148M-03 .....Standard Specifications for Steel Castings

A242-00 .....Standard Specifications for High Strength Low Alloy Structural Steel AASHTO No. M161

A307-02 .....Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

A536-04 .....Standard Specifications for Ductile Iron Castings

B61-02.....Steam or Valve Bronze Castings

B62-02.....Composition Bronze or Ounce Metal Castings

B88-02.....Seamless Copper Water Tube

B828.....Standard Practice: Soldering and Brazing Copper Tube and fittings

C32-04.....Sewer and Manhole Brick (Made from Clay or Shale)

C139-03.....Concrete Masonry Units for Construction of Catch Basins and Manholes

D1784-03 .....Standard Specifications for Rigid PVC Compounds and CPVC Compounds

D1869-00 .....Standard Specifications for Rubber Rings for Asbestos Cement Pipe

D2464-99 .....Standard Specifications for Threaded PVC Pipe Fittings, Schedule 80

D2467-02 .....Standard Specifications for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D3139-98 .....Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

F477-02e1 .....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

C32-04.....Standard Specifications for Sewer Manhole Brick

D. American Water Works Association (AWWA):

B300-04.....Hypochlorites

B301-04.....Liquid Chlorine

C104-04.....Cement Mortar Lining for Ductile Iron Pipe and Fittings for Water

C105-99.....Polyethylene Encasement for Gray and Ductile C.I. Piping for Water and Other Liquids

C110-03.....Ductile-Iron and Gray-Iron Fittings, 80 mm (3 Inches) Through 1200 mm (48 Inches) for Water and Other Liquids

C111-01.....Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings

C115-99.....Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges

C150-02.....American National Standard for Thickness Design of Ductile Iron Pipe

C151-96.....Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

C153-00.....Ductile-Iron Compact Fittings, 80 mm (3 inches) Through 300 mm (12 Inches) for Water and Other Liquids

C500-02.....Gate Valves for Water and Sewerage Systems

C502a-95.....Dry-Barrel Fire Hydrants

C503-97.....Wet-Barrel Fire Hydrants

C508-01.....Swing Check Valves for Waterworks Service, 2 Inches (50 mm) Through 24 Inches (600mm) NPS

C509-01.....Resilient Seated Gate Valve for Water and Sewage System

C510-97.....Double Check Valve Back-Flow Prevention Assembly

C511-97.....Reduced Pressure Principle Back-Flow Prevention Assembly

C550-01.....Protective Epoxy Interior Coatings for Valves and Hydrants

C600-01.....Installation for Ductile-Iron Water Mains and Their Appurtenances

C605-94.....Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

C651-92.....Disinfecting Water Mains

C800-01.....Underground Service Line Valves and Fittings

C900-97.....Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Thru 12 Inches, for Water

C905-97.....Polyvinyl Chloride (PVC) Pressure Pipe 14 Inches Thru 36 Inches

E. National Fire Protection Association (NFPA):

24-95 .....Installation of Private Fire Service Mains and Their Appurtenances

291-01 .....Fire Flow Testing and Marking of Hydrants

1141-98 .....Fire Protection in Planned Building Groups

F. NSF International:

14-03 .....Plastics Piping Components and Related Materials

61-02 .....Drinking Water System Components-Health Effects (Sections 1-9)

G. American Welding Society (AWS):
A5.8-04 .....Brazing Filler Metal

H. Foundation for Cross-Connection Control and Hydraulic Research-2005

I. Copper Development Association's Copper Tube Handbook-2005

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE AND FITTINGS:

A. Ductile iron pipe, direct buried:
   1. Provide ductile iron pipe conforming to the requirements of AWWA C151, Pressure Class 350 for Pipe 100 mm through 300 mm (4 inches through 12 inches) in diameter and 250, [ ] minimum for pipe larger than 300 mm (12 inches) in diameter, with standard thickness cement mortar lining interior, and interior asphaltic seal coat and exterior asphaltic coating, in accordance with AWWA and ANSI Standards.
   2. Below Grade: Supply pipe in lengths not in excess of a nominal 6 m (20 feet) with rubber ring type push-on joints, mechanical joint or approved restrained joint. Provide flange joint pipe where shown on the drawings. Provide mechanical and restrained joint pipe with sufficient quantities of accessories as required for each joint.
   3. When a polyethylene encasement over pipe, fittings, and valves is a requirement as indicated on the drawings, the material, installation and workmanship shall conform to applicable sections of AWWA C105. Make provisions to keep the polyethylene from direct exposure to sunlight prior to installation. Backfill following installation without delay to avoid exposure to sunlight.

B. Ductile Iron Pipe Above Grade or in Below Ground Concrete Pits:
   1. Flanged ductile iron pipe, AWWA C115, with factory applied screwed long hub flanges except as otherwise specified hereinafter. Face and drill flanges after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and flush with end of pipe, ANSI B16.1, 850 kPa (125 psi) or 1725 kPa (250 psi) standard, for the purpose intended.
   2. Wall Sleeve Castings: Size and types shown on the drawings and be hot dipped galvanized. Seal strips, where required shall be Link Seal as manufactured by Thunderline Corp., Wayne, Michigan or equal.
   3. Pipe Thickness Class: Minimum of Class 53 as defined in AWWA C150 for all sizes of flanged pipe.
   4. Rubber Ring Gaskets: Full face type, AWWA C111, 2 mm (1/16 inch) rubber ring gaskets and of approved composition suitable for the required service.
   5. Pipe and fittings exposed to view in the finished work are to be painted in accordance with Section 09 91 00, PAINTING. Pipe shall not receive the standard tar or asphalt coat on the outside surfaces but shall be shop primed on the outside with one coat of Kop-Coat No. 621 Rust Inhibitive Primer or equal. Paint color shall match the wall color.
   6. Bolts and Nuts on Flanged Fittings: Grade B, ASTM A307. Low alloy, high strength steel in accordance with AWWA C111. Assemble stainless steel bolts and nuts using anti-seize compound to prevent galling.

C. All Pipe Fittings: Ductile iron with a minimum pressure rating of 2400 kPa (350 psi). Fittings shall meet the requirements of ANSI and AWWA specifications as applicable. Rubber gasket joints shall conform to AWWA C111 for mechanical and push-on type joints. Ball joints shall conform to AWWA C151 with a separately cast ductile iron bell conforming to ASTM A148. Flanged fittings shall conform to AWWA C115 and be furnished flat faced and drilled to 850 kPa (125 psi) or 1725 kPa (250 psi) template in accordance with ANSI B16.1 with full faced gaskets.

D. Provide cement mortar lining and bituminous seal coat on the inside of the pipe and fittings in accordance with AWWA C104. Provide standard asphaltic coating on the exterior.

E. Provide a factory hydrostatic test of not less than 3.5 MPa (500 psi) for all pipe in accordance with AWWA C151.

F. Provide non-detectable adhesive backed identification tape on top and sides of all buried ductile iron pipe, extended from joint to joint along the length of the pipe and have black lettering identifying the pipe service at no more than 300 mm (12 inch) intervals. According to service, the tape background color shall be as follows: force main/sanitary-green; potable water-blue; reclaimed water-lavender.

2.2 POLYVINYL CHLORIDE PIPE AND FITTINGS:

A. Class-Rated Polyvinyl Chloride (PVC) Pipe:
   1. PVC pipe and accessories 100 mm to 356 mm (4 inches–14 inches) in diameter, AWWA C900 “Polyvinyl Chloride (PVC) Pressure Pipe”, Class 200, DR 14, cast iron outside diameters, unless otherwise shown or specified.
   2. PVC pipe and accessories 400 mm (16 inches) or larger, AWWA C905, “Polyvinyl Chloride Water Transmission Pipe”, Class 235, DR 18, cast iron outside diameters unless otherwise shown or specified. Pipe and accessories shall bear the NSF mark indicating pipe size, manufacturer’s name, AWWA and/or ASTM Specification number, working pressure and production code. Pipe and couplings shall be made in accordance with ASTM D1784.
   3. PVC Pipe and Accessories Smaller than 100 mm (4 inches): Schedule 80, meeting the requirements of ASTM D-1785, Type 1, Grade 1. All exposed piping shall be CPVC meeting requirements of ASTM F441.

B. Joints:
   1. Pipe 75 mm (3 inches) and Greater in Diameter: Push-on type with factory installed solid cross section elastomeric ring meeting the requirements of ASTM F-477.
   2. Pipe Less Than 75 mm (3 inches) in Diameter: Threaded (ASTM D-2464) or solvent welded (ASTM 2467). Use Teflon tape or liquid Teflon thread lubricant approved for use on plastic on all threaded joints.

C. Fittings:
   1. Class-Rated Pipe 75 mm (3 inches) in Diameter and Greater: Ductile iron with mechanical joints conforming to the requirements of AWWA C153.
   2. For Schedule 80 Pipe less than 75 mm (3 inches) in Diameter: Threaded or solvent weld. Threaded PVC fittings shall conform to ASTM D2464. CPVC fittings shall conform to ASTM F437 for threaded fittings and ASTM F439 for solvent weld fittings.

2.3 COPPER PIPE AND TUBING:

A. Copper Piping: ASTM B88, Type K, or Type L with flared fittings in accordance with AWWA C800, with sweat cast brass fittings per ANSI B16.18. Use brazing alloy, AWS A5.8, Classification BCuP.

2.4 VALVES:

A. Asbestos packing is not allowed.

B. Gate:
   1. 75 mm (3 inches) and Larger: Resilient seated, ductile iron body, bronze mounted, inclined seats, non-rising stem type turning counter-clockwise to open, 1375 kPa (200 pound) WOG. AWWA C509. The resilient seat shall be fastened to the gate with stainless steel fasteners or vulcanizing methods. The interior and exterior shall be coated with thermo-setting or fusion epoxy coating in accordance with AWWA C550.
   2. Operator:
      a. Underground: Except for use with post indicators, furnish valves with 50 mm (2 inch) nut for socket wrench operation. Post indicator shall comply with the requirements of NFPA 24 and shall be fully compatible with the valve provided.
      b. Above Ground and in Pits: Hand wheels.
   3. Joints: Ends of valves shall accommodate, or be adapted to, pipe installed.

C. Check: Swing.
   1. Smaller than 100 mm (4 inches): Bronze body and bonnet, ASTM B61 or B62, 1375 kPa (200 pound) WOG.
   2. 100 mm (4 inches) and Larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, 1375 kPa (200 pound) WOG. Check valves for fire lines shall conform to AWWA C508 and shall be epoxy coated and lined per AWWA C550.

D. Corporation stops and saddles shall conform to AWWA C800.

E. Curb Stop: Smaller than 75 mm (3 inches). Waterworks standard for Type "K" copper, single piece cast bronze body with tee top operated plug sealed with O-ring gaskets, 1375 kPa (200 pound) WOG per AWWA C800.

2.5 CURB STOP BOX:

A. Cast iron extension box with screw or slide type adjustment and flared base. Box shall be adapted, without full extension, to depth of cover required over pipe at stop location. Cast the word "WATER" in cover and set cover flush with finished grade. Curb stop shut-off rod shall extend 600 mm (2 feet) above top of deepest stop box.

2.6 VALVE BOX:

A. Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness of metal shall be 5 mm (3/16 inch). Box shall be adapted, without full extension, to depth of cover required over pipe at valve location. Cast the word "WATER" in cover. Provide [ ] "T" handle socket wrenches of 16 mm (5/8 inch) round stock long enough to extend 600 mm (2 feet) above top of deepest valve box.

2.7 POST INDICATOR VALVE:

A. Valve: Valve shall conform to the specifications listed in Section 2.4 for gate valves. The Post Indicator shall conform to NFPA 24, and shall be fully compatible with the valve and all the supervisory switches.

2.8 FIRE HYDRANTS:

A. Size of main valve opening of each hydrant shall be 125 mm (5 inches), minimum. Hose thread, size of fire apparatus connection, and shape, size and direction of rotation of operating head of hydrant shall be identical with those in use at the site.

B. Hydrant shall be type AWWA C502, heavy construction, of proper length to connect pipe without extra fittings, and shall be the traffic type with safety flange on barrel and safety couplings on the valve stem with the following features:
   1. Interior removable without digging up hydrant; can be packed under pressure; 150 mm (6 inch) bell connection; one steamer nozzle and two hose nozzles with nozzle caps securely chained to barrel; suitable drainage device; single rubber or leather-faced valve in base; nozzles, stuffing boxes, wedge nuts, seat rings, clamp plates, etc. Threaded joints or spindles shall be bronze. Upper and lower barrels shall be of equal diameters. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 50 mm (2 inches) above finished grade. All fire hydrants shall have 150 mm (6 inch) bottom connection.
   2. Provide fire hydrants with a finish paint identical to the existing fire hydrants.

2.9 PIPE SLEEVES:

A. Ductile iron or zinc coated steel.

2.10 BACKFLOW PREVENTER:

A. Potable Water and Irrigation Water Service: Reduced Pressure Principle Type AWWA C511, except pressure drop at rated flow shall not exceed 100 kPa (15 psi). Gate valves installed on the assembly shall be resilient seated valve conforming to AWWA C509.

B. Fire Service: Double detector check valve. AWWA C510 and NFPA 14.

C. In cold climate areas, backflow assemblies and devices shall be protected from freezing by a method acceptable to local jurisdiction.

D. Backflow preventers shall be approved by the Foundation for Cross-Connection Control and Hydraulic Research per current edition of the Manual of Cross-Connection Control.

E. Backflow preventer shall not be located in any area containing fumes that are toxic, poisonous or corrosive.

F. Direct connections between potable water piping and sewer connected wastes shall not exist under any condition with or without backflow protection.

G. Backflow preventer shall be accessed and have clearance for the required testing, maintenance and repair. Access and clearance shall require a minimum of one (1) foot (305 mm) between the lowest portion of the assembly and grade, floor or platform. Installations elevated more than five (5) feet (1524 mm) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

2.11 WATER METER:

A. Furnish and install approved meter.

2.12 VAULTS (BACKFLOW PREVENTER OR METER):

A. Top and base shall be reinforced concrete.

B. Walls shall be reinforced concrete, precast concrete, or segmental block (ASTM C139).

2.13 CAST IRON FRAME AND COVER, STEPS, ETC.:

A. Cast iron frame and cover, steps, etc. shall comply with State Department of Transportation standard details. Identify cover as “WATER”.

2.14 FLEXIBLE EXPANSION JOINTS: (PROVIDE FOR DOMESTIC AND FIRE SERVICE)

A. Ductile iron with ball joints rated for 1725 kPa (250 PSI) working pressure conforming to ANSI/AWWA A21.53/C153, capable of deflecting a minimum of 30 degrees and expanding simultaneously to the amount shown on the drawings. Flexible expansion joint shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 375 µm (15 mils) of fusion bonded epoxy conforming to the applicable requirements of ANSI/AWWA C213 and shall be factory holiday tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to ANSI/AWWA A21.11/C110. Bolts and nuts high strength steel with synthetic gaskets that comply with AWWA C110.

2.15 POTABLE WATER:

A. Water used for filling, flushing, and disinfection of water mains and appurtenances shall conform to Safe Drinking Water Act.

2.16 DISINFECTION CHLORINE:

A. Liquid chlorine shall conform to AWWA B301 and AWWA C651.

B. Sodium hypochlorite shall conform to AWWA B300 with 5 percent to 15 percent available chlorine.

C. Calcium hypochlorite shall conform to AWWA B300 supplied in granular form or 5.g tablets, and shall contain 65 percent chlorine by weight.

2.17 WARNING TAPE

A. Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape, detectable type, blue with black letters, and imprinted with “CAUTION BURIED WATER LINE BELOW”.

PART 3 - EXECUTION

3.1 BUILDING SERVICE LINES:

A. Install water service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings to which such service is to be connected and make connections thereto. If building services have not been installed provide temporary caps.

3.2 REGRADING:

A. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.3 PIPE LAYING, GENERAL:

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Resident Engineer.

B. All pipe and fittings shall be subjected to a careful inspection just prior to being laid or installed. If any defective piping is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional expense to the Government. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work, and when installed or laid, shall conform to the lines and grades required.

C. All buried piping shall be installed to the lines and grades as shown on the drawings. All underground piping shall slope uniformly between joints where elevations are shown.

D. Contractor shall exercise extreme care when installing piping to shore up and protect from damage all existing underground water line and power lines, and all existing structures.

E. Do not lay pipe on unstable material, in wet trench, or when trench or weather conditions are unsuitable.

F. Do not lay pipe in same trench with other pipes or utilities unless shown otherwise on drawings.

G. Hold pipe securely in place while joint is being made.

H. Do not walk on pipes in trenches until covered by layers of earth well tamped in place to a depth of 300 mm (12 inches) over pipe.

I. Full length of each section of pipe shall rest solidly upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipes on wood blocking.

J. Tees, plugs, caps, bends and hydrants on pipe installed underground shall be anchored. See section 3.7 “PIPE SUPPORTS”.

K. Close pipe openings with caps or plugs during installation. Tightly cover and protect equipment against dirt, water and chemical, or mechanical injury. At completion of all work, thoroughly clean exposed materials and equipment.

L. Good alignment shall be preserved in laying. The deflection at joints shall not exceed that recommended by the manufacturer.

M. Warning tape shall be continuously placed 300 mm (12 inches) above buried water pipes.

3.4 DUCTILE IRON PIPE:

A. Installing Pipe: Lay pipe in accordance with AWWA C600 with polyethylene encasement if required in accordance with AWWA C105. Provide a firm even bearing throughout the length of the pipe by tamping selected material at the sides of the pipe up to the spring line.

B. All pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.

D. Jointing Ductile-Iron Pipe:

1. Push-on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe is to be aligned with the bell of the pipe to which it is joined, and pushed home with approved means.
2. Mechanical Joints at Valves, Fittings: Install in strict accordance with AWWA C111. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gaskets with soapy water before tightening the bolts. Bolts shall be tightened to the specified torque.
3. Ball Joints: Install in strict accordance with the manufacturer's instructions. Where ball joint assemblies occur at the face of structures, the socket end shall be at the structure and ball end assembled to the socket.
4. Flanged joints shall be in accordance with AWWA C115. Flanged joints shall be fitted so that the contact faces bear uniformly on the gasket and then are made up with relatively uniform bolt stress.

3.5 PVC PIPE:

A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA 605. Place selected material and thoroughly compacted to one foot above the top of the pipe and thereafter back filled as specified in Section 31 20 00, EARTH MOVING.

B. Copper Tracer Wire: Copper tracer wire consisting of No. 14 AWG solid, single conductor, insulated copper wire shall be installed in the trench with all piping to permit location of the pipe with electronic detectors. The wire shall not be spiraled around the pipe nor taped to the pipe. Wire connections are to be made by stripping the insulation from the wire and soldering with rosin core solder. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 300 m (1000 feet), provide a 2.3 kg (5 pound) magnesium anode attached to the main tracer wire by solder. The solder joint shall be wrapped with rubber tape and with electrical tape. An anode shall be attached at the end of each line.

C. Magnetic markers may be used in lieu of copper tracer wire to aid in future pipe locating. Generally, install markers on 6 m (20 foot) centers. If pipe is in a congested piping area, install on 3 m (10 foot) centers. Prepare as-built drawing indicating exact location of magnetic markers.

3.6 COPPER PIPE:

A. Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations. Copper piping shall be bedded in 150 mm (6 inches) of sand and then back filled as specified in Section 31 20 00, EARTH MOVING.

3.7 PIPE SUPPORTS:

A. Supports:
   1. All piping shall be properly and adequately supported. Hangers, supports, base elbows and tees, and concrete piers and pads shall be provided as indicated on the drawings. If the method of support is not indicated on the drawings, exposed piping shall be supported by hangers wherever the structure is suitable and adequate to carry the superimposed load. Supports shall be placed approximately 2.4 m (8 feet) on centers and at each fitting.
   2. Hangers shall be heavy malleable iron of the adjustable swivel type, split ring type, or the adjustable-swivel, pipe-roll type for horizontal piping and adjustable, wrought iron, clamp type for vertical piping. Flat steel strap or chain hangers are not acceptable unless indicated on the drawings.

3. Hangers shall be attached to the structure, where possible, by beam clamps and approved concrete inserts set in the forms before concrete is poured. Where this method is impractical, anchor bolts with expanding lead shields, rawl drives, or malleable iron expansion shields will be permitted.
4. Where hangers cannot be used, the Contractor shall provide pipe saddle supports with pipe column and floor flange.

3.8 RESTRAINED JOINTS:

A. Sections of piping requiring restrained joints shall be constructed using pipe and fittings with restrained "locked-type" joints and the joints shall be capable of holding against withdrawal for line pressures 50 percent above the normal working pressure but not less than 1375 kPa (200 psi). The pipe and fittings shall be restrained push-on joints or restrained mechanical joints.

B. The minimum number of restrained joints required for resisting force at fittings and changes in direction of pipe shall be determined from the length of retained pipe on each side of fittings and changes in direction necessary to develop adequate resisting friction with the soil. Restrained pipe length shall be as shown on the drawings.

C. Restrained joint assemblies with ductile iron mechanical joint pipe shall be "Flex-Ring", "Lok-Ring", or mechanical joint coupled as manufactured by American Cast Iron Pipe Company, "Mega-Lug" or approved equal.

D. Ductile iron pipe bell and spigot joints shall be restrained with EBBA Iron Sales, Inc. Series 800 Coverall or approved equal.

E. Ductile iron mechanical joint fittings shall be restrained with EBBA Iron Sales, Inc. Series 1200 Restrainer. The restraining device shall be designed to fit standard mechanical joint bells with standard T head bolts conforming to AWWA C111 and AWWA C153. Glands shall be manufactured of ductile iron conforming to ASTM A536. Set screws shall be hardened ductile iron and require the same torque in all sizes. Steel set screws not permitted. These devices shall have the stated pressure rating with a minimum safety factor of 2:1. Glands shall be listed with Underwriters Laboratories and/or approved by Factory Mutual.

F. Thrust blocks shall not be permitted.

G. Where ductile iron pipe manufactured with restrained joints is utilized, all restrained joints shall be fully extended and engaged prior to back filling the trench and pressurizing the pipe.

H. PVC pipe bell and spigot joints shall be restrained with the Uni-Flange Corp. Series 1350 Restrainer or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.

I. Ductile iron mechanical joint fittings used with PVC pipe shall be restrained with UNI-Flange Corp. Series 1300 Restrainer, EBBA Iron, Inc, Series 2000PV Mechanical Joint Restrainer Gland, or approved equal. The restraining device and Tee head bolts shall be manufactured of high strength ductile iron meeting ASTM A-536. Clamping bolts and nuts shall be manufactured of corrosion resistant high strength, low alloy steel meeting the requirements of ASTM A242.

3.9 PIPE SEPARATION:

A. Horizontal Separation-Water Mains and Sewers:
   1. Water mains shall be located at least 3 m (10 feet) horizontally from any proposed drain, storm sewer, sanitary or sewer service connection.

2. Water mains may be located closer than 3 m (10 feet) to a sewer line when:
   a. Local conditions prevent a lateral separation of 3 m (10 feet); and
   b. The water main invert is at least 450 mm (18 inches) above the crown of the sewer; and
   c. The water main is either in a separate trench or in the same trench on an undisturbed earth shelf located one side of the sewer.
3. When it is impossible to meet (1) or (2) above, both the water main and drain or sewer shall be constructed of mechanical joint ductile iron pipe. Ductile iron pipe shall comply with the requirements listed in this specification section. The drain or sewer shall be pressure tested to the maximum expected surcharge head before back filling.

B. Vertical Separation-Water Mains and Sewers:
1. A water main shall be separated from a sewer so that its invert is a minimum of 450 mm (18 inches) above the crown of the drain or sewer whenever water mains cross storm sewers, sanitary sewers or sewer service connections. The vertical separation shall be maintained for that portion of the wear main located within 10 feet horizontally of any sewer or drain crossed. A length of water main pipe shall be centered over the sewer to be crossed with joints equidistant from the sewer or drain.
2. Both the water main and sewer shall be constructed of slip-on or mechanical joint ductile iron pipe or PVC pipe equivalent to water main standards of construction when:
   a. It is impossible to obtain the proper vertical separations described in (1) above; or
   b. The water main passes under a sewer or drain.
3. A vertical separation of 450 mm (18 inches) between the invert of the sewer or drain and the crown of the water main shall be maintained where a water main crosses under a sewer. Support the sewer or drain lines to prevent settling and breaking the water main.
4. Construction shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer or drain line is at least 3 m (10 feet).

3.10 SETTING OF VALVES AND BOXES:

A. Provide a surface concrete pad 450 by 450 by 150 mm (18 by 18 by 6 inches) to protect valve box when valve is not located below pavement.

B. Clean valve and curb stops interior before installation.

C. Set valve and curb stop box cover flush with finished grade.

D. Valves shall be installed plumb and level and in accordance with manufacturer's recommendations.

3.11 SETTING OF FIRE HYDRANTS:

A. Set center of each hydrant not less than 600 mm (2 feet) nor more than 1800 mm (6 feet) back of edge of road or face of curb. Fire apparatus connection shall face road with center of nozzle 450 mm (18 inches) above finished grade. Set barrel flange not more than 50 mm (2 inches) above finished grade.

B. Set each hydrant on a slab of stone or concrete not less than 100 mm (4 inches) thick and 375 mm (15 inches) square. The service line to the hydrant, between the tee and the shoe of the hydrant, shall be fully restrained.

C. Set bases in not less than 0.4 cubic meter (1/2 cubic yard) of crushed rock or gravel placed entirely below hydrant drainage device.

D. Clean interiors of hydrants of all foreign matter before installation.

3.12 PIPE SLEEVES:

A. Install where water lines pass through retaining walls, building foundations and floors. Seal with modular mechanical type link seal. Install piping so that no joint occurs within a sleeve. Split sleeves may be installed where existing lines pass through new construction.

3.13 FLUSHING AND DISINFECTING:

A. Flush and disinfect new water lines in accordance with AWWA C651.

B. Initial flushing shall obtain a minimum velocity in the main of 0.75 m/sec (2.5 feet per second) at 40 PSI residual pressure in water main. The duration of the flushing shall be adequate to remove all particles from the line.

Pipe Diameter		Flow Required to Produce 2.5 ft/sec(approx.) Velocity in Main		Number of Hydrant Outlets			
				Size of Tap. in. (mm)			
				1(25)	1 ½(38)	2(51)	2 1/2-in (64 mm)
In	(mm)	gpm	(L/sec)	Number of taps on pipe			
4	(100)	100	(6.3)	1	--	--	1
6	(150)	200	(12.6)	--	1	--	1
8	(200)	400	(25.2)	--	2	1	1
10	(250)	600	(37.9)	--	3	2	1
12	(300)	900	(56.8)	--	--	3	2
16	(400)	1,600	(100.9)	--	--	4	2

C. The backflow preventers shall not be in place during the flushing.

D. The Contractor shall be responsible to provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used, and the Contractor shall provide all required temporary pumps, storage facilities required to complete the specified flushing, and disinfection operations.

E. The Contractor shall be responsible for the disposal of all water used to flush and disinfect the system in accordance with all governing rules and regulations. The discharge water shall not be allowed to create a nuisance for activities occurring on or adjacent to the site.

F. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the State Health Department. The cost of sampling, transportation, and testing shall be the responsibility of the Contractor.

G. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.

H. Before backflow preventers are installed, all upstream piping shall be thoroughly flushed.

3.14 HYDROSTATIC TESTING:

A. Hydrostatic testing of the system shall occur prior to disinfecting the system.

B. After new system is installed, except for connections to existing system and building, backfill at least 300 mm (12 inches) above pipe barrel, leaving joints exposed. The depth of the backfill shall be adequate to prevent the horizontal and vertical movement of the pipe during testing.

C. Prior to pressurizing the line, all joint restraints shall be completely installed and inspected.

D. If the system is tested in sections, and at the temporary caps at connections to the existing system and buildings, the Contractor shall provide and install all required temporary thrust restraints required to safely conduct the test.

E. The Contractor shall install corporation stops in the line as required to purge the air out of the system. At the completion of the test, all corporation stops shall be capped.

F. The Contractor shall perform pressure and leakage tests for the new system for 2 hours to 1375 kPa (200 psi). Leakage shall not exceed the following requirements.
   1. Copper Tubing: No leaks.
   2. Ductile Iron Pipe: AWWA C600.Provide to Resident Engineer office.
   3. Polyvinyl Chloride (PVC) AWWA C605.Provide to Resident Engineer office.

3.15 BACKFLOW PREVENTOR TESTING:

A. All backflow preventers shall be tested and certified for proper operation prior to being placed in operation.

B. Original copies of the certification shall be submitted to the Resident Engineer.

END OF SECTION

SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 - PART 1 - GENERAL

1.1 DESCRIPTION:

A. Outside, underground sanitary sewer system, complete, ready for operation, including all gravity flow lines, pressure (force) lines manholes, cleanouts, frames, covers, structures, appurtenances, and connections to new building and structure, service lines, existing sanitary sewer lines, and existing sanitary structures, and all other incidentals.

1.2 RELATED WORK:

A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.

B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

C. Concrete Work Reinforcing, Placement and Finishing; Section 03 30 00, CAST-IN-PLACE CONCRETE Section 03 30 53, MISCELLANEOUS CAST-IN-PLACE CONCRETE.

D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.

E. Protection of Materials and Equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 QUALITY ASSURANCE:

A. Products Criteria:
   1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
   2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, including model number, securely affixed in a conspicuous place on equipment, or name or trademark, including model number cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to Public Sanitary Sewer lines and the extension, and/or modifications to Public Utility Systems.

1.4 SUBMITTALS:

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

B. Manufacturers' Literature and Data: Submit the following as one package:
   1. Pipe, Fittings, and, Appurtenances.
   2. Jointing Material.
   3. Manhole and Structure Material.
   4. Frames and Covers.
   5. Steps and Ladders.
   6. Gate Valves.

7. Valve Boxes.
8. Check Valves.

1.5 APPLICABLE PUBLICATIONS:

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

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

A48/A48M-03 ..... Gray Iron Castings

A536-84(2004) ..... Ductile Iron Castings

A615/A615M-06 ..... Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A625/A625M-03 ..... Tin Mill Products, Black Plate, Single Reduced

A746-03 ..... Ductile Iron Gravity Sewer Pipe

C12-06 ..... Installing Vitrified Clay Pipe Lines

C76-05b/C76M-05b ..... Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

C139-05 ..... Concrete Masonry Units for Construction of Catch Basins and Manholes

C150-05 ..... Portland Cement

C425-04 ..... Compression Joints for Vitrified Clay Pipe and Fittings

C478-06a/C478M-06a ..... Precast Reinforced Concrete Manhole Sections

C700-05 ..... Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

C828-03 ..... Low-Pressure Air Test of Vitrified Clay Pipe Lines

C857-95(2001) ..... Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

D698-00ae1 ..... Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D2321-05 ..... Underground Installation of Thermoplastic Pipes for Sewers and Other Gravity-Flow Applications

D2412-02 ..... Determination of External Loading Characteristics of Plastic Pipe by Parallel- Plate Loading

D2992-01 ..... Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings

D3034-04a ..... Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3212-96a (2003) e1 .....Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3261-03 .....Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing

D3350-05 .....Polyethylene Plastics Pipe and Fittings Materials

D4101-05a.....Polypropylene Injection and Extrusion Materials

F477-02e1 .....Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F679-06 .....Poly (vinyl chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F714-05 .....Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F794-03 .....Poly (Vinyl Chloride)(PVC) Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F894-05 .....Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

F949-03 .....Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings

C. American Water Works Association (AWWA):

C105/A21.5-05.....Polyethylene Encasement for Ductile Iron Pipe Systems

C110/A21.10-03.....Ductile-Iron and Gray-Iron Fittings for Water

C111/A21.11-00.....Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C115-99.....Flanged Ductile-Iron Pipe with Threaded Flanges

C116-03.....Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron Pipe and Gray Iron Fittings for Water Supply Service

C151-/A21.51-02 Ductile-Iron Pipe, Centrifugally Cast for Water

C153-00 Ductile-Iron Compact Fittings for Water Services

C508-01.....Swing Check Valves for Waterworks, 2 inches (50 mm) Through 24 inches (600 mm) NPS

C509-01.....Resilient Seated Gate Valves for Water-Supply Service

C515-01.....Reduced-Wall, Resilient-Seated Gate Valves For Water Supply Service

C512-04.....Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service

C550-05.....Protective Epoxy Interior Coatings for Valves and Hydrants

C600-05.....Installation for Ductile-Iron Water Mains and Their Appurtenances

C605-94.....Underground Installation of Polyvinyl (PVC) Pressure Pipe and Fittings for Water

C900-97 .....Polyvinyl Chloride (PVC) Pressure Pipe, 100 mm (4 inches) Through 300 mm (12 inches) for Water Distribution

C905-97.....Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 350 mm through 1,200 mm (14 Inches through 48 Inches), for Water Transmission and Distribution

C906-99.....Polyethylene (PE) Pressure Pipes and Fittings, 100 mm through 1575 mm (4 Inches through 63 Inches), for Water Distribution

D. American Association of State Highway and Transportation Officials (AASHTO):
M198-05.....Joints for Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants

E. Uni-Bell PVC Pipe Association:
Uni-B-6-98.....Recommended Practice Low Pressure Air Testing of Installed Sewer Pipe

PART 2 - PRODUCTS

2.1 PIPING:

A. Gravity Flow Lines (Pipe and Fittings):
1. Vitrified Clay: Pipe and fittings shall conform to ASTM C700, extra strength, with gasketed bell and spigot end joints. Joints on the pipe and fitting shall conform to ASTM C425.
2. Polyvinyl Chloride (PVC):
   a. Pipe and Fittings, 100 to 375 mm (4 to 15 inches) in diameter, shall conform to ASTM D3034, Type PSM, SDR 26. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.
   b. Pipe and fittings, 450 to 900 mm (18 to 36 inches) in diameter, shall be solid wall or have a corrugated or ribbed exterior profile and a smooth interior. Pipe shall conform to the following:

1) Pipe and fittings shall conform to ASTM F949 corrugated sewer pipe with a smooth interior. The corrugated outer wall shall be fused to the smooth interwall at the corrugation valley. Pipe and fitting shall have a smooth bell, elastomeric joints conforming to ASTM D3212, and shall have a minimum pipe stiffness of 350 kPa (50 psi) at 5 percent deflection, when tested in accordance with ASTM D2412. Corrugation shall be perpendicular to the axis of the pipe to allow gaskets to be installed on field cut sections of pipe without the requirement for special fittings.
2) Ribbed wall PVC pipe and fittings shall conform to ASTM F794 ribbed sewer pipe with smooth interior pipe and fittings shall have a smooth bell, elastomeric joints conforming to ASTM D3212, and shall have a minimum pipe stiffness of 320 kPa (46 psi) when tested in accordance with ASTM D 2412, at 5 percent vertical deflection. Joints shall not leak at 7.6 m (25 feet) of head under 5 percent deflection.
3) Solid wall pipe and fittings shall conform to ASTM F679, SDR 26 pipe and fittings shall gaskets conforming to ASTM F477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).

3. Ductile Iron Pipe (DIP) for Sanitary Sewer: Shall conform to ASTM A746, thickness Class 51 unless otherwise shown or specified. Joints on pipe and fittings shall be push-on style and conform to AWWA C110 and AWWA C111, rated for 1.03 MPa (150 psi). Exterior coating shall be approximately 0.025 mm (1 mil) asphaltic coating as specified in ASTM A746. Interior lining shall be a catalyzed coal tar epoxy, having a minimum thickness of 0.60 mm (24 mils), a permeability rating of 0.13 perms, direct impact rating of 11.3 Nm (100 in-lbs), an abrasion resistance of 20 liters of sand per mil, and dielectric strength of 250 volts per mil. Pipe and fittings shall be polyethylene encased with 0.20 mm (8 mil) polyethylene sheeting per AWWA C105. Color of polyethylene encasement shall be green.
4. High density polyethylene (HDPE) pipe and fittings 450 mm to 900 mm (18 inches to 36 inches) shall conform to ASTM F894. Pipe and fittings shall have a smooth interwall and profile exterior, and be as noted on the drawings. Joints shall be water tight elastomeric gaskets in accordance with ASTM D3212, or thermal welded joints.

B. Gravity flow lines with secondary containment (pipe and fittings):
1. Piping systems conveying hazardous materials shall be constructed with a watertight primary (carrier) pipe completely enclosed within a watertight secondary (containment) pipe.
2. Fiberglass Piping and Fittings: Shall be manufactured in accordance with ASTM D2992 using a filament-winding process. Joints shall be adhesive bonded straight or tapered spigot and bells. Taper angles shall not be greater than 0.5 degrees. The pipe and fittings shall have an integral epoxy resin-rich reinforced liner not less than 0.50 mm (0.020 inch) for carrier pipes, and not less than 0.25 mm (0.010 inch) for containment pipe.
3. The carrier pipe shall be installed with manufactured spacers to maintain a minimum interstitial space of 19 mm (0.75 inch) between the carrier pipe and the containment pipe.
4. The piping shall be equipped with adequate monitoring ports to detect the presence of fluids within the containment pipe and for the extraction of fluids from the containment pipe.

2.2 JOINTING MATERIAL:

A. Gravity Flow Lines:
1. Vitrified Clay Pipe: Rubber gasket, ASTM C425.
2. Ductile Iron Pipe: Push-on or mechanical joints, AWWA C111, AWWA C110. Flange joints shall comply with AWWA C115. Flange joints shall only be used in vaults or above-grade.
3. Polyvinyl Chloride (PVC) Pipe (Gravity Use): Joints, ASTM D3212. Elastomeric gasket, ASTM F477.

4. High Density Polyethylene (HDPE) pipe and fitting joints, ASTM E-3212, elastomeric gaskets, ASTM F477.

B. Gravity Flow with Secondary Containment: Tapered or straight bell and spigot with adhesive bond. Completed joint shall be equal or greater than the pressure rating of the pipe.

C. Pressure (Force) Main:
   1. All joints indicated on the drawings as being "restrained" shall be fully restrained and capable of restraining 50 percent above all loads acting on the joint, but not less than 1035 kPa (150 psi). Thrust blocks shall not be permitted.
   2. Ductile iron pipe and fittings, mechanical or push-on, conforming to AWWA C110 and C111. Restrained joints shall meet the following requirements:
      a. Push-on joints shall be restrained by a mechanical locking slot cast integrally in the bell of the pipe or fitting. The spigot shall have a retainer weldment or band. Locking segments, placed in the slots in the bell, shall form a mechanical restraint and prevent the opening of the joint.
      b. Mechanical joint restraint shall be incorporated into the design of the follower gland. The restraining mechanism shall consist of individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be made of Grade 60-42-10 ductile iron conforming to ASTM A536. The wedges shall be ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell conforming to AWWA C111 and AWWA C153 of the latest revision. Torque limiting twist-off nuts shall be used to insure proper actuation of the restraining wedges. The gland shall be specifically designed for the type of pipe (DIP or PVC) connected to the fitting.
   3. Polyvinyl Chloride (PVC) Pipe (Pressure Use):
      a. Push-on joints shall conform to AWWA C900, C905.
      b. Push-on gaskets for pipe, ASTM F477.
      c. Restrained joints shall comply with one of the following:
         1) Joints to mechanical ductile iron fittings shall comply with the requirements for ductile iron pipe, except the mechanical joint restraint gland shall be specifically designed for use with PVC pipe.
         2) Push-on bell and spigot joints shall be retained with retaining rings and thrust rods. The rings shall be ductile iron conforming to ASTM A536. The rings shall be split style with serrated inside face which grips the pipe when the halves of the ring is assembled together. The ring shall not bear directly on the back of the bell. The rods shall be of adequate size and number to resist all axial movement of the joint.
   4. High Density Polyethylene (HDPE) pipe and fittings shall be fusion butt welded, flanged, or mechanical couplings as recommended by the manufacturer. Restrained joints shall be limited to fusion welded and flanged.

2.3 MANHOLES AND VAULTS:

A. Manholes and vaults shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. The manholes and vaults shall be in accordance with State Department of Transportation or State Roads Commission standard details, and the following:

1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.
5. Vaults: Reinforced concrete, as indicated on the plans, or precast reinforced concrete. Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C857.
6. Mortar:
   a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, l/4 part lime hydrate, and 3 parts sand.
   b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21 L (5-l/2 gallons) per sack of cement.
7. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M198.
8. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words “sanitary sewer”. The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
9. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 406 mm (16 inches) wide and project a minimum of 178 mm (7 inches) away from the wall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
10. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 10 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

2.4 CONCRETE:

A. Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

2.5 REINFORCING STEEL:

A. Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.6 CONCRETE PROTECTIVE COATING:

A. Concrete coating for the interior of wet wells shall consist of an epoxy blended filler sealer, and a cross linked epoxy phenolic cured, resistant protective coating.

2.7 ACID NEUTRALIZATION TANKS:

A. Acid neutralization tanks shall be constructed of 6 mm (1/4 inch) plate non code mild carbon steel suitable for rubber type lining with all welds double butt, continuous full welded, non porous and ground smooth and having no crevices, offsets or sharpened edges. The bottom and side walls shall be lined with 6 mm (1/4 inch) thermoplastic sheet lining fused directly to white ceramic lining 50 mm (2 inches) thick laid in Permamite acid and alkali proof mortar. The tank shall include 1050 mm (42 inch) ID manway riser constructed of steel shell with an interior corrosion resistant coating and complete cast iron frame and lid at the finish grade. Neutralizing charge shall be limestone, 75 mm (3 inches) in size.

2.8 GATE VALVES:

A. AWWA C509, resilient seated gate valves rated for 1360 kPa (200 psi) WSP, reduced-wall resilient seated gates valves may be supplied in accordance with AWWA C515. Asbestos packing is prohibited. The interior and exterior of the valve shall be epoxy coated for AWWA C550.

B. Operation:
   1. Shall turn counterclockwise to open.
   2. Underground: 50 mm (2 inch) nut for socket wrench operation.
   3. Above Ground and In Pits: Handwheels.

C. Joints: End of valve shall accommodate, or be adapted to, pipe furnished.

2.9 VALVE BOXES:

A. Cast iron extension box with screw or slide-type adjustment and flared base. Minimum thickness or metal shall be 5 mm (3/16 inch). Box shall be of such length as will be adapted, without full extension, to depth of cover required over pipe at valve location.

B. Cast the word "SEWER" on the cover.

C. Provide two (2) "T" handle socket wrenches, of 16 mm (5/8 inch) round stock long enough to extend 600 mm (2 feet) above top of deepest valve box.

2.10 CHECK VALVES

A. Check valves shall be swing-check valves conforming to AWWA C508. The interior and exterior of the valve shall be epoxy coated per AWWA C550. The check valve shall be rated for minimum of 850 kPa (125 psi) working pressure.

2.11 OIL AND GREASE INTERCEPTOR AND GREASE REMOVAL PIT:

A. Shall be constructed of reinforced precast concrete or cast-in-place concrete of the shape and configuration indicated on the plans. Precast vaults shall be constructed in accordance with ASTM C857 and be rated for HS20-44 loading. The concrete shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, and reinforcement shall comply with ASTM A615, Grade 60. Access to the trap shall be through 600 mm (24 inches) diameter manhole frame and cover or through hinged aluminum access manways.

B. Baffles shall be constructed of 6 mm (1/4 inch) mild carbon steel with 6 mm (1/4 inch) thermoplastic coating.

2.12 AIR RELEASE VALVE:

A. Valves shall be combination air release and vacuum valve with a single body. The valves shall be rated for 1025 kPa (150 Psi) working pressure, and conform to AWWA C512. Valve shall be provided with threaded connections, and be mounted on a full opening ball valve which shall isolate the valve from the system.

2.13 CLEANOUT FRAMES AND COVERS:

A. Frames and covers shall be gray iron casting conforming to ASTM C48. The frame and cover shall be rated for HS20-44 wheel loading, have a studded pattern on its cover, vent holes, and lifting slots. The cover shall fit firmly on the frame without movement when subject to vehicular traffic. The word “SEWER” shall be cast on the cover.

2.14 WARNING TAPE:

A. Standard, .1mm (4Mil) polyethylene 76 mm (3 inch) wide tape detectable type, green with black letters and imprinted with “CAUTION BURIED SEWER LINE BELOW”.”

PART 3 - EXECUTION

3.1 BUILDING SERVICE LINES:

A. Install sanitary sewer service lines to point of connection within approximately 1500 mm (5 feet) outside of buildings where service is required and make connections. Coordinate the invert and location of the service line with the Contractor installing the building lines.

B. Connections of service line to building piping shall be made after the new sanitary sewer system has been constructed, tested, and accepted for operation by the Resident Engineer. The Contractor shall install all temporary caps or plugs required for testing.

C. When building services have not been installed at the time when the sanitary sewer system is complete, provide temporary plugs or caps at the ends of all service lines. Mark the location and depth of the service lines with continuous warning tape placed 300 mm (12 inches) above service lines.

3.2 ABANDONED MANHOLES STRUCTURES AND PIPING:

A. Manholes and Structures Outside of Building Areas: Remove frame and cover, cut and remove the top of an elevation of 600 mm (2 feet) below finished grade. Fill the remaining portion with compacted gravel or crushed rock or concrete.

B. Manholes and Structures within Building Areas: Remove frame and cover and remove the entire structure and the base.

C. Piping under and within 1500 mm (5 feet) of building areas shall be completely removed.

D. Piping outside of building areas shall be completely removed**.**

E. The Contractor shall comply with all OSHA confined space requirements while working within existing manholes and structures.

F. When the limit of the abandonment terminates in an existing manhole to remain, the flow line in the bench of the manhole to the abandoned line shall be filled with concrete and shaped to maintain the flowline of the lines to remain.

3.3 REGRADING:

A. Raise or lower existing manholes and structures frames and covers, cleanout frames and covers and valve boxes in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Adjust the elevation of the cleanout pipe riser, and reinstall the cap or plug. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.

B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.

C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.4 CONNECTIONS TO EXISTING VA OWNED MANHOLES:

A. During construction of new connections to existing manholes, it shall be the sole responsibility of the Contractor to maintain continued sanitary sewer service to all buildings and users upstream. The contractor shall provide, install, and maintain all pumping, conveyance system, dams, weirs, etc. required to maintain the continuous flow of sewage. All temporary measures required to meet this requirement shall be subject to the review of the Resident Engineer.

B. Core existing structure, install pipe at the design invert. Install an elastomeric gasket around the pipe, and grout the interstitial space between the pipe and the core.

C. The bench of the manhole shall be cleaned and reshaped to provide a smooth flowline for all pipes connected to the manhole.

D. Connections and alterations to existing manholes shall be constructed so that finished work conforms as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting and shaping.

3.5 CONNECTIONS TO EXISTING PUBLIC UTILITY COMPANY MANHOLES:

A. Comply with all rules and regulations of the public utility.

B. The connection to the existing utility shall comply with the standard details and specifications of the public utility company, except as specifically modified on the plans and specifications.

3.6 PIPE SEPARATION:

A. Horizontal Separation - Water Mains and Sewers:
   1. Existing and proposed water mains shall be at least 3 meters (10 feet) horizontally from any proposed gravity flow and pressure (force main) sanitary sewer or sewer service connection.
   2. Gravity flow mains and pressure (force) mains may be located closer than 3 meters (10 feet) but not closer than 1.8 m (6 feet) to a water main when:
      a. Local conditions prevent a lateral separation of ten feet; and
      b. The water main invert is at least 450 mm (18 inches) above the crown of the gravity sewer or 600 mm (24 inches) above the crown of the pressure (force) main; and
      c. The water main is in a separate trench separated by undisturbed earth.
   3. When it is impossible to meet (1) or (2) above, both the water main and sanitary sewer main shall be constructed of push-on or mechanical joint ductile iron pipe. The pipe for the sanitary sewer main shall comply with the specifications for pressure (force) mains, and the water main material shall comply with Section 33 10 00, WATER UTILITIES. The sewer shall be pressure tested as specified for pressure (force) mains before backfilling.

B. Vertical Separation - Water Mains and Sewers at Crossings:
   1. Water mains shall be separated from sewer mains so that the invert of the water main is a minimum of 600 mm (24 inches) above the crown of gravity flow sewer or 1200 mm (48 inches) above the crown of pressure (force) mains. The vertical separation shall be maintained within 3 meters (10 feet) horizontally of the sewer and water crossing. When these vertical separations are met, no additional protection is required.
   2. In no case shall pressure (force) sanitary main cross above, or within 600 mm (24 inches) of water lines.
   3. When it is impossible to meet (1) above, the gravity flow sewer may be installed 450 mm (18 inches) above or 300 mm (12 inches) below the water main, provided that both the water main and sewer shall be constructed of push-on or mechanical ductile pipe. Pressure (Force) sewers may be installed 600 mm (24 inches) below the water line provided both the water line and sewer line are constructed of ductile iron pipe. The pipe for the sewer shall conform to the requirements for pressure sewers specified herein. Piping for the water main shall conform to Section 33 10 00, WATER UTILITIES.
   4. The required vertical separation between the sewer and the water main shall extend on each side of the crossing until the perpendicular distance from the water main to the sewer line is at least 3 meters (10 feet).

3.7 GENERAL PIPING INSTALLATION:

A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade. Pressure (force) mains shall have the bells facing the direction of flow.

B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.

C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.

D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.

E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.

F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.

G. Do not lay sewer pipe in same trench with another pipe or other utility. Sanitary sewers shall cross at least 600 mm (2 feet) below water lines.

H. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 300 mm (12 inches) over the crown of the pipe.

I. Warning tape shall be continuously placed 300 mm (12 inches) above sewer pipe

J. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
   1. Ductile Iron Piping: AWWA C111 and C600.
   2. Vitrified Clay Piping: ASTM C12.
   3. Polyvinyl Chloride (PVC) Piping: ASTM D2321.
   4. High Density Polyethylene (HDPE) Piping: Comply with manufacturer's recommendations with gasketed joints.

K. Gravity Flow Lines with Secondary Containment:
   1. Install per manufacturer's recommendations. Install all pipe centering devices to maintain an interstitial space below the invert of the carrier pipe. Both the carrier and containment pipe shall be tested for leaks.

L. Installation of Pressure (Force) Mains:
   1. Sections of piping listed on the drawings shall be fully restrained using approved joint restraint devices. Joint restraint devices shall be installed in accordance with the manufacturer's recommendations. For devices with twist of nuts, the twist of nuts shall be placed on top of the fitting for the Engineer's inspection. The Contractor shall torque test all bolts, set screws, identified by the Resident Engineer.
   2. Thrust blocks shall not be permitted.
   3. Install pressure (force) mains in accordance with the provisions of these specifications and the following standards:
      a. Ductile Iron Piping: AWWA C111 and C600.
      b. Polyvinyl Chloride (PVC) Piping: AWWA C605.
      c. High Density Polyethylene (HDPE) Piping: Per manufacturer's recommendations.

3.8 MANHOLES AND VAULTS:

A. General:
   1. Circular Structures:
      a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
      b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top, shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
      c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
   2. Rectangular Structures:

a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE.
b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.

3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
5. Forming directly in concrete base of structure.
6. Building up with brick and mortar.
7. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (1-inch per foot) nor more than 1:6 (2 inches per foot). Bottom slab and benches shall be concrete.
8. The wall that support access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
9. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
10. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.9 SEWER AND MANHOLE SUPPORTS, CONCRETE CRADLES:

A. Reinforced concrete as detailed on the drawings. The concrete shall not restrict access for future maintenance of the joints within the piping system.

3.10 VAULTS:

A. Install precast concrete vaults on a 200 mm (8 inches) compacted aggregate base course. The floor, walls, and top shall be level and plumb.

B. Vaults shall be sized as indicated on the drawings. Orientate vault and internal piping, valves and appurtenances to provide access to all valves and appurtenances for operation and maintenance of the equipment.

C. Paint interior of dry well and vaults with two (2) coats of alkyd enamel masonry paint.

3.11 CLEANOUTS:

A. 150 millimeters (6 inches) in diameter and consisting of a ductile iron 45 degree fitting on end of run, or combination Y fitting and l/8 bend in the run with ductile iron pipe extension, water tight plug or cap and cast frame and cover flush with finished grade. Center-set cleanouts, located in unpaved areas, in a 300 by 300 by 150 mm (12 by 12 by 6 inches) thick concrete slab set flush with adjacent finished grade. Where cleanout is in force main, provide a blind flange top connection. The center of the flange shall be equipped with a 50 mm (2 inches) base valve to allow the pressure in the line to be relieved prior to removal of the blind flange. Frames and covers for pressure (force) mains shall be 600 mm (24 inches) in diameter.

B. The top of the cleanout assembly shall be 50 mm (2 inches) below the bottom of the cover to prevent loads being transferred from the frame and cover to the piping.

3.12 SETTING OF GATE VALVES:

A. Avoid setting valves under pavement except where shown on the drawings.

B. Clean valve interior before installation.

C. Set valve plumb, restrain ends of valves when indicated on the drawing.

D. Set valve box cover flush with the finished grade. Valve box shall be centered over the operating nut.

3.13 SETTING OF CHECK VALVES:

A. Check valves shall be installed in a vault, direct burial of check valves shall not be permitted.

B. Check valves shall be set in the horizontal position, with adequate clearance to the structure to allow for movement of the lever and maintenance of the valve.

C. Clean the interior of the valve and check its operation prior to installation.

D. After installation, adjust the weight on the lever to provide proper operation in accordance with the manufacturer’s recommendations.

3.14 SETTING OF AIR RELEASE VALVES:

A. Set valves in vault with adequate space for maintenance of the valve. The vault shall have a solid floor to prevent all sanitary blowoff from being absorbed into the soils.

B. Valves shall be set plumb and supported to the vault. Maintain accessibility to the isolation valve on the air valve line.

C. Install the valve after the completion of testing of the pressure (force) main.

3.15 INSPECTION OF SEWERS:

A. Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade. Lip at joints on the inside of gravity sewer lines are not acceptable.

3.16 TESTING OF SANITARY SEWERS:

A. Gravity Sewers and Manholes (Select one of the following):
   1. Air Test: Vitrified Clay Pipe ASTM C828. PVC Pipe, Uni-Bell Uni-B-6. Clean and isolate the section of sewer line to be tested. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. The line shall be pressurized to 28 kPa (4 psi) and allowed to stabilize. After pressure stabilization, the pressure shall be dropped to 24 kPa (3.5 psi) greater than the average back-pressure of any groundwater above the sewer. The minimum test time shall be as specified in Uni-Bell Uni-B-6.
   2. Exfiltration Test:

a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During one hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11 L (3.0 gallons) per hour per 30 m (100 feet).

b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.

3. Infiltration Test: If ground water level is greater than 900 mm (3 feet) above invert of the upper manhole, infiltration tests are acceptable. Allowable leakage for this test will be the same as for the exfiltration test.

B. Pressure (Force) Mains: Test at 690 kPa (100 psi) for two hours. Leakage shall be per the following:

$$L=J*D*\sqrt{P}/4500$$

Where:

L = Maximum Allowable Leakage in Gallons per Hour

J = Number of Joints in Test Area

D = Diameter of Pipe in Inches

P = Average Test Pressure (Psi)

C. Testing of Fiberglass Sewage Holding Tanks: No leakage at 35 kPa (5 psi) air pressure test with 5:1 safety factor. Test by Contractor after installation.

D. Testing of Concrete Wet Well: No leakage with the wet well completely filled with water for a duration of 4 hours.

END OF SECTION

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section specifies construction of outside, underground storm sewer systems. The storm sewer systems shall be complete and ready for operation, including all drainage structures, frames, grate and covers, connections to new buildings, structure service lines, existing storm sewer lines and existing drainage structures and all required incidentals.

1.2 RELATED WORK:

A. Maintenance of Existing Utilities: Section 01 00 00, GENERAL REQUIREMENTS.

B. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

C. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.

D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.

E. Protection of Materials and Equipment: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

1.3 QUALITY ASSURANCE:

A. Products Criteria:
   1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
   2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, 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.

B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection to public storm sewer lines and the extension, and/or modifications to Public Utility systems.

1.4 SUBMITTALS:

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

B. Manufacturers' Literature and Data: Submit the following as one package:
   1. Piping.
   2. Jointing material.
   3. Manhole, inlet and catch basin material.
   4. Frames and covers.
   5. Steps.
   6. Resilient connectors and downspout boots.

C. One copy of State Department of Transportation standard details of MANHOLES, INLETS and catch basins.

D. One copy of State Department of Transportation specification.

1.5 APPLICABLE PUBLICATIONS:

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

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

A48-03/A48M-03.....Gray Iron Castings

A536-84(2004).....Ductile Iron Castings

A615-05/A615M-05.....Deformed and Plain-Billet Steel Bars for Concrete Reinforcement

A655-04e1/A655M-04e1... Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

A742-03/A742M-03.....Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe

A760-01a/A760M-01a .....Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

A762-00/A762M-00.....Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains

A798-01/M798M-01 .....Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

A849-00 .....Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe

A929-01/A929M-01.....Steel Sheet, Metallic Coated by the Hot Dip Process for Corrugated Steel Pipe

C76-05a/C76M-05a.....Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

C139-03.....Concrete Masonry Units for Construction of Catch Basins and Manholes

C150-04ae1 .....Portland Cement

C443-05/C443M-05 .....Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C478-03a/C478M-03a.....Precast Reinforced Concrete Manhole Sections

C506-05/C506M-05 .....Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe

C507-05a/C507M-05a.....Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe

C655-04e1/C655M-04e1.....Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe

C1433-04e1/C1433M-04e1 ..... Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers

C828-03 ..... Low-Pressure Air Test of Vitrified Clay Pipe Lines

C857-95(2001) ..... Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C923-02/C923M-02 ..... Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Materials

C924-02/C924M-02 ..... Testing Concrete Pipe Sewer Lines by Low Pressure Air Test Method

C1103-03/C1103M-03 ..... Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

D698-00ae1 ..... Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))

D1056-00 ..... Flexible Cellular Materials-Sponge or Expanded Rubber

D2412-02 ..... Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading

D2321-04e1 ..... Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications .

D3034-04a ..... Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3212-96a(2003)e1 ..... Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3350-04 ..... Polyethylene Plastics Pipe and Fittings Materials

D4101-05a ..... Polypropylene Injection and Extrusion Materials

F477-02e1 ..... Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F679-03 ..... Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F714-05 ..... Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F794-03 ..... Poly (Vinyl Chloride)(PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F894-98a ..... Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

F949-03 .....Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior

F1417-92(2005).....Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

NOTE: ASTM test methods shall be the current version as of the date of advertisement of the project.

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

HB17.....Standard Specifications for Highway Bridges

M190-04.....Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches

M198-05.....Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets

M294-04.....Corrugated Polyethylene Pipe, 300-1500 mm (12 to 60 inches) Diameter

PART 2 - PRODUCTS

2.1 PIPING:

A. Gravity Lines (Pipe and Appurtenances):
   1. Concrete:
      a. Reinforced pipe, ASTM C76. Class III, V. Joints shall be watertight flexible joints made with rubber-type gaskets conforming to ASTM C443.
   2. 2. Polyvinyl Chloride (PVC):
      a. Pipe and Fittings, Type PSM PVC Pipe, shall conform to ASTM D3034, Type PSM, SDR 35. Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D 3212. Gaskets shall conform to ASTM F 477. Solvent welded joints shall not be permitted.
      b. Pipe and fittings, smooth wall, corrugated or ribbed PVC, shall conform to the following:
         1) Pipe and fittings shall conform to ASTM F949 corrugated sewer pipe with a smooth interior. The corrugated outer wall shall be fused to the smooth interwall at the corrugation valley. Pipe and fitting shall have a smooth bell, elastomeric joints conforming to ASTM D 3212, and shall have a minimum pipe stiffness of 345 kPa (50 psi) at 5 percent deflection, when tested in accordance with ASTM D 2412. Corrugation shall be perpendicular to the axis of the pipe to allow gaskets to be installed on field cut sections of pipe without the requirement for special fittings.

2) Ribbed wall PVC pipe and fittings shall conform to ASTM F794, Series 46. Ribbed sewer pipe with smooth interior pipe and fittings shall have a smooth bell, elastomeric joints conforming to ASTM D 3212, and shall have a minimum pipe stiffness of 320 kPa (46 psi) when tested in accordance with ASTM D 2412, at 5 percent vertical deflection. Joints shall not leak at 7.6 m (25 feet) of head under 5 percent deflection.

3) Solid wall pipe and fittings shall conform to ASTM F 679, SDR 35 pipe and fittings shall gaskets conforming to ASTM F 477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).

3. High Density Polyethylene (HDPE):
   a. Smooth Wall PE Pipe: Shall comply with ASTM F714, DR 21 for pipes 75 to 600 mm (3 to 24 inches), and SDR 26 for pipes 650 to 1200 mm (26 to 48 inches). Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.
   b. Corrugated Polyethylene Pipe shall not be used.

Nominal Size	Minimum Wall Area	Min. Moment of Inertia mm^4/mm (in^4/in)
300 mm (12 in)	3200 mm²/m (1.50 in²/ft)	390 (.024)
375 mm (15 in)	4000 mm²/m (1.91 in²/ft)	870 (.053)
450 mm (18 in)	4900 mm²/m (2.34 in²/ft)	1020 (.062)
600 mm (24 in)	6600 mm²/m (3.14 in²/ft)	1900 (.116)
750 mm (30 in)	8300 mm²/m (3.92 in²/ft)	2670 (.163)
900 mm (36 in)	9500 mm²/m (4.50 in²/ft)	3640 (.222)
1050 mm (42 in)	9900 mm²/m (4.69 in²/ft)	8900 (.543)
1200 mm (48 in)	10900 mm²/m (5.15 in²/ft)	8900 (.543)
1350 mm (54 in)	12000 mm²/m (5.67 in²/ft)	13110 (.800)
1500 mm (60 in)	13650 mm²/m (6.45 in²/ft)	13110 (.800)

4. Corrugated Steel Pipe shall not be used.

2.2 JOINTING MATERIAL:

A. Concrete Pipe: Rubber gasket ASTM C443.

B. Polyvinyl Chloride (PVC) Pipe:
   1. PVC Plastic Pipe: Joints shall comply with ASTM D3212, Elastomeric Gaskets shall comply with ASTM F477 and as recommended by the manufacturer.

C. PE Plastic Pipe:
   1. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion as recommended by the manufacturer.

2.3 MANHOLES, INLETS AND CATCH BASINS:

A. Manholes, inlets and catch basins shall be constructed of precast concrete segmental blocks, precast reinforced concrete rings, precast reinforced sections, or cast-in-place concrete. Manholes, inlets and catch basins shall be in accordance with State Department of Transportation standard details, and the following VA requirements, in case of variance, VA requirements supersede:

1. Precast Concrete Segmental Blocks: Blocks shall conform to ASTM C139 and shall not be less than 150 mm (6 inches) thick for manholes to a depth of 3.6 m (12 feet); not less than 200 mm (8 inches) thick for manholes deeper than 3.6 m (12 feet) deep. Blocks shall be not less than 200 mm (8 inches) in length. Blocks shall be shaped so that joints seal and bond effectively with cement mortar. Parge structure interior and exterior with 15 mm (1/2 inch) of cement mortar applied with a trowel and finished to an even glazed surface.
2. Precast Reinforced Concrete Rings: Rings or sections shall have an inside diameter as indicated on the drawings, and shall be not less than 1200 mm (48 inches) in diameter. Wall thickness shall conform to requirements of ASTM C76, except that lengths of the sections may be shorter as conditions require. Tops shall conform to ASTM C478. Top section shall be eccentric cone type. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
3. Precast Reinforced Concrete Manhole Risers and Tops: Design, material and installation shall conform to requirements of ASTM C478. Top sections shall be eccentric. Steps on inside wall shall be in the same plane from bottom of structure to manhole cover.
4. Flat top manhole tops shall be reinforced concrete as detailed on the drawings.
5. Precast Catch Basins: Concrete for precast sections shall have a minimum compressive strength of 35 MPa (5,000 psi) at 28 days, ASTM A615, Grade 60 reinforcing steel, rated for AASHTO HS20-44 loading with 30 percent impact, and conform to ASTM C-857.
6. Mortar:
   a. Precast Concrete Segmental Block Structures: By volume, 1 part of Portland cement, l/4 part lime hydrate, and 3 parts sand.
   b. Precast Reinforced Concrete Ring and Riser Structures: By volume, 1 part of Portland cement and 2 parts sand. Water in mixture shall produce a stiff, workable mortar, but shall not exceed 21L (5-l/2 gallons) per sack of cement.
7. Flexible sealing compound shall be packaged in extruded preformed shape, sized to completely fill the joint between precast sections, and form permanently flexible watertight seal. The sealing compound shall be non-shrink and meet AASHTO M-198B.
8. Frames and covers shall be gray cast iron conforming to ASTM A48. The frame and cover shall be rated for HS20-44 loading, have a studded pattern on the cover, and the words "storm sewer". The studs and the lettering shall be raised 8 mm (5/16 inch). The cover shall be a minimum of 600 mm (24 inches) in diameter and shall have four 19 mm (3/4 inch) vent holes and two lifting slots. The bearing surface of the frame and cover shall be machine finished. The cover shall fit firmly on the frame without movement when subject to traffic.
9. Manhole steps shall be polypropylene plastic coated on a No. 4 deformed rebar conforming to ASTM C478, Polypropylene shall conform to ASTM D4101. Steps shall be a minimum of 250 mm (10 inches) wide and project a minimum of 125 mm (5 inches) away from the mall. The top surface of the step shall have a studded non-slip surface. Steps shall be placed at 300 mm (12 inch) centers.
10. Ladders, brackets and hardware shall be constructed of welded aluminum, rails shall be 9 mm (3/8 inch) by 63 mm (2-1/2 inches) spaced a minimum of 400 mm (16 inches) apart. Rungs shall be 35 mm (1-3/8 inches) in diameter and have a non-slip surface. Standoffs shall offset the ladder 180 mm (7 inches) from the wall. The ladder assembly shall be rated for a minimum of 2200 N (500 pounds).

B. Prefabricated Corrugated Metal Manholes: Manholes shall be the type and design as indicated on the drawings and as recommended by the manufacturer.

C. Prefabricated Plastic Manholes and Drain Basins: Plastic manholes and drain basins shall be as indicated on the drawings.

D. Frame and Cover for Gratings: Frame and cover for gratings shall be cast ductile iron conforming to ASTM A536 in accordance with State Department of Transportation standard details. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the drawings.

2.4 HEADWALLS:

A. Headwalls shall be cast-in-place concrete and in accordance with State Department of Transportation standard details. Concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform with the provisions of Division 03 of these specifications.

2.5 CONCRETE:

A. Concrete shall be in accordance with State Department of Transportation standard specification Section 90: Portland Cement Concrete. For concrete not specified in above standards, concrete shall have a minimum compressive strength of 20 MPa (3000 psi) at 28 days. The cement shall be Type III conforming to ASTM C150. Concrete shall conform to the provisions of Division 03 of these specifications.

2.6 REINFORCING STEEL:

A. Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.7 FLARED END SECTIONS:

A. Flared End Sections: Sections shall be of standard design fabricated from zinc-coated steel sheets conforming to requirements of ASTM A929.

2.8 PRECAST REINFORCED CONCRETE BOX.

A. Precast Reinforced Concrete Box: For highway loadings with 600 mm (2 feet) of cover or more subjected to dead load only, conform to ASTM C1433; For less than 600 mm (2 feet) of cover subjected to highway loading, conform to ASTM C1433.

2.9 RESILIENT CONNECTORS AND DOWNSPOUT BOOTS:

A. Resilient Connectors: Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923.

B. Downspout Boots: Boots used to connect exterior downspouts to the storm drainage system shall be of gray cast iron conforming to ASTM A48, Class 30B or 35B.

2.10 WARNING TAPE:

A. Standard, 4-Mil polyethylene 76 mm (3 inch) wide tape detectable type, purple with black letters, and imprinted with “CAUTION BURIED STORM SEWER BELOW”.

PART 3 - EXECUTION

3.1 EXCAVATION FOR STORM DRAINS AND DRAINAGE STRUCTURES:

A. Excavation of trenches and for appurtenances and backfilling for storm drains, shall be in accordance with the applicable portions of Section 31 20 00, EARTH MOVING.

3.2 PIPE BEDDING:

A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

3.3 GENERAL PIPING INSTALLATION:

A. Lay pipes true to line and grade. Gravity flow sewer shall be laid with bells facing upgrade.

B. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.

C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.

D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.

E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.

F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.

G. Do not lay sewer pipe in same trench with another pipe or other utility.

H. Do not walk on pipe in trenches until covered by layers of shading to a depth of 300 mm (12 inches) over the crown of the pipe.

I. Install gravity sewer line in accordance with the provisions of these specifications and the following standards:
   1. Reinforced Concrete Pipe: Comply with manufacturer's recommendations with gasketed joints.
   2. Polyvinyl Chloride (PVC) Piping: ASTM D2321.
   3. High Density Polyethylene (HDPE) Piping: Comply with manufacturer's recommendations with gaskets with fused joints

J. Warning tape shall be continuously placed 300 mm (12 inches) above storm sewer piping.

3.4 REGRADING:

A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.

B. During periods when work is progressing on adjusting manholes or structures cover elevations, the Contractor shall install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure, and shall prevent debris from entering the wastewater stream.

C. The Contractor shall comply with all OSHA confined space requirements when working within existing structures.

3.5 CONNECTIONS TO EXISTING VA-OWNED MANHOLES:

A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

3.6 MANHOLES, INLETS AND CATCH BASINS:

A. General:
   1. Circular Structures:
      a. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 15 mm (1/2 inch) or cement mortar applied with a trowel and finished to an even glazed surface.
      b. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
      c. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.
   2. Rectangular Structures:
      a. Reinforced concrete structures shall be installed in accordance with Division 03, CONCRETE of these specifications.
      b. Precast concrete structures shall be placed on a 200 mm (8 inch) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on a 200 mm (8 inches) thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D 698. Set precast section true and plumb. Seal all joints with preform flexible gasket material.
   3. Do not build structures when air temperature is 0 degrees C (32 degrees F), or below.
   4. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
      a. Forming directly in concrete base of structure.
      b. Building up with brick and mortar.

5. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1:12 (25mm per 300mm, 1-inch per foot) nor more than 1:6 (50mm per 300mm, 2 inches per foot). Bottom slab and benches shall be concrete.
6. The wall that supports access rungs or ladder shall be 90 degrees vertical from the floor of structure to manhole cover.
7. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
8. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 50 mm (2 inches) above the adjacent finish grade. Install a 200 mm (8 inches) thick, by 300 mm (12 inches) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.7 CURB INLETS, CATCH BASINS, AND AREA DRAINS:

A. Reinforced concrete as shown or precast concrete.

3.8 INSPECTION OF SEWERS:

A. Inspect and obtain the Resident Engineer's approval. Thoroughly flush out before inspection. Lamp between structures and show full bore indicating sewer is true to line and grade. Lip at joints on inside of sewer is prohibited.

3.9 TESTING OF STORM SEWERS:

A. Gravity Sewers (Select one of the following):
   1. Air Test: Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
   2. Exfiltration Test:
      a. Subject pipe to hydrostatic pressure produced by head of water at depth of 900 mm (3 feet) above invert of sewer at upper manhole under test. In areas where ground water exists, head of water shall be 900 mm (3 feet) above existing water table. Maintain head of water for one hour for full absorption by pipe body before testing. During 1 hour test period, measured maximum allowable rate of exfiltration for any section of sewer shall be 11L (3.0 gallons) per hour per 30 m (100 feet).
      b. If measurements indicate exfiltration is greater than maximum allowable leakage, take additional measurements until leaks are located. Repair and retest.

END OF SECTION

SECTION 33 46 13
FOUNDATION DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies foundation drainage system, including installation, backfill, and cleanout extensions, to place of connection to storm sewer.

1.2 SUBMITTALS

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

B. Samples: For each type of filter fabric, pipe, and fitting indicated

C. Product Data: Certifications from the manufacturers attesting that materials meet specification requirements.

1.3 RELATED WORK:

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

B. Safety requirements: Section 01 0 00, GENERAL REQUIREMENTS.

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.

1.4 APPLICABLE PUBLICATIONS

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

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

HB17-02	Standard Spec for Highway Bridges, Div II, Section 36.4.2.4, Joint Properties.
M6-03	Fine Aggregate for Portland Cement Concrete
M86/M86M-06	Concrete Sewer, Storm Drain, and Culvert Pipe
M175/M175M-05	Perforated Concrete Pipe
M288-06	Geotextile Specification for Highway Applications
T281-06	Vitrified Clay Pipe

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

A74-05	Standard Specification for Cast Iron Soil Pipe and Fittings
A746-03	Standard Specification for Ductile Iron Gravity Sewer Pipe
C14/C14M-05a	Standard Specification for Non-reinforced Concrete Sewer, Storm Drain, and Culvert Pipe
C118/C118M-05a	Standard Specification for Concrete Pipe for Irrigation or Drainage
C443/C443M-05a	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C444/C444M-03	Standard Specification for Perforated Concrete Pipe

D448-03a	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
D2321-05	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2729-03	Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D2737-03	Standard Specification for Polyethylene (PE) Plastic Tubing
D3034-06	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D4216-03	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) and Related PVC and Chlorinated Poly (Vinyl Chloride) (CPVC) Building Products Compounds
F477-02e1	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F758-95(2000)	Standard Specification for Smooth-Wall Poly (Vinyl Chloride)(PVC)Plastic Underdrain Systems for Highway, Airport, and Similar Drainage.

D. Caltrans Standard Specifications, May 2006

68-1.025	Standard Specification for Permeable Material

PART 2 - PRODUCTS

2.1 MATERIALS

A. Underslab Header:
1. ASTM A74 or ASTM A746 cast-iron soil pipe and fittings in NPS 4 to NPS 15 (DN 100 to DN 375). Joints shall be hub-and-spigot, gasket type.
2. PE drainage tubing and fittings per ASTM D2737, in NPS 4 to NPS 10 (DN 100 to DN 250). Joints shall be coupling type.
3. PE pipe and fittings per ASTM D2737, in NPS 12 to NPS 36 (DN 300 to DN 900). Joints shall be coupling type.
4. PVC sewer pipe and fittings per ASTM D3034, in NPS 4 to NPS 15 (DN 100 to DN 375). Joints shall be bell-and-spigot. ASTM F477, elastomeric seal gaskets shall be used.

B. Perforated Drainage Pipe:
1. Perforated, PE pipe and fittings per ASTM D2737, in NPS 4 to NPS 6 (DN 100 to DN 150). Joints shall be coupling type.
2. Perforated, PE pipe and fittings per ASTM D2737, in NPS 8 to NPS 24 (DN 200 to DN 600). Joints shall be coupling type.
3. Perforated, PVC sewer pipe and fittings per ASTM D2729, in NPS 4 (DN 100) only. Joints shall be bell-and-spigot, loose type.
4. Perforated, clay pipe and fittings per AASHTO T281 in NPS 3 to NPS 24 (DN 80 to DN 600). Joints shall be socket-and-spigot, closed type.
5. Perforated, concrete pipe and fittings per AASHTO M175/M175M, standard strength or ASTM C444/C444M, Type 1, and applicable requirements of ASTM C14/C14M, Class 2, in NPS 4 to NPS 24 (DN 100 to DN 600). Joints shall be socket-and-spigot type. ASTM C443/C443M rubber gaskets shall be used.

C. Cleanout Extension: ASTM A74, cast iron pipe or ASTM A746 ductile iron. Gravity Sewer pipes shall have a neoprene gasket joints and long sweep elbow fittings.

D. Drainage Conduit:

1. Pipe, fittings, and couplings shall be perforated and smooth PVC complying with ASTM D4216 and ASTM D2729.
2. Pipe size shall be 200 mm (8 inches) and have a high minimum flow rate equal to a NPS 4 (DN 100) pipe.
3. Fittings shall be PVC with NPS 4 (DN 100) outlet connection.
4. Couplings shall be PVC.

E. Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:

F. Drainage Mat: Formed three dimensional polyethylene or high-impact polymeric core or compression-resistant nylon matting of open three-dimensional construction.

G. Drainage Material:
Caltrans Class 2 permeable material, Caltrans Standard Specifications Section 68-1.025

H. Concrete Sand: AASHTO M6.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Laying: Prior to installation of bedding materials or piping, examination of excavation and subgrades are to be observed by the Resident Engineer. Invert elevation of drain pipe shall not be higher than top of lowest floor elevation nor lower than a 45 degree line projected from bottom of any adjacent footing. Lay drain lines and firmly bed in Class 2 permable material (see Caltrans Standard Specifications 68-1.025) granular material a minimum of 75 mm (3 inches) below invert to top of pipe to true grades and alignment with bells facing upgrade, and to slope uniformly between elevations shown on foundation drainage drawings. Keep trenches dry until pipe is in place and granular material backfill is completed to 300 mm (1 foot) above top of pipe, unless otherwise noted.
   1. Install gaskets, seals, sleeves, and couplings according to manufacturers written instructions and per the applicable standard:
      a. PE and PVC pipe installation shall be per ASTM D2321 and ASTM F758.
      b. Concrete piping shall be per ASTM C14/C14M, AASHTO M86/M86M, and ASTM C118/C118M.
      c. PE joint construction shall be per ASTM D2737 and AASHTO HB17, Division II, Section 26.4.2.4, “Joint Properties.”
      d. PVC joint construction shall be per ASTM D3034 with elastomeric seals gaskets per ASTM D2321.
      e. Perforated PVC joint construction shall be per ASTM D2729, with loose bell and spigot joints.
      f. Perforated concrete joint construction, including fittings and gaskets, shall be per ASTM C443/C443M.
   2. Lay perforated pipe with perforations down. Lay plain end pipe with closed joints held in place with two No. 9 spring steel wire clips at each joint or by standard clay collars.
   3. For foundation subdrainage, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 900 mm (3 feet), unless otherwise indicated.
   4. For underslab subdrainage, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
   5. Install cleanout extensions where shown on the Contract Documents.

6. Prior to backfilling, check drain lines to assure free flow. Remove obstructions and recheck lines until satisfactory.

B. Backfilling: Place 6 inches of Caltrans Class 2 permeable material (see Caltrans Standard Specification Section 68-1.025) on all sides of pipes and wrap pipes in filter fabric. Remainder of backfill shall be comparable to existing adjacent soils. In bituminous and concrete paving areas, backfill to the bottom of the base course with pervious material. Where foundation drain is within 600 mm (2 feet) of finished grade, one-half of fill shall be made with Caltrans Class 2 permeable material.

C. When drain lines are left open for connection to discharge line, the open ends shall be temporarily closed and their location marked with wooden stakes.

END OF SECTION

SECTION 33 63 00
STEAM ENERGY DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Underground steam distribution and condensate return piping system. Type of system shall be: pre-engineered direct-buried drainable-dryable-testable (DDT).

1.2 DEFINITIONS

A. System: A complete underground steam and condensate distribution system including all components such as carrier piping, pipe supports, insulation, protective enclosures, anchors, corrosion protection and accessories.

B. Pre-Engineered Direct-Buried System: System that is designed and factory-fabricated by a company specializing in these systems. The system includes pre-fabricated protective enclosures and does not require a concrete trench or tunnel. The pre-engineered system shall include all piping and components to a point at least 150 mm (6 inches) inside the building.

C. Drainable-Dryable-Testable (DDT) Pre-Engineered Direct-Buried System: A factory-fabricated system including an airtight and watertight outer protective casing, an insulated carrier pipe and an air space between the insulated carrier pipe and the casing. Drains and vents are provided in the ends of the system (in manholes or buildings). The drains allow draining of ground water or condensate that may leak into the air space if there is a failure in the casing or the carrier pipe. The vents allow water vapor to escape and provide an indication of leakage.

D. Carrier Pipe: Pipe carrying the steam or condensate.

E. Casing: Outer protective pipe on pre-engineered systems. Carrier pipe and insulation are within the casing. The casing may also be referenced as the “conduit”.

F. Project Drawings: The “MS” and civil project drawings accompanying this specification provide information on:
   1. The size of carrier pipes, approximate length, and site location of the system.
   2. The elevation and routing of the piping on the site.
   3. The obstacles located within approximately 25 m (8 feet) of the centerline of the system, including crossing utilities, that must be avoided or altered.
   4. Type of system required , pre-engineered direct-buried.
   5. Location of piping anchors.
   6. Operating pressure and temperature of systems.
   7. Details of building entrances.
   8. Other pertinent general information.

G. Pressures: Pressures listed in this section are gage pressure unless otherwise noted.

1.3 RELATED WORK

A. Phasing of work: Section 01 00 00, GENERAL REQUIREMENTS.

B. Excavation, shoring and backfill: Section 31 20 00, EARTH MOVING.

C. Concrete work: Section 03 30 00, CAST-IN-PLACE CONCRETE.

1.4 QUALITY ASSURANCE

A. Approval by Contracting Officer is required of products or services of proposed manufacturers, suppliers and installers.

B. For pre-engineered direct-buried systems submit certification that:
   1. Manufacturers regularly and currently manufacture the product.
   2. There is a permanent service organization trained by the manufacturer that will provide the required field supervision of the installation of the system or equipment. Submit name and address of the service organization.

C. The manufacturer of pre-engineered direct-buried distribution system shall design the system to comply with the requirements of these specifications and is responsible for the complete product to be supplied, fabrication, witnessing installation and testing of the system. The complete design of the system shall be prepared, signed and sealed by a Professional Engineer employed by the system manufacturer.

D. Products Experience Record:
   1. Pre-Engineered Direct-Buried Systems: Shall be manufactured by a company which specializes in these systems and which has been in this business for five or more years.
   2. All Other Products: The designs shall be of current production and have been in satisfactory operation on at least three installations for approximately five years.

E. Provide a complete installation with all necessary specialties, materials and equipment fully and properly connected and coordinated. Installation shall be fully operational upon completion of work defined and as phased.

F. Apply and install systems, materials, equipment and specialties in accordance with manufacturer's instructions. Printed instructions shall be available at the site prior to and during construction.

G. Materials, design, installation and workmanship shall conform to applicable local codes, and to national codes and standards as referenced in this specification.

H. Manufactured Products:
   1. When two or more items serve the same function, they shall be products of one manufacturer.
   2. Manufacturers of assemblies of products, which include components made by others, shall assume complete responsibility for final assembled unit.
      a. All components of an assembled unit need not be products of the same manufacturer.
      b. Constituent parts that are alike shall be products of a single manufacturer.
      c. Components shall be compatible with each other and with the total assembly for intended service.
   3. All systems and equipment shall be free from defects that would adversely affect the performance, maintainability, or appearance of individual components or overall assembly.
   4. Each product shall be designed for the service conditions specified for that product. If no conditions are specified, the product shall be suitable for the actual service conditions.

I. Manufacturer’s Identification: Components of equipment shall bear manufacturer’s name or trademark and model number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment. Refer to Part 2 for requirements for pre-engineered direct-buried systems.

J. Radiographic Testing of Welds: Weld examination methods and procedures and the interpretation of examining films shall conform to ASME B31.1. The testing firm shall utilize the proper film exposure, techniques, and penetrameter to produce density and geometric sharpness required for first quality film, and all radiographs shall be reviewed and interpreted and reading reports signed by not less than an American Society for Non-Destructive Testing (ASNT) Certified Level III Radiographer.

1.5 SUBMITTALS

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

B. Submit information and materials under this section separate from information and materials submitted under other sections and mark "SUBMITTED UNDER Section 33 63 00, STEAM ENERGY DISTRIBUTION, GROUP _____."

C. Submit all items listed under each group simultaneously (except for items that can only be submitted during construction and upon completion of construction).

1. Group I, Pre-Engineered Direct-Buried Systems:
   a. Certification that system manufacturer regularly and currently manufactures direct-buried systems, and that the designs of the system and equipment to be provided for this project conform to specification requirements. This certification shall be an original signed by a principal officer of the manufacturer.
   b. Complete descriptions and drawings of design of system and materials of construction including component parts, assembly, carrier pipes, casing, anchors, pipe guides, pipe supports, expansion loops and elbows, and building wall penetrations, end seals, leak plates, field installation instructions.
   c. A detailed design layout of the system showing the size, type, and location of each component, the design of anchors and building wall penetrations, the design of the transition points to existing systems.
   d. Manufacturer’s quality assurance plan for fabrication, delivery, storage, installation and testing of system.
   e. Certificate of Qualification from system manufacturer that the manufacturer’s field representative regularly performs the specified duties of monitoring the installation of the system and is technically qualified and experienced in the installation of the system and is authorized by the supplier to make and sign the daily reports specified herein.
   f. Manufacturer’s data sheets and thickness of carrier pipe insulation.
   g. Calculations approved and stamped by Professional Engineer demonstrating that allowable stress of piping will not be exceeded due to thermal expansion and that anchor forces and moments are not excessive. Calculations shall be performed by a finite-element, three dimensional analysis computer program. Final report shall show node stresses, forces, moments and displacements.
   h. All drawings and calculations shall have Professional Engineer's stamp.
   i. A proposed schedule of activities indicating when various items of work and tests are to be carried out and when quality control inspectors of the supplier will be present at the job site.
   j. The daily written report from the manufacturer’s representative at the job site during all stages of material delivery and construction.
   k. Proposed changes in design due to unforeseen conflicts or interferences along the route of the system.
   l. Upon completion of the work:

1) Certificate of Compliance signed by principal officers of the manufacturer and the contractor certifying that the system has been installed in accordance with contract requirements.
2) Operation and maintenance manual.
3) As-built layout of system including all final elevations (hard copies and AutoCAD on CD).

2. Group V, Expansion Compensation :
   a. Joint locations, sizes, types, movements.
   b. Anchor locations, design, forces and moments.

D. Independent Weld Testing Firm for Carrier Piping in Pre-Engineered Direct- Buried Systems:
   1. Certificate of Qualification of testing firm.
   2. Certificate of Acceptability of actual welds.

E. Proposed test procedures and samples of test data sheets for each required test, 30 days prior to the test date. Provide calibration data on all test instruments. Tests shall not begin until procedures have been approved.

F. Test reports resulting from testing of installed systems, in booklet form showing all field tests performed to prove compliance with specified performance criteria.

1.6 STORAGE AND HANDLING

A. Equipment and material placed on the job shall remain in the custody of the Contractor until final acceptance whether or not the Government has reimbursed the Contractor for the equipment and material.

B. The Contractor is solely responsible for the protection of the equipment and material against damage from any source. Protect piping systems against entry of water and mud and all foreign substances by installing watertight protection on open ends at all times. Protect direct-buried system coatings from ultraviolet light (sunlight). Existing equipment worked on by the Contractor or in the Contractor's working area shall be under the custody and responsibility of the Contractor.

C. All insulated piping systems exposed to water must be replaced with new systems.

D. Place all damaged items in first class new operating condition or replace damaged items as determined and directed by the Resident Engineer (RE)/Contracting Officers Technical Representative (COTR), at no additional cost to the Government.

1.7 JOB CONDITIONS

A. Phasing of demolition and construction shall be in accordance with the provisions of Section 01 00 00, GENERAL REQUIREMENTS, and as shown on steam distribution drawings.

B. Interruption of Existing Service: Arrange, phase and perform work and provide temporary facilities, materials, equipment, and connections to utilities, to assure adequate steam and condensate return service for existing installations at all times. Only such absolutely necessary interruptions as may be required for making connections will be permitted, and only at such times when approval is obtained from RE/COTR. Interruptions to steam and condensate service shall be only with prior approval, and be the minimum possible duration. All interruptions shall be as scheduled under Article "Phasing" of Section 01 00 00, GENERAL REQUIREMENTS as approved by the RE/COTR.

1.8 APPLICABLE PUBLICATIONS

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

B. Federal Specifications (Fed. Spec.):

A-A-60005 NOT 1	Frames, Covers, Grating, Steps, Sump And Catch Basin, Manhole
L-P-535E	Plastic Sheet (Sheeting): Plastic Strip: Poly (Vinyl Chloride) and Poly (Vinyl Chloride-Vinyl Acetate)
L-S-125B	Screening, Insect, Nonmetallic

C. Military Specifications (Mil. Spec.):

MIL-S-901D	Shock Tests. H.I. (High Impact) Shipboard Machinery, Equipment and Systems

D. ASTM International (ASTM):

A36/A36M-05	Structural Steel
A47/A47M-99(2004)	Ferritic Malleable Iron Castings
A53/A53M-06a	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A105/A105M-05	Carbon Steel Forgings for Piping Applications
A106/A106M-06a	Seamless Carbon Steel Pipe for High-Temperature Service
A126-04	Gray Iron Castings for Valves, Flanges and Pipe Fittings
A134-96(2005)	Pipe, Steel, Electric-Fusion(Arc)-Welded (Sizes NPS 16 and over)
A135/A135M-06	Electric-Resistance Welded Steel Pipe
A139/A139M-04	Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over)
A167-99(2004)	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
A193/A193M-07	Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
A194/A194M-07a	Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
A197/A197M-00(2006)	Cupola Malleable Iron
A216/A216M-07	Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
A234/A234M-07	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
A240/A240M-07e1	Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications
A395/A395M-99(2004)	Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
A536-84(2004)	Ductile Iron Castings
B61-02	Steam or Valve Bronze Castings.
B209-06	Aluminum and Aluminum-Alloy Sheet and Plate
C411-05	Hot-Surface Performance of High-Temperature Thermal Insulation
C449/C449M-00	Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
C533-07	Calcium Silicate Block and Pipe Thermal Insulation
C547-06	Mineral Fiber Pipe Insulation
C552-03	Cellular Glass Thermal Insulation
C591-07	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
C655-04e1	Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
C920-05	Elastomeric Joint Sealants

C1126-04	Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
C1136-06	Flexible, Low Permeance Vapor Retarders for Thermal Insulation
D1784-06a	Rigid Poly (Vinyl Chloride)(PVC) Compounds and Chlorinated Poly (Vinyl Chloride)(CPVC) Compounds
D2310-06	Machine-Made "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
D2487-06	Soils for Engineering Purposes (Unified Classification System)
D2996-01(2007)e1	Filament-Wound Fiberglass (Glass-Fiber-Reinforced-Thermosetting-Resin) Pipe

E. American Society of Mechanical Engineers (ASME):

B16.3-2006	Malleable Iron Threaded Fittings
B16.5-2003	Pipe Flanges and Flanged Fittings NPS ½ - 24
B16.9-2003	Factory-Made Wrought Buttwelding Fittings
B16.11-2005	Forged Fittings, Socket-Welding and Threaded
B31.1-2004	Code for Pressure Piping, Power Piping, with Amendments
B31.9-2004	Code for Pressure Piping, Building Services Piping, with Amendments
B40.100-2005	Pressure Gauges and Gauge Attachments

Boiler and Pressure Vessel Code, Section VIII: 2007 Edition, with Amendments

F. American Welding Society (AWS):

AWS B2.1-00	Welding Procedure and Performance Qualification

G. Manufacturers Standardization Society of the Valve and Fitting Industry (MSS):

SP45-03	By-Pass and Drain Connection Standard
SP58-02	Pipe Hangers and Supports-Materials, Design and Manufacture
SP69-03	Pipe Hangers and Supports-Selection and Application
SP80-03	Bronze Gate, Globe, Angle and Check Valves

H. National Fire Protection Association (NFPA):

255-06	Test of Surface Burning Characteristics of Building Materials

I. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

ASHRAE Handbook	2004 HVAC Systems and Equipment

J. American Concrete Institute (ACI):

318-05	Building Code Requirements for Reinforced Concrete

K. NACE International (Corrosion Engineers) (NACE):

RP0169-02	Standard Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems

L. Expansion Joint Manufacturers Association (EJMA):

8th Edition-2003	Standards of the Expansion Joint Manufacturers Association

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

M300-03	Inorganic Zinc Rich Primer

N. Society for Protective Coatings (SSPC):

SP-10/NACE No. 2-2004	Near White Blast Cleaning

O. Unified Facilities Guide Specifications (UFGS):

UFGS 33 63 13	Exterior Underground Steam Distribution System (April 2006 or later)

PART 2 - PRODUCTS

2.1 PRE-ENGINEERED, FACTORY-FABRICATED, DIRECT-BURIED, DRAINABLE-DRYABLE-TESTABLE (DDT) SYSTEMS

A. Complete steam and condensate piping system with carrier pipes, carrier pipe insulation with jackets and banding, air space, steel casing, outer casing secondary insulation, and accessories. Do not locate condensate pipes in casings (conduits) that contain steam pipes.

B. Design Pressure and Temperature: All components of system shall be suitable for carrier pipe pressures and temperatures as follows:
   1. Steam System: 1000 kPa (150 psi); 185 °C (366 °F).
   2. Condensate System: 345 kPa (50 psi); 154 °C (310 °F).

C. Description of System Design: Refer to Part 1, "DEFINITIONS".

D. Steam Carrier Pipes: Refer to Paragraph, "STEAM PIPING".
   1. No piping joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
   2. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected.

E. Condensate Carrier Pipes: Refer to Paragraph, "STEAM CONDENSATE PIPING".
   1. No piping joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.
   2. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected.

F. Carrier Pipe Insulation:
   1. Conform to minimum thickness and type of insulation listed in Tables 1 and 2 below as required for service temperature in carrier pipe as listed below.
   2. Section A: Steam temperature is 172 °C (341°F), steam pressure is 800kPa (120psi). Pumped condensate temperature is 93 °C (200 °F).
   3. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1
Minimum Pipe Insulation Thickness mm (inches)
For Steam 110 to 2800 kPa (16 to 408 psi) gage

Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp
25 (1)	50 (2)	65 (2 1/2)	100 (4)
40 (1 1/2)	50 (2)	65 (2 1/2)	100 (4)
50 (2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
65 (2 1/2)	65 (2 1/2)	85 (3 1/2)	110 (4 1/2)
80 (3)	75 (3)	100 (4)	125 (5)
100 (4)	75 (3)	100 (4)	125 (5)
125 (5)	75 (3)	100 (4)	125 (5)

TABLE 1 Minimum Pipe Insulation Thickness mm (inches) For Steam 110 to 2800 kPa (16 to 408 psi) gage			
Nominal Pipe Diameter mm (inches)	MPT-PC MPT-PF	Delta	Thermo-12 Super Caltemp
150 (6)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
200 (8)	85 (3 1/2)	110 (4 1/2)	135 (5 1/2)
250 (10)	100 (4)	125 (5)	150 (6)

Notes: Insulation listed has passed the 96-hour boiling water test.
Pipes smaller than 25 mm (1 inch) shall have same insulation thickness as 25 mm (1 inch) pipe.

TABLE 2 Minimum Pipe Insulation Thickness mm (inches) For , Condensate Return			
Nominal Pipe Diameter mm (inches)	MPT-PF MPT-PC	Delta	Thermo-12 Super Caltemp
25 (1)	40 (1 1/2)	50 (2)	75 (3)
40 (1 1/2)	40 (1 1/2)	50 (2)	75 (3)
50 (2)	40 (1 1/2)	50 (2)	75 (3)
65 (2 1/2)	40 (1 1/2)	50 (2)	75 (3)
80 (3)	50 (2)	65 (2 1/2)	85 (3 1/2)

Notes: Insulation listed has passed the 96-hour boiling water test which indicates that satisfactory performance in underground service can be expected.
Pipes smaller than 25 mm (1 inch) shall have the same insulation thickness as required for 25 mm (1 inch) pipe.
"Delta" is available from Rockwool, Leeds, AL.
"MPT" is available from Mineral Products of Texas, Houston, TX.
"Thermo-12" and "Super Caltemp" is available from Industrial Insulation Group, Brunswick, GA.

4. Insulation Banding and Jacket: Stainless steel bands and clips, at least 13 mm (0.5 inches) wide, ASTM A-167 (304 stainless steel), maximum spacing 460 mm (18 inches). A minimum of two bands is required for each 1300 mm (4 foot) section of insulation. Vinyl-coated fiberglass scrim jacket, Fed. Spec. L-S-125, Type II, Class 2, with 18 x 16 mesh (number of filaments per inch) and made of 0.335 mm (0.013 inches) diameter vinyl-coated fibrous glass yarn. Install bands over the jacket to secure the insulation to the carrier pipe.

G. Casing: Smooth-wall steel, electric resistance welded, conforming to ASTM A134, ASTM A135, or ASTM A139. Plastic casings are not permitted. Use eccentric connectors as necessary between casing sections to provide continuous gravity drainage in bottom of casing between manholes and between manholes and buildings.

Casing Diameter mm (in.)	Minimum Thickness mm (in.)
150 - 1170 (6 - 46)	6.35 (0.250)

H. Casing End Seal Plates with Vents and Drains: ASTM A36 steel, minimum thickness 9.5 mm (0.375 inches) for casings up thru 300 mm (12 inches) diameter and 13 mm (0.5 inches) for casings over 300 mm (12 inches) diameter. Provide 25 mm (one inch) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains. Install vent riser pipes, ASTM A53, Schedule 40, galvanized, extending through top of manhole and terminate 300 mm (12 inches) above grade with 180-degree bend.

I. Gland Seals: Not permitted because of the possibility of water entering the system thru the gland seal from a flooded manhole.

J. Air Space: Provide continuous 25 mm (one inch) minimum air space between carrier pipe insulation and casing.

K. Outer Conduit Insulation and Jacket: Conduit insulation shall be spray applied polyurethane foam, having a nominal 2 lb/ft^3 density for all straight lengths and fittings. The insulation thickness shall be 1 inch maximum. Quality assurance procedures for the insulation shall include either a visual check prior to jacketing, an infrared inspection or an x-ray inspection of the entire length to insure there are no insulation voids. The urethane foam shall have the minimum characteristics of 0.18 K-factor, density of 2 lb/ft^3, closed cell content of 90 to 95% and compression strength of 40 psi. The polyurethane foam insulation shall be tested by the manufacturer for mechanical and thermal properties to assure compliance with the above values. All test samples will be taken from production material, identified, tagged and tested in accordance with the table below. Test reports showing results will be furnished to the engineer for approval. Data supplied by the polyurethane foam chemical supplier is not acceptable.

L.

Attribute	ASTM STD	Sample Frequency	Requirement
Insulation Density	D 1622	Once per shift	$\geq$ 2 lb/ft^3
Insulation Compression Strength	D 1621	Once per shift	$\geq$ 40 psi
Insulation Closed Cell Content	D 2856	Once per shift	$\geq$ 90%
Insulation Thermal Conductivity	C 518	Once per shift	< 0.18 Btu-in/hr/ft^2/°F

The outer jacket shall be High Density Polyethylene and shall be applied directly onto the urethane foam insulation. All straights and fittings shall be factory jacketed.

M. Coating of End Plates and Casing (Conduit) Sections Extending in Manholes: Zinc-rich coating that conforms to AASHTO M300, Type IA except that volatile organic compounds shall not exceed 0.34 kg per liter (2.8 pounds per gallon). The zinc rich coating shall be applied in accordance with the recommendations of the coating manufacturer including surface preparation. No additional top coat shall be applied.

N. Carrier Pipe Guides and Supports: Maximum spacing 3000 mm (10 feet) on centers, no more than 1500 mm (5 feet) from pipe ends, minimum of three guides per elbow section. Designed to permit thermal expansion without damage, provide proper pipe guiding and support, and to allow horizontal movement in two directions as necessary at expansion loops and bends. Design of guides and supports must permit continuous drainage of water in bottom of casing. Pipe insulation shall extend thru the pipe guides and supports and be protected by steel sleeves. Design of guides and supports shall be such that no metal-to-metal contact exists between the casing and the carrier pipe. Insulation or non-metallic material used to ensure no metal to metal contact shall be designed to not be compressed by the weight of the carrier pipe when full of water.

O. Anchor Plates: ASTM A36 steel, welded to carrier pipe and casing, 13 mm (0.5 inches) minimum thickness, passages for air flow and water drainage thru the annular air space in the system. Coated with same coating material as the casing. Locate 900 to 1500 mm (3 to 5 feet) from piping entrance to or building wall. Walls of buildings cannot be utilized as anchor points.

P. Field Connection of Casing Sections: Steel section conforming to casing specification, welded to casing sections, coated on all surfaces with system manufacturer's coating field repair compound, and covered with a 1.3 mm (0.05 inch) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 °C (176 °F).

Q. Building Wall Penetrations: Provide steel leak plates welded to wall sleeves or to casings. Where wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight EPDM Link-Seal (Thunderline Corp) or equal, rated for 121 °C (250 °F) minimum. Building walls cannot be used as anchor points.

R. Manufacturer's Identification: Provide embossed brass or stainless steel tag hung by a brass or stainless steel chain at each end of each conduit or insulated piping in the manholes and buildings. The tag shall identify system manufacturer's name, date of installation, government contract, and manufacturer's project number.

S. Branch Piping Connections: All branch piping connections must be located in manholes.

T. Manufacturers: Perma-Pipe, or equal.

2.2 STEAM CARRIER PIPING

A. Pipe: Steel; seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 40. Standard weight permitted for pipe sizes 300 mm (12 inches) and above. Grade F, furnace butt-welded pipe, is not permitted.

B. Joints:
   1. In direct-buried systems: Butt-weld except socket-weld for pipe sizes two-inches and below. Manufacturer's standard sliding gasketed joints permitted between sections of WSL pre-engineered direct-buried systems. No joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping sections that are a portion of an expansion loop or bend shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by a American Society for Non-Destructive Testing (ASNT) Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 50 mm (2 inches) and below.

C. Fittings:

1. Butt-Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe. All elbows shall be long radius unless otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured.
2. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

2.3 STEAM CONDENSATE CARRIER PIPING

A. Pipe: Seamless, ASTM A53, Grade B or ASTM A106, Grade B; electric resistance welded ASTM A53, Grade B; Schedule 80. Grade F, furnace butt-welded, pipe is not permitted.

B. Joints:
1. In direct-buried systems: Butt-weld except socket-weld is required for pipe sizes 50 mm (two inches) and below. Manufacturer's standard sliding, gasketed joints permitted between factory-fabricated sections of direct buried WSL system. No joints allowed in factory-fabricated straight sections of pre-engineered direct-buried systems. Factory-fabricated direct-buried piping systems that are a portion of expansion loops or bends shall have all welded joints 100% radiograph inspected. All radiographs shall be reviewed and interpreted by a ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report. Dye penetrant testing may be utilized for pipe sizes 50 mm (2 inches) and below.

C. Fittings:
1. Welded Joints: Steel, ASTM A234, Grade B, ASME B16.9, same schedule as adjoining pipe.
2. Socket-Welded Joints: Forged steel, ASME B16.11, 13,800 kPa (2000 psi) class.

2.4 EXPANSION LOOPS AND BENDS

A. Stresses shall be less than the maximum allowable stress in the Power Piping Code (ASME B31.1). Submit shop drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides and supports. Base calculations on 1000 kPa (150 psi) and 185 °C (366 ° F) for steam line loops and bends and 345 kPa (50 psi) and 154 °C (310 °F) for condensate return line loops and bends. Base calculations on actual pressures and temperatures if they are higher than those listed above.

B. Base calculations for condensate on 100 kPa (15 psi) and 121 °C (250 °F) and comply with Building Services Piping Code (ASME B31.9).

2.5 BURIED UTILITY WARNING TAPE

A. Tape shall be 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1750 psi) lengthwise and 10,300 kPa (1500 psi) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 GENERAL

A. Connecting to Existing Work: Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstruction shall be bypassed, removed, replaced or relocated, patched and repaired. Work disturbed or damaged shall be replaced to its prior condition, as required by Section 01 00 00, GENERAL REQUIREMENTS.

B. Coordination: Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems. The contractor at his cost shall perform any relocation of equipment or systems to comply with the requirement of operability and maintainability.

C. Excavation, trenching, shoring, sheathing, bracing, and backfilling shall conform to Section 31 20 00, EARTH MOVING.

D. Grading: Unless otherwise shown on drawings, steam lines shall be graded downward not less than 50 mm in 12 meters (two inches in 40 feet) in direction of the flow. Provide eccentric reducing fittings on steam mains and branches, (except on vertical piping). Install said fittings to maintain continuity of grade in bottom of pipeline.

3.2 DEMOLITION

A. Perform work in accordance with requirements for phasing.

B. Completely remove all pipe, valves, fittings, insulation, and all hangers including the connection to the structure and any fastenings.

C. Seal all openings in manhole or building walls after removal of piping.

D. All material and equipment removed shall become the property of the Contractor and shall be removed from Government property within one week and shall not be stored in operating areas.

E. All flame cutting shall be performed with adequate fire protection facilities available as required by safety codes and Resident Engineer.

F. Asbestos Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT or Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT.

3.3 PIPING JOINTS AND FITTINGS

A. Welded Joints:
   1. Branch connections shall be made with either welding tees or welding outlet fittings. Welding outlet fittings shall be forged, integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow.
   2. Clean pipe and fittings before welding and installation in system.

B. Fittings: All pipe intersections and all changes in direction shall be made with factory-built-reinforced fittings. Field-fabricated fittings and miters are not permitted.

3.4 CLEANING OF PIPING

A. Clean pipe and fittings inside and outside before and after assembly. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe “pig” before connecting pipe sections, valves, equipment or fittings.

3.5 WELDING

A. The Contractor is entirely responsible for the quality of the welding and shall:
   1. Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
   2. Comply with ASME B31.1 and AWS B2.1.
   3. Perform all welding operations required for construction and installation of the heat-distribution system.

B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1 and AWS B2.1, and also as outlined below.

C. Examining Welder: Examine each welder at job site, in the presence of the Resident Engineer (RE)/Contracting Officer's Technical Representative (COTR), 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:
   1. Allowed to weld only in the position in which he has qualified.
   2. Required to identify his welds with his specific code marking signifying his name and number assigned.

D. Examination Results: Provide the RE/COTR with a list of names and corresponding code markings. Retest welders that fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.

E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.

F. Alignment: Utilize split welding rings or approved alternate method for field joints on all carrier pipes above 50 mm (two inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 50 mm (two inches) and smaller with welding sockets.

G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 0 °C (32 °F) or lower, the pipe shall be heated to approximately 38 °C (100 °F) for a distance of 300 mm (one foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 °C (32 °F).

H. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be requalified.

I. Electrodes: Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

J. Radiographic Testing: An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of all field welds in the carrier piping of direct-buried systems, in accordance 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, prior to installing conduit field joints, trench covers, backfilling and hydrostatic testing. 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. The RE/COTR reserves the right to review all inspection records, and if any welds inspected are found unacceptable they shall be removed, rewelded, and radiographically reexamined at no cost to the Government.

3.6 DIRECT-BURIED SYSTEM INSTALLATION:

A. The system manufacturer shall oversee the delivery, storage, installation and testing of the system. All work shall be in strict accordance with the requirements specified herein and with the printed instructions of the manufacturer. Printed instructions must be available at the site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the system designer and the RE/COTR.

B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design and as specified in Section 31 20 00, EARTH MOVING . Beach sand or any sand with large amounts of chlorides is not permitted. Place system on a 300 mm (12 inch) thick sand bed and backfill on all sides with 150 mm (6 inch) thick sand as measured from outside the casing. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks or substances that could damage the system coating. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and system has been satisfactorily pressure tested including hydrostatic testing of carrier pipes and air testing of casings.

C. Representative of System Manufacturer: This shall be a person who regularly performs the duties listed below, is certified in writing by the system manufacturer to be technically qualified and experienced in the installation of the system, and shall be authorized by the manufacturer to make and sign the daily reports specified herein. The representative shall be present at the job site when the following types of work are being performed:
   1. Inspection and unloading of material delivered to site.
   2. Inspection of trench prior to commencing installation of system.
   3. Inspection of concrete anchors .
   4. Cold springing.
   5. Hydrostatic test of all service lines.
   6. Field joint closure work.
   7. Air test of conduit.
   8. Repair of any coatings.
   9. Initial backfill up to 250 mm (10 inches) above the top of the casing.
   10. The slope of the system. Elevation readings shall be witnessed and recorded.
   11. Operational tests.

D. Reports to Contracting Officer:
   1. Obtain a written report prepared daily and signed by the representative of the system manufacturer. Present the original report to the RE/COTR on the same day it is prepared, and forward one copy to the manufacturer's main office.

2. The report shall state whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the plans, specifications, and manufacturer's printed instructions and is satisfactory in all respects. When any work connected with the installation is unsatisfactory, the report shall state what corrective action has been taken or shall contain the system manufacturer's recommendations for corrective action. The report shall identify any conditions that could result in an unsatisfactory installation, including such items as open conduit ends left in the trench overnight . The daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system design. Signed and sealed copies of the daily report shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished as specified.
3. Upon completion of the work and before final acceptance, deliver to the RE/COTR a notarized Certificate of Compliance signed by principal officers of both the manufacturing and the contracting firm, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions.
4. The manufacturer shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

E. Protect casing coating from damage during rigging, storage and installation. Protect casing and carrier pipe ends from water intrusion during rigging and installation. Protect casing coatings from ultraviolet light (sunlight).

F. Defective Material: The Representative shall take prompt action to return to the factory all damaged or defective material and shall order prompt replacement of such material.

G. Slope of Carrier Pipes: Maintain constant slope as shown or specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the conduit system has been installed to the elevations shown on the shop drawings. Slope shall be uniform within 0.1 percent. These measurements shall be recorded by the Contractor, included in the direct buried system manufacturer representative's daily report, and given to the RE/COTR prior to covering the top of the casing with backfill.

H. Cleaning of Piping: Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab or pipe "pig" before connecting pipe sections, valves, or fittings.

I. Field Tests: Refer to Article, TESTS.

J. Wet Insulation: Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.

K. Vents and Drains on Ends of DDT Systems: At each casing termination (end plate) in buildings, plug the casing drain openings with brass plugs and extend one inch pipe size ASTM A53 galvanized vent pipes from the casing vents one foot above the conduit in buildings.

L. Buried Utility Warning Tape: Install tape 300 mm (12 inches) below grade above the piping system.

3.7 BURIED UTILITY WARNING TAPE

A. Bury directly above direct-buried system approximately 300 mm (12 inches) below grade.

3.8 IDENTIFICATION SIGNS

A. Pipe Identification: Label service of all pipes at building entrance . Refer to Section 09 91 00, PAINTING.

3.9 TESTS

A. Demonstrate leak-tightness of all piping systems by performing hydrostatic and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments must be approved by the RE/COTR.

B. Pressure test direct-buried systems in conformance with requirements stated in this specification and in printed instructions for the system supplied. Tests must include carrier piping and casing.

C. Radiographic testing of carrier pipe welds: Refer to Article, WELDING, in Part 3 of this specification.

D. Before conducting steam system operating test, flush lines with high pressure water until discharge shows no foreign matter to the satisfaction of RE/COTR.

E. Hydrostatic and Operational Tests of Carrier Piping: Steam and condensate carrier piping shall be tested hydrostatically before insulation is applied at field joints and shall be proved tight at a pressure 1-1/2 times distribution supply pressure for a period not less than 2 hours with no pressure decay.
   1. Test direct-buried systems prior to backfilling.
   2. Remove or isolate any elements of the system which are not designed for the test pressure.
   3. Prior to acceptance of installation, Contractor shall subject system to operating tests as may be required by RE/COTR to demonstrate satisfactory functional and operating efficiency. These operating tests shall cover a period of not less than six hours for each portion of system tested. Conduct tests at times as the RE/COTR may direct.
   4. Provide calibrated instruments, equipment, facilities and labor, at no additional cost to the Government. Test gage shall read in increments not exceeding 1 kPa (0.1 psi).
   5. Repeat tests when failures occur.
   6. After completion of satisfactory test, replace all elements that have been removed prior to testing.

F. Pneumatic Testing of DDT System Casings:
   1. Perform test on all sections of the system before field-coating the field joints and before back-filling.
   2. Test shall be with compressed air at 100 kPa (15 psi) for 24 hours with pressure source disconnected and with no decay in pressure. Corrections to the readings are permissible to compensate for significant ambient temperature changes during the test period.
   3. Pressure shall be measured with a gage with reading increments of 1 kPa (0.1 psi).
   4. Each casing field joint shall be tested for leaks by means of soap solution or equivalent.

G. Deficiencies discovered shall be corrected at the Contractor's expense, to satisfaction of RE/COTR. Major deficiencies or failure to correct deficiencies, to the satisfaction of the RE/COTR, may be considered cause for rejecting the entire installation.

END OF SECTION