



**Michael E. DeBakey VA Medical Center
Houston, TX**

**Specifications
Issue for Bid
Volume 2: Divisions 21 - 34**

Project Manual For:

580-317 Parking Garage A Phase I

**VA No. 580-317
HOK No. 10.10019.00**

August 8, 2011

**Architects:
HOK
2800 Post Oak Blvd, Suite 3700
Houston, TX 77056**

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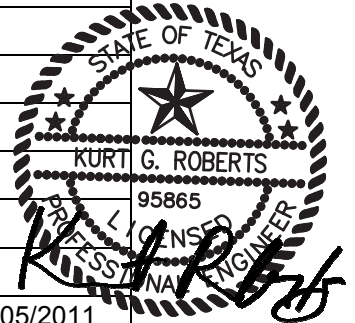
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DIVISION 21 00 00

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
- M. Section 21 05 12, GENERAL MOTOR REQUIREMENTS FOR FIRE-SUPPRESSION EQUIPMENT.
- N. 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. 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. Interstitial space.
3. Hangers, inserts, supports, and bracing.
4. Pipe sleeves.
5. Equipment penetrations of floors, walls, ceilings, or roofs.

D. Maintenance Data and Operating Instructions:

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

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

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 ELECTRIC MOTORS

- A. Section 21 05 12, GENERAL MOTOR REQUIREMENTS FOR FIRE-SUPPRESSION EQUIPMENT, specifies the applicable requirements for electric motors. 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. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

2.3 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 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.

2.4 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.
- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
 - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2. Valve lists: Typed or printed plastic coated card(s), sized 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
 - 3. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

2.5 FIRESTOPPING

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

2.6 GALVANIZED REPAIR COMPOUND

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

AK2.7 PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve 25 mm (one inch) above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from this requirement must receive prior approval of Resident Engineer.
- D. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- E. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- F. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight

with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

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

2.8 TOOLS AND LUBRICANTS

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

2.9 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

PART 3 - EXECUTION

3.1 INSTALLATION

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

B. Protection and Cleaning:

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

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

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

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

F. Inaccessible Equipment:

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

3.2 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.

3.3 LUBRICATION

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

3.4 STARTUP AND TEMPORARY OPERATION

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.5 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.

3.6 INSTRUCTIONS TO VA PERSONNEL

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

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MEP

DIVISION 21 00 00

SECTION 21 05 12 - MOTOR REQUIREMENTS FOR FIRE-SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of motors for fire-suppression equipment.

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 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.
- C. Section 26 24 19, MOTOR-CONTROL CENTERS: Multiple motor control assemblies, which include motor starters.
- D. Other sections specifying motor driven equipment in Division 21.

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. Include electrical ratings, dimensions, mounting details, materials, horsepower, 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 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 properly applied, installed, adjusted, lubricated, 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 designation only.
- B. National Electrical Manufacturers Association (NEMA):
 - MG 1-98.....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):
 - 70-02.....National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 MOTORS:

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. Voltage ratings shall be as follows:
 - 1. Single phase:
 - a. Motors connected to 120-volt systems: 115 volts.
 - b. Motors connected to 208-volt systems: 200 volts.
 - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
 - 2. Three phase:
 - a. Motors connected to 208-volt systems: 200 volts.
 - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
 - c. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
 - d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
 - e. Motors connected to high voltage systems: Shall conform to NEMA Standards for connection to the nominal system voltage shown on the drawings.
- C. Number of phases shall be as follows:
 - 1. Motors, less than 373 W (1/2 HP): Single phase.
 - 2. Motors, 373 W (1/2 HP) and larger: 3 phase.
 - 3. Exceptions:

- a. Hermetically sealed motors.
- b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- F. Motor Enclosures:
 - 1. Shall be the NEMA types shown on the drawings for the motors.
 - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.
 - 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.
- G. Additional requirements for specific motors, as indicated in other sections, shall also apply.
- H. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts 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 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%

I. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.

J. Premium efficiency motors shall be used where energy cost/kW x (hours use/year) > 50.

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

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

- - - E N D - - -

MEP

DIVISION 21 00 00

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 rooms, attic space, elevator machine rooms, elevator pits, linen and trash chutes, and accessible shafts.
- B. The design and installation of a standpipe system combined with the sprinkler system.
- C. Installation of a new fire pump, sized to meet the system flow and pressure per NFPA 14, NFPA 13 and NFPA 20 the latest editions to 690 kPa (100 psi) at the top of standpipe.
- D. Installation of new sectional valves in the standpipe system feed mains as indicated on the drawings.
- E. 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.
- F. 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 standpipe system and fire pump shall be in accordance with the

required advisory provisions of NFPA 13, 14, 20, 25, 75, 82. 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.

1.4 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).
- 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 six hours notification.

1.5 SUBMITTALS

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Emergency service point of contact name and 24 hour emergency telephone number.
- C. Manufacturer's Literature and Data:
 1. Pipe and fittings.
 2. Valves
 3. Drips
 4. Fire Department Siamese Connection
 5. Inspectors Test Alarm Modules
 6. Pressure Gages
 7. Pressure Switches
 8. Pipe Hangers and Supports
 9. Water Flow Switches
 10. Valve Tamper Switches
 11. Water Motor Alarm
 12. Water Measuring Device
 13. Fire Pump
 14. Jockey Pump

- 15. Test Header
- 16. Fire Pump Controller and Transfer Switch
- 17. Fire Pump Test Data
- E. Detailed drawings in accordance with NFPA 13 NFPA 14 and NFPA 20 the latest editions. Drawings shall be prepared using CADD software stamped by fire protection professional engineer and include all new 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. Operation and Maintenance Data:
 - 1. Indicating Valves
 - 2. Water Flow and valve tamper switches
 - 3. Alarm Valves
 - 4. Fire Pump
 - 5. Excess Pressure Pump
 - 6. Copy of NFPA 25
- H. Recommended preventive maintenance schedule.

1.6 AS-BUILT DOCUMENTATION

- A. A mylar as-built drawing and two blue-line 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 operation and maintenance data updated to include submittal review comments and any equipment substitutions including one copy of NFPA 25.
- D. 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)
- 14-2003.....Installation of Standpipe and Hose Systems
 - 20-2003.....Installation of Centrifugal Fire Pump
 - 24-2002.....Installation of Private Fire Service Mains and Their Appurtenances
 - 25-2004.....Inspection, Testing and Maintenance of water Based Fire Protection Systems
 - 70-2004.....National Electrical Code
 - 72-2002.....National Fire Alarm Code
 - 82-2004.....Incinerators, Waste and Linen Handling Systems and Equipment
 - 170-2005.....Standards for Fire Safety Symbols
 - 291-2002.....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 fire pump systems shall be provided by a factory trained authorized representative of the manufacturer of the major equipment for a period of five years 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 20, 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 fire pump, standpipe system and all but a single sprinkler must be operational before the responding service person leaves the facility.
- N. The contractor shall maintain a log at the fire pump controller. The log shall list the date and time of all examinations and trouble calls, condition of the system, and name of technician. Each trouble call shall be fully described, including the nature of the trouble, necessary correction performed, and parts replaced.

PART 2 - PRODUCTS

2.1 GENERAL

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. Threaded or flanged fittings shall be ANSI B1 6.3 cast iron, class 125 minimum. Threaded fittings are not permitted on pipe with wall thickness less than schedule 40.
- C. All fittings on galvanized piping shall be galvanized in accordance with ASTM A53.
- D. Slip type or clamp-on type rubber gasketed fittings shall be listed for each piping application.
- E. 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
 - 5. Seamless copper tube - follow ASTM B 75
 - 6. Seamless copper water tube - follow ASTM B88
 - 7. Wrought seamless copper and copper alloy tube - follow ASTM B 251
 - 8. Fluxes for soldering applications of copper and copper alloy tube - follow ASTM B 813
 - 9. Brazing filler metal - follow AWS A5.8
 - 10. Solder metal, 95-5 - follow ASTM B 32
 - 11. Alloy material - follow ASTM B 446
 - 12. Non-metallic piping CPVC pipe - follow ASTM F 442
- F. 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 butt weld fittings - follow ASME B16.9
 - 5. Buttwelding ends for pipe, valves, flanges, and fitting - follow ASME B16.25
 - 6. Wrought copper and copper alloy solder joint pressure fittings - follow ASME B16.22
 - 7. Cast copper alloy solder joint pressure fitting - follow ASME B16.18
 - 8. Chlorinated polyvinyl chloride (CPVC) - follow ASTM F 437
- G. 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, and on the suction side of either the fire pump or jockey pump.

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. 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

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

Brass, pad mounted, 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". 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 FIRE PUMP

- A. Provide a fire pump system, complete with pump, motor, controller, accessories, and complying with all the requirements of NFPA 20 latest edition. Pump shall deliver not less than 65 percent of rated head at 150 percent of rated capacity. Churn pressure shall not exceed 140 percent of rated design pressure. Suction pressure is 0 kPa (psi) and total discharge pressure is 150 kPa (psi).

- B. Provide a vertical base mounted, split case, bronze fitted, single stage, double suction, centrifugal fire pump.
- C. Mount pump on a fabricated steel base complete with coupling and direct connect to a 111,855 (150) W (HP), 480 volt, 3 phase, 60 cycle open drip-proof, ball bearing, squirrel cage induction motor. Locked rotor current shall not exceed the values specified in NFPA 20.
- D. Provide fire pump controller, approved for fire pump service, completely assembled, wired and tested at the factory. Mark controller "Fire Pump Controller". Enclose equipment in approved NEMA 3R enclosure. The combined manual and automatic type controller shall include the following:
 - 1. Disconnect switch, externally operable, quick break type.
 - 2. Circuit breaker, time delay type with trips in all phases for 300 percent of the motor full load current.
 - 3. Motor starter Wye-Delta starting primary resistance reduced voltage starting capable of being energized automatically through the pressure switch or manually by means of an externally operable handle.
 - 4. Running period timer set to keep motor in operation, when started automatically, for a period not to exceed ten minutes.
 - 5. Pilot lamp to indicate circuit breaker closed and power available.
 - 6. Ammeter test link and voltmeter test line.
 - 7. Alarm relay to energize an audible or visible alarm through an independent source of power to indicate circuit breaker open or power failure.
 - 8. Provide means on the controller to operate an alarm contact continuously while the pump is running.
 - 9. Provide all necessary wiring and interface circuitry to enable fire alarm system to accept monitoring signals from controller.
- E. Provide fire pump controller with an automatic and manual built-in emergency transfer switch specifically approved for fire pump service. All wiring between the fire pump controller and the transfer switch shall be done at the factory and the entire unit assembly factory tested. The transfer switch shall include emergency power isolation switch, control relays, solid state sensing and timing equipment as well as the power transfer switch all in an NEMA 3R enclosure.

- F. Hydrostatically test the pump at 150 percent of the working pressure but in no case to less than 1700 kPa (250 psi). Provide a complete factory performance test and furnish characteristic curves prepared from the test results.
- G. Include the following accessories with the fire pump unit:
1. Eccentric tapered suction reducer.
 2. Concentric tapered discharged increaser.
 3. Hose valves.
 4. Caps and chains.
 5. Pressure gages.
 6. Circulation relief valve.
 7. Automatic air release valve.
 8. Ball drip valve.
 9. Coupling guard.
 10. Water measuring device.
 11. Test header.
- H. Provide remote alarm panel and mount at location of constant attendance. Alarm panel shall operate on 115 volt, 60 Hertz power for supervisory voltage. Furnish panel with visible/audible pump power failure, pump running supervisory power failure alarm signals and phase reversal on line side of motor starter. Provide auxiliary contacts for connection to Engineering Control Center. Coordinate panel location with Owner.
- I. Provide the services of a factory-trained representative to align coupling and be available to assist in final acceptance test.
- J. Set main relief valve to prevent pressure on the fire protection system components in excess of that pressure which the system is capable of withstanding. Install in accordance with NFPA 20.
- K. Water Measuring Device: Capable of water flow of not less than 175 percent of pump rated capacity, to test the pump. Provide discharge drain line from the device to a suitable drain.
- L. Pump Settings:
1. Jockey Pump Stop Point: Pump churn pressure plus the minimum static supply pressure.
 2. Jockey Pump Start Point: Jockey pump stop point less 70 kPa (10 psi).

3. Fire Pump Start Point: Jockey pump start point less 35 kPa (5 psi).
Use 70 kPa (10 psi) increments for each additional fire pump.
4. Where minimum run timer is provided, fire pump shall continue to operate after attaining these pressures. Final pressures shall not exceed pressure rating of the system.
5. When the operating differential of pressure switches does not permit these settings, settings shall be as close as equipment will permit. Establish settings through observation of pressures on test gages.
6. When minimum run timer is provided, the fire pump shall continue to operate at churn pressure beyond the stop setting. Final pressure shall not exceed the pressure rating of the system components.

2.7 JOCKEY PUMP

- A. Provide jockey pump capable of delivering .68 L/s (10 gpm) when operating at a total developed head of 112 meters (369 ft.).
- B. Pump shall be close coupled turbine type, cast iron frame and case, bronze impeller, bronze fitted, stainless steel shaft, tungsten carbide mechanical seal.
- C. Pump: 111,855 W (3 HP), 3450 R.P.M., 60 Hz, 480 volt, open drip proof motor.
- D. Jockey Pump Controller: UL Listed, with magnetic starter, fusible disconnect switch, hand-off automatic selector switch, control circuit transformer, running period timer, adjustable Mercury tube pressure switch, and NEMA 2, driptight, rated for 480 volts, 3 phase.
- E. Jockey pumps must be sized to make up the allowable leakage rate within 10 minutes or 1 GPM whichever is larger and should have rated capacities of not less than accepted leakage rate. They shall have discharge pressure sufficient to maintain the desired fire protection system pressure.

2.8 TEST HEADER

In-line flow switch for 1500 gpm.

2.9 IDENTIFICATION SIGNS

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.

2.10 STANDPIPE FIRE HOSE RACK

- A. 1-1/2" angle valve rough brass 300 psi, escutcheon, satin brass hose rack nipple, satin brass pin lug coupling, FM listed 500 psi acceptance pressure test poly-flex hose, satin brass fog nozzle, red glossy polyester coated hose rack, red vinyl-coated fabric with Velcro closures: lettered "FIRE HOSE KEEP CLEAR"

2.11 HANGERS AND EARTHQUAKE BRACING

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

2.12 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.

2.13 VALVE SUPERVISORY SWITCHES

- A. Provide each indicating sprinkler, standpipe and fire pump 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.

2.14 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.

2.15 WATER MOTOR GONG

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

2.16 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.

2.17 PRESSURE GAUGE

- A. Provide a 1280 kPa (200 psi) pressure gauge at each flow alarm switch location, at the top of each standpipe riser, at each main drain connection, and on the suction and discharge of the fire pump.

2.18 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, when required by the reviewing Authority, showing stress developed in hangers, piping, fittings and safety factors allowed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Supervisory Switches: For each indicating standpipe system riser, main service entrance, fire pump supply and discharge, jockey pump supply, 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 standpipe riser and where indicated on drawings, provide a waterflow switch. Install waterflow switch and adjacent valves in easily accessible locations.
- C. 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 over splash block, indirectly over standpipe drain connected to storm sewer, 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.
- D. Provide a 1280 kPa (200 psi) pressure gage at each flow alarm switch location, at the top of each standpipe riser, at each main drain connection, and on the suction and discharge of the fire pump.
- E. Conceal all piping, except in pipe basements, stairwells and rooms without ceilings.
- F. Install new piping and sprinklers aligned with natural building and other sprinklers lines.
- G. 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.
- H. Piping arrangement shall avoid contact with other piping and equipment and allow clear access to other equipment or devices requiring access or maintenance.
- I. 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.
- J. For each new or existing 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.).
- K. Firestopping shall comply with Section 07 84 00, FIRESTOPPING. All holes through stairways, smoke barrier walls, and fire walls shall be sealed on a daily basis.
- L. Provide hydraulic design information signage as required by NFPA 13 and 14.

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

3.2 TEST

- A. Standpipe and Hose System: NFPA 25.
- B. Centrifugal Fire Pumps: NFPA 20.

3.3 INSTRUCTIONS

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 fire pump and sprinkler system, on the dates requested by the COTR.

- - - END - - -

MEP

DIVISION 21 00 00

SECTION 21 12 00 FIRE-SUPPRESSION STANDPIPES

PART 1 - GENERAL

1.1 DESCRIPTION

Fire-suppression wet standpipes.

1.2 SCOPE OF WORK

- A. Design, installation and testing shall be in accordance with NFPA 14 except for specified exceptions.
- B. Design, materials, equipment and installation, inspection and testing of a complete and ready for operation fire-suppression wet standpipe system as required by NFPA 14.
- C. Expansion or revision of the building system fire alarm system to incorporate new system alarms and supervisory devices.
- D. Painting of exposed piping and supports to match surrounding background in stairways and red in unfinished areas.

1.3 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 33 10 00, WATER UTILITIES.
- C. Section 07 84 00, FIRESTOPPING, Treatment of penetrations through rated enclosures.
- D. Section 08 31 13, ACCESS DOORS AND FRAMES: for access panels for plaster or gypsum finishes.
- E. Section 09 91 00, PAINTING.
- F. Section 21 10 00, WATER-BASED FIRE-SUPPRESSION SYSTEMS, fire pumps, etc.
- G. Section 28 31 00, FIRE DETECTION AND ALARM, Connection to fire alarm of flow switches, pressure switches and valve supervisory switches.
- H. Section 21 05 11 COMMON WORK RESULTS FOR FIRE SUPPRESSION for general mechanical requirements and items, which are common to more than one section.

1.4 QUALITY ASSURANCE

- A. Designer's Qualifications: Design work and shop drawings shall be prepared by a licensed engineer practicing in the field of Fire Protection Engineering.

- B. Installer Reliability: The installer shall possess a valid State of (insert state in which work is being performed) contractor's license. The installer shall provide documentation of having successfully completed three projects of similar size and scope.
- C. Materials and Equipment: All equipment and devices shall be of a make and type listed by UL and approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA.
- D. Testing: Materials and Testing Certificate as per NFPA 14. Provide certificates for all parts of the system.

1.5 DESIGN CRITERIA

- A. The design, materials, equipment, installation, and testing of the system shall be in accordance with NFPA 14 the latest edition.
- B. For hydraulic calculations, calculated demand shall not fall less than 10 percent below the water supply curve.
- B. Water Supply: Base water supply on a fire pumper truck being able to provide 3785 l/m (1000 gpm) at 1035 kPa (150 psig) and 2650 l/m (700 gpm) at 1380 kPa (200 psig) at the fire department connection.
- C. Size standpipes to provide 100 psig) at the most remote connections.

1.6 SUBMITTALS

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are stamped by a Registered Professional Engineer practicing in the field of Fire Protection Engineering. As Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably bind submittals in notebooks or binders and provide index referencing the appropriate specification section. Submittals shall include, but not be limited to, the following:
 - 1. Certificates:

- a. Designer's and Installer's qualifications and documentation of previous work.
 - b. Materials and Testing certificates as specified.
2. Drawings: Submit detailed 1:100 (1/8 inch) scale (minimum) working drawings conforming to NFPA 14. Include a site plan showing the fire hydrant nearest the fire department connection.
3. Manufacturers Literature and Data Sheets: All pertinent literature and data for the materials and equipment proposed for the project. Include listing information and installation instructions in data sheets. Clearly identify the item to be used.
 - a. For backflow preventers, provide flow test curves from UL, FM, or the Foundation for Hydraulic Research and Cross-Connection Control to verify pressure loss calculations.
 - b. Provide for materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.
4. Calculation Sheets: Submit hydraulic calculations in accordance with NFPA 14.
5. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Submittals shall include, but not be limited to, the following:
 - a. One complete set of reproducible as-built drawings showing the installed system with the specific interconnections between the waterflow switch or pressure switch and the fire alarm equipment. One copy of final CADD drawing files shall be provided on diskettes that are compatible with the VAMC CADD system.
 - b. Four sets of complete, simple, understandable, step-by-step, testing instructions giving recommended and required testing frequency of all equipment, methods for testing all equipment, and a complete trouble shooting manual. Provide maintenance instructions on replacing any components of the system including internal parts, periodic cleaning and adjustment of the equipment and components with information as to the address and telephone

number of both the manufacturer and the local supplier of each item.

- c. Certificates shall document all parts of the installation.
 - 1. Designer's and Installer's qualifications and documentation of previous work.
 - 2. Materials and Testing certificates as specified.
- d. Instruction Manual: Provide one copy of the instruction manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser.

1.7 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Mechanical Engineers (ASME):
 - B16.3-99.....Malleable Iron Threaded Fittings
- C. Factory Mutual Engineering Corporation (FM):
 - Approval Guide - 2001
- C. National Fire Protection Association (NFPA):
 - 14-2003.....Installation of Standpipe, Private Hydrant and Hose Systems
 - 101-2003.....Safety to Life from Fire in Buildings and Structures (Life Safety Code)
 - 170-1999.....Fire Safety Symbols
- D. Underwriters Laboratories, Inc. (UL):
 - Fire Protection Equipment Directory - 2002
- E. Uniform Building Code - 1997

PART 2 PRODUCTS

2.1 GENERAL

All devices and equipment shall be Underwriters Laboratories listed for their intended purpose.

2.2 PIPING & FITTINGS

- A. Shall be in accordance with NFPA 14.black steel, schedule 10 minimum.
- B. Threaded or flanged fittings shall be ANSI B 16.3 cast iron, class 125 minimum. Threaded fitting are not permitted on pipe with wall thickness less than Schedule 40.

C. Clamp-on fittings with rubber gaskets shall be listed for the piping application.

D. Plain end pipe, fittings with locking lugs or shear bolts are not permitted. Use nonferrous piping in MRI Scanning Rooms.

2.3 VALVES

A. Do not use quarter turn ball valves for 50 mm (2 inch) or larger drain valves.

2.5 IDENTIFICATION SIGNS/HYDRAULIC PLACARDS

A Provide for all new and existing sectional valves, riser control valves, drain valves and alarm devices. The signs shall be in accordance with NFPA 14 and attached securely to each item.

B Plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Enter pertinent data for each system on the hydraulic placard.

2.6 STANDPIPE FIRE HOSE RACK (FHR-1)

Hose rack and cover- red vinyl-coated fabric cover with Velcro closures; lettered "Fire Hose Keep Clear". 2-1/2" x 1-1/2" assembly for class III service.

2.7 VALVE SUPERVISORY SWITCHES:

A. Provide each indicating standpipe and 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. Water flow Alarm Switches: Mechanical, non-coded, non-accumulative retard and adjustable from 0 to 60 seconds minimum. Set flow switches at an initial setting between 20 and 30 seconds.

F. Valve Supervisory Switches for Ball and Butterfly Valves: May be integral with the valve.

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

2.8 GAUGES

Provide gauges as required by NFPA 14.

2.9 PIPE HANGERS AND SUPPORTS

Supports, hangers, etc., of an approved pattern placement to conform to NFPA 14. System piping shall be substantially supported to the building structure. Materials used in the installation or construction of hangers and supports shall be listed and approved for such application. Hangers or supports not specifically listed for service shall be designed and bear the seal of a professional engineer.

2.10 WALL, FLOOR AND CEILING PLATES

Provide chrome plated steel escutcheon plates for exposed piping passing through walls, floors or ceilings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Install concealed piping in spaces that have finished ceilings. Sidewall heads may need to be utilized. Locate piping in stairways as near to the ceiling as possible to prevent tampering by unauthorized personnel, and to provide a minimum headroom clearance of 2250 mm (seven feet six inches). To prevent an obstruction to egress, provide piping clearances in accordance with NFPA 101.
- C. Face fire department connections in valve outward in a manner which prevents crimping of the hose.
- D. Welding: Conform to the requirements and recommendations of NFPA 14.
- E. Drains: Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks.
Install drips and drains where necessary and required by NFPA 14.
- F. Valve Supervisory Switches: Provide supervisory switches for standpipe control valves. Do not provide standpipe hose valves and test and drain

valves with supervisory switches. Do not provide valve supervisory switches on standpipe hose valves, test or drain valves. See Section 28 31 00, FIRE DETECTION AND ALARM for connections.

- G. Waterflow Alarm Switches: Install waterflow switch and adjacent valves in easily accessible locations.
- H. Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- I. Provide pressure gauge at each water flow alarm switch location, at the top of each standpipe, and at each main drain connection.
- J. For each fire department connection, provide the symbolic sign given in NFPA 170 and locate 2400 to 3000 mm (8 to 10 feet) above each connection location. Size the sign to 450 by 450 mm (18 by 18 inches) with the symbol being at least 350 by 350 mm (14 by 14 inches).
- K. Penetrations: Sleeve or core drill concrete and masonry. Provide clearance between pipe and openings as required by NFPA 14. Seal penetrations and clearances in fire rated wall and floor assemblies with listed through-penetration firestop materials in accordance with Section 07 84 00, FIRESTOPPING.
- L. For each fire department supply connection, provide the symbolic sign given in NFPA 170 located 2400 to 3000 mm (8 to 10 feet) above each connection. The sign shall be 450 by 450 mm (18 by 18 inches) with the symbol being at least 350 by 350 mm (14 by 14 inches).
- M. Securely attach identification signs to control valves, drain valves, and test valves. Locate hydraulic placard information signs at each sectional control valve where there is a zone water flow switch.
- N. Interruption of Service: There shall be no interruption of the existing, water, electric, or fire alarm services without prior permission of the Contracting Officer. Contractor shall develop an interim fire protection program where interruptions involve in occupied spaces. Request in writing at least one (1) week prior to the planned interruption. Any interruption shall be limited to 4 hours for final connections or repairs.
- O. Welding: All welding shall conform to the requirements and recommendations of NFPA 14 latest editions.

3.2 INSPECTION AND TEST

- A. Flushing: Flush newly installed systems prior to performing hydrostatic tests in order to remove any debris which may have been left as well as ensuring piping is unobstructed.
- B. Hydrostatic Testing: Hydrostatically test the system including the fire department connections, as specified in NFPA 14, NFPA-25 and NFPA 13 latest edition, in the presence of the Authority Having Jurisdiction or his designated representative.
- C. Final Inspection and Testing: Test the system in accordance with NFPA 14, NFPA 25 and NFPA 13 latest editions after all necessary corrections have been accomplished. Advise the Authority Having Jurisdiction who will then schedule the final inspection and test. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct any deficiencies found and retest the system. Include the operation of all features of the systems under normal conditions in the test.

3.3 INSTRUCTIONS

Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COTR/Resident Engineer.

3.3 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.

- - - E N D - - -

MEP

DIVISION 21 00 00

SECTION 21 41 00 - STORAGE TANKS FOR FIRE SUPPRESSION WATER

PART 1 - GENERAL

1.01 RELATED WORK

- A. Section 21 05 00: Common Work Results for Fire Suppression
- B. Section 23 09 23: Building Automation and Direct Digital Controls
- C. Division 26: Electrical.

1.02 SUBMITTALS

- A. Submit product data for review.

1.03 CODE COMPLIANCE / QUALITY INSURANCE

- A. Comply with the most stringent of applicable codes for the design, fabrication and installation of water tanks and systems.
- B. Design and install tanks in compliance with applicable Codes and requirements of authorities having jurisdictions including requirements of:
 - 1. Owner's insuring agency.
 - 2. Approved edition of NFPA 22.
 - 3. NFPA 780 - "Standard for the Installation of Lightning Protection Systems", Section 404.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

2.02 INTERIOR TANKS

- A. Top, side and bottom - 1/4" plate steel minimum, ASTM A36.
- B. Steel channel stiffeners where required.
- C. Return bend vent pipe, diameter not less than one half the area of the overflow drain. Cover vent pipe with stainless steel screen.
- D. Stainless steel, 150 psi ANSI flanges and 3,000 psi stainless steel half couplings.
- E. Split flange float access opening for fill valves.
- F. Solenoid valves for alta sonic level indicators.
- G. Water level check gauge with two, one-half inch angle valves with ball checks, 1/4" needle drain valve and 5/8" rigid plastic sight glass. Sight glass to be run inside a continuous piece of baked urethane unistrut channel for protection.
- H. Attach a metal nameplate in plain view indicating the name of

fabricator, date of fabrication and serial number of tank.

- I. 4' x 4' anti-vortex plate on pump suction inlet.
- J. Refer to drawings and/or details for dimensions and additional equipment.

2.03 PROTECTIVE COATINGS

- A. Surface Preparation: In accordance with SSPC-SP10 (63) near white blast clean with 2.0 to 3.0 mil surface profile.
- B. Application: Conform to standards of Steel Structures Painting Manual, Volume I, Good Painting Practice. (Latest Edition).
- C. Interior Surfaces: Two coats MEI-500, a two component, 100% solids, coating based on polybenzimidazol-epoxy-phenolic novlac resin, applied to a minimum thickness of 15 to 18 mils D.F.T. on flat surfaces and to greater thicknesses on corners and rough areas such as nozzle penetrations as required, and as listed in ANSI/NSF Standard 61.
- D. Exterior Surfaces for Interior Tanks: One coat of ACRO 1124 VOC Phenolic Modified Red Iron Oxide Inhibitive Primer 1.0 to 3.0 mils D.F.T. on shell of the tank(s); two coats MEI-500 Epoxy, 10-20 mils D.F.T., on the top and ACRO 8507, 20-30 mils D.F.T., on the bottom of the tank(s).

2.04 FILL VALVE

- A. CLA-VAL No. 136G-03BCSY, normally closed, self contained solenoid fill valves with opening and closing speed control and stainless steel trim shall be provided, to be activated by the Ultrasonic level transmitter. Valves shall be piped as detailed on the plans. The valve operation shall be lead/lag with the lead fill valve automatically alternated after each fill cycle.
- B. For exterior fill connections, heat trace the cover of the fill valves and the fill valve pilot tubing.

2.05 LEVEL ALARMS

- A. Level Alarm Signal Requirements: Unipoint ultrasonic level alarm and valve control sensors and level signal panel with all control relays, terminals, level sensing equipment, alarms, and all other apparatus and accessories specified or necessary for complete signal and valve control system shall be provided. System shall be the unit responsibility of one supplier.

- B. Ultrasonic level transmitter: Gems sensors series UCL-210 continuous ultrasonic sensor, PVDF, NEMA 4 enclosure and 2" NPT connection for measurement up to 12" in depth.
 - 1. Level Alarm and Valve Control Panel:
 - a. UNIPOINT custom level control and alarm panel, NEMA 4X fiberglass enclosure.
 - b. UNIPOINT custom level control and alarm panel, NEMA 4X fiberglass enclosure.
 - c. Amber "Power On" light.
 - d. Electronic analog panel meter controller with LED display of tank level and setpoint position.
 - e. Common alarm buzzer with silencing push button.
 - f. High & Low Level alarm lights.
 - g. Auxiliary alarm contacts for remote alarm device.
 - h. Amber "Power On" light.
 - i. Electronic analog panel meter controller with LED display of tank level and setpoint position.
 - j. Common alarm buzzer with silencing push button.
 - k. High & Low Level alarm lights.
 - l. Auxiliary alarm contacts for remote alarm device.
- C. Level Indicator/Gauge
 - 1. Interior Tanks: Provide clear plastic tubing with unistrut housing and angle valves with drain. Locate gauge on tank to be within view of the fire pump.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Construct tanks in accordance with AWS specifications for vessel fabrication, with structural design in accordance with AISC latest issue and with all new material to assure against the possibility of contamination from previous usage.
- B. Interior Coating Inspection
 - 1. Inspection to commence only after the coating has sufficiently cured, usually one to five days (consult the coating manufacturer for specific curing schedule).
 - 2. Film Thickness: Check with a non-destructive, magnetic pull-off type gauge, such as Mikrotest model DFG-100 or electronic

thickness gauge. Verify accuracy of thickness gauge with National Bureau of Standards certified thickness calibration plates.

3. Provide written certification to the Architect and/or Owner's Representative that tests were performed and successful results obtained.
4. Set water tank on the equipment pad prepared with two coats of ACRO 8507 quick dry coal tar with final D.F.T. of 16-20 mils to cover the entire top and bottom of the water tanks.
- C. Fill Valves: Set floats on fill valves to provide water levels in tanks as detailed on the plans.
- D. Level Alarm Systems: Set ultra sonic sensor to provide alarms at levels as detailed on plans. Provide a representative of the level alarm system manufacturer for a minimum of one day to supervise the final adjustment of the level alarms systems after installation is completed and to instruct the Owner's operating personnel in its use. The manufacturer is to maintain a local service organization and spare parts available from local stock.
- E. Tank Protection
 1. Locate tanks at an elevation to prevent tank from being subject to flooding conditions. Coordinate with project Civil Engineer and/or Owner's Representative to establish and/or confirm flood elevation criteria.
 2. Secure tanks against unauthorized entry with such protective measures as required by the Owner's Security Representative.
 3. Where required, seismic protection measures shall be employed in accordance with all applicable Codes and Authorities Having Jurisdiction.
- F. Installer Testing
 1. Tank Bottoms
 - a. Upon completion of the welding of the tank bottom, test welds by one of the following methods and shall be made entirely tight:
 - 1) Air pressure or vacuum applied to the joints, using soap suds, linseed oil, or other suitable material for the detection of leaks.
 - 2) Joints tested by the magnetic particle method.

b. General

- 1) Upon completion of the tank construction, fill tank with water (furnished at the final tank site by the Contractor) using the pressure necessary to fill the tank to the maximum working water level. Any leaks in the shell, or bottom that are disclosed by the test shall be repaired by chipping or melting out defective welds and re-welding. Repair work shall be done on joints only when the water in the tank is a minimum of 2 ft. below the point under repair. The tank shall be tested as watertight to the satisfaction of the project engineer and/or Owner's Representative.

c. Disposal of Test Water

- 1) The Contractor shall provide a means for disposing of test water.

d. Periodic Inspection

- 1) In addition to local code and engineering/inspection maintenance requirements, periodically inspect, test, and maintain tanks in accordance with NFPA 25 - "Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems" during the project warranty period.

--END OF SECTION --

MEP

DIVISION 22 00 00

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

- D. Section 01 00 00, GENERAL REQUIREMENTS.
- E. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- F. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- G. Section 31 20 00, EARTH MOVING: Excavation and Backfill.
- E. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- F. Section 05 31 00, STEEL DECKING, Section 05 36 00, COMPOSITE METAL DECKING: Building Components for Attachment of Hangers.
- G. Section 05 50 00, METAL FABRICATIONS.
- H. Section 07 84 00, FIRESTOPPING.
- I. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- J. Section 07 92 00, JOINT SEALANTS.
- K. Section 09 91 00, PAINTING.
- L. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS
- M. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
- N. Section 23 09 23, DIRECT DIGITAL CONTROLS FOR HVAC.
- O. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- P. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT .
- Q. 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, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.

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

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

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

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

G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.

1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.

2. Equipment and materials identification.

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

I. Maintenance Data and Operating Instructions:

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

1.5 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

2. Damaged equipment shall be replaced with an identical unit as determined and directed by the RE/COTR. Such replacement shall be at no additional cost to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

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

1.6 APPLICABLE PUBLICATIONS

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

H. 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.

2.7 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. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.
- C. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, fans, etc. shall be identified.
- D. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- E. Control Items: 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.
- F. 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.
 3. Power-driven fasteners: Permitted in existing concrete or masonry 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. 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.
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (No. 12 gage), designed to accept special spring held, hardened steel nuts. Trapeze hangers are not permitted for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91kg (200 pounds).
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4-inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 13 mm (1/2-inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.
- I. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 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.
- J. Pre-insulated Calcium Silicate Shields:
- 1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.
 - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
 - 3. Shield thickness shall match the pipe insulation.
 - 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
 - a. Shields for supporting cold water shall have insulation that extends a minimum of one inch past the sheet metal.
 - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS-SP 69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psi) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
 - 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.
- K. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

2.11 PIPE PENETRATIONS

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.
- B. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.

2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- 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 shall be provided 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 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.
- F. 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.
- G. 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.
- H. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

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

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.

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

- B. 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.

C. Structural systems necessary for pipe and equipment support shall be coordinated 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. 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.

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. 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.

- I. 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.
- J. 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.
- K. 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
- L. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- 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 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.

3.6 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. 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.

3.7 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.

3.8 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.

3.9 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.

3.10 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.

3.11 INSTRUCTIONS TO VA PERSONNEL

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

Michael E. DeBakey VA Medical Center
Parking Garage A Phase 1
VA Project No. 580-317
HOK Project No. 10.10019.00

Issue for Bid, 08-8-2011

Common Work Results For Plumbing

- - - E N D - - -

MEP

DIVISION 22 00 00

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.

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:

1.6 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 -----

MEP

DIVISION 22 00 00

SECTION 22 11 00 - FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

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):
 - 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
- D. 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
- E. 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
- F. American Welding Society (AWS):
- A5.8-92.....Filler Metals for Brazing
- G. National Association of Plumbing - Heating - Cooling Contractors
(PHCC):
- National Standard Plumbing Code - 1996
- H. International Association of Plumbing and Mechanical Officials (IAPMO):
- Uniform Plumbing Code - 2000
- IS6-93.....Installation Standard
- I. 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
- J. 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

K. Plumbing and Drainage Institute (PDI):

PDI WH-201.....Water Hammer Arrestor

PART 2 - PRODUCTS

2.1 INTERIOR DOMESTIC WATER PIPING

A. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless, steel ASTM A312, schedule 10 may be used.

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.

C. Fittings for Stainless Steel:

1. Stainless steel butt-welded fittings, Type 316, Schedule 10, conforming to ANSI B16.9.
2. Grooved fittings, stainless steel, Type 316, Schedule 10, conforming to ASTM A403. Segmentally fabricated fittings are not allowed. 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.

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.

G. Reagent Grade Water Piping and Dialysis Water Piping:

1. Polypropylene, ASTM D4101, Schedule 80 pressure pipe with dimensions in conformance with ASTM D2447, but without additions of modifiers, plasticizers, colorants, stabilizers or lubricants. This virgin unplasticized pipe and fittings shall transport 10 megohm water with no loss of purity. Provide socket fusion joints.
2. Polyethylene, food and medical grade, capable of transporting 10 megohm water with no loss of purity. Processed by continuous compression molding without the addition of fillers, polymer modifiers or processing aids. Uniform color with no cracks, flaws, blisters or other imperfections in appearance. Provide heat fusion butt welded joints. In accordance with manufacturer's recommendations, provide continuous channel support under all horizontal piping.

2.2 EXPOSED WATER PIPING

A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water piping connecting fixtures, casework, cabinets, the 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, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09 91 00, PAINTING.

2.3 ETO WATER PIPING

Stainless steel, ASTM A312, Schedule 10 with stainless steel butt welded fittings.

2.4 TRAP PRIMER WATER PIPING:

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.

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

2.5 WATERPROOFING

- A. Provide at points where pipes pass through membrane waterproofed floors or walls in contact with earth.
- B. Floors: Provide cast iron stack sleeve with flashing device and a underdeck clamp. After stack is passed through sleeve, provide a waterproofed caulked joint at top hub.
- C. Walls: See detail shown on drawings.

2.6 STRAINERS

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Smaller than 80 mm (3 inches), brass or bronze; 80 mm (3 inches) and larger, cast iron or semi-steel.

2.7 DIELECTRIC FITTINGS

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

2.8 STERILIZATION CHEMICALS

- A. Liquid Chlorine: ASTM E1120.
- B. Hypochlorite: ASTM E1229, or Fed. Spec. AA-1427C, grade B.

2.9 WATER HAMMER ARRESTER:

Closed copper tube chamber with permanently sealed 410 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved 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, except for plastic and glass, shall be reamed to full size after cutting.
 3. All pipe runs shall be laid out to avoid interference with other work.
 4. Install union and shut-off valve on pressure piping at connections to equipment.
 5. Pipe Hangers, Supports and Accessories:
 - a. All piping shall be supported per 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 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. Reagent Grade Water Systems: Fill system with water and maintain hydrostatic pressure of 690 kPa (100 psi) gage during inspection and prove tight.
- D. All Other Piping Tests: Test new installed piping under 1 1/2 times actual operating conditions and prove tight.

3.3 STERILIZATION

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.
- B. Use either liquid chlorine or hypochlorite for sterilization.

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MEP

DIVISION 22 00 00

SECTION 22 13 00 -FACILITY SANITARY AND VENT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

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 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.
- E. Section 07 92 00 Joint Sealants: Sealant products.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Piping.
 - 2. Floor Drains.
 - 3. Cleanouts.
 - 4. All items listed in Part 2 - Products.
- C. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

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. interior waste and vent piping above grade.
2. Cast iron Pipe shall be hubless (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.

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. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.

2.2 EXPOSED WASTE PIPING

- A. Full iron pipe size chrome plated brass piping shall be used in finished rooms for exposed waste piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
1. The Pipe shall meet Fed. Spec. WW-P-351, standard weight.
 2. The Fittings shall conform to ANSI B16.15, cast bronze threaded fittings with chrome finish, (125 and 250).
 3. Nipples shall conform to ASTM B 687, Chromium-plated.
 4. Unions shall be brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
- B. In unfinished Rooms such as mechanical Rooms and Kitchens, Chrome-plated brass piping is not required. The pipe materials specified under the paragraph "Sanitary Waste, Drain, and Vent Piping" can be used. The sanitary pipe in unfinished rooms shall be painted as specified in Section 09 91 00, PAINTING.

2.3 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 interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.
- E. Open Sight Drains (OSDs) shall be cast iron, constructed as shown by detail.

2.5 FLOOR DRAINS

- A. FD-1 floor drain shall comply with ANSI A112.6.3. The floor drain shall have a cast iron body. Strainer shall consist of a slotted cast iron floor-level grate extension. Minimum dimensions as follows:
 - 1. Area of strainer and collar - 23 000 square mm (36 square inches).

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-1): 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.
- B. Walls: See detail shown on drawings.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. Unless specifically indicated on the drawings, the minimum slope shall be 2% slope.
- H. The piping shall be installed free of sags and bends.
- I. Seismic restraint shall be installed where required by code.
- J. 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.

- K. 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.
- L. 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"
- M. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".
- N. Aboveground PVC piping shall be installed according to ASTM D2665.
Underground PVC piping shall be installed according to ASTM D2321.

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.

- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

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.
 4. 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.
 5. 250 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.
- E. The maximum spacing for plastic pipe shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).

- G. 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.
 7. Riser clamps shall be malleable iron or steel.
 8. Rollers shall be cast iron.
 9. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- H. 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.
- I. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- J. 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 shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- K. 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.
 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 (2 ounces) of peppermint into each line or stack.

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MEP

DIVISION 22 00 00

SECTION 22 14 00 - FACILITY STORM DRAINAGE

PART 1 - GENERAL

1.1 DESCRIPTION

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. Polyvinyl Chloride (PVC)

1. Polyvinyl chloride storm sewer pipe and fittings are permitted for single story structures except for mechanical equipment rooms and

other areas containing air handling equipment or hot water generation equipment.

2. Polyvinyl chloride storm sewer pipe and fittings shall be schedule 40 solid core sewer piping conforming to ASTM D1785 and D 2665, Sewer and Drain Series, with ends for solvent cemented joints.
3. Polyvinyl chloride joints shall be solvent welded socket type using solvent cement conforming to ASTM D2564.

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

2.2 PUMPED DRAIN PIPING:

- A. Pumped drain piping under 100 mm (4 inches) shall be copper tube conforming to ASTM B88, type K or L. For pumped drain piping 100 mm (4 inches) and above, galvanized steel conforming to A 53, seamless, schedule 40 may be used.
- B. Pumped drain pipe fittings shall comply with the following:
 1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22.
 2. Unions shall be bronze, MSS SP-72, SP-110. Solder or braze joints.
 3. Grooved fittings, 65 mm to 100 mm (2-1/2 to 4 inch) wrought copper ASTM A75 C12200, 125 to 150 mm (5 to 6 inch) bronze castings ASTM B584, CDA 844. Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), malleable iron, ASTM A47 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with colored alkyd enamel.
- C. Adapters shall be provided for joining screwed pipe to copper tubing.
- D. The solder shall use a non-corrosive flux conforming to ASTM B32.

2.3 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 PVC soil pipes, the sleeve material shall be elastomeric seal or PVC, conforming to ASTM F 477 or ASTM D5926.
3. 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.

2.4 CLEANOUTS

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be

provided. Two way cleanouts where shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.

- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

2.5 ROOF DRAINS AND CONNECTIONS

- A. Roof Drains: Roof Drains (RD-1) 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. Promenade Drains: The roof drain shall have a flat, round, loose, non-slip, bronze grate set in square, non-slip bronze frame strainer with the integral flange not larger than 200 mm (8 inches) in diameter. For an insulated roof, the roof drain shall be provided with an adjustable drainage collar, which can be raised or lowered to meet the required insulation heights, sump receiver and deck clamp. Bottom section shall serve as roof drain during construction before insulation is installed.
 - 2. Roof drains in areas subject to freezing shall have heat tape and shall be insulated.
 - 3. Trench drain (TD) ductile iron frame and grate frame and grate shall be capable of handling solid tire traffic and provide high resistance against in pack of steel containers, struts, and metal

- wheels. Provide pre-sloped channels as required to extend full width of garage ramp.
- B. Expansion Joints: Expansions joints shall be heavy cast iron with cast brass or copper expansion sleeve having smooth bearing surface working freely against a packing ring held in place and under pressure of a bolted gland ring, forming a water and air tight flexible joint. Asbestos packing is prohibited.
- C. Interior Downspouts: An expansion joint shall be provided, specified above, at top of run on straight, vertical runs of downspout piping 12 m (40 feet) long or more.
- D. Downspout Nozzle: The downspout nozzle fitting shall be of brass, unfinished, with internal pipe thread for connection to downspout.

2.6 WATERPROOFING

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

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 every 1.22 m (4 feet) of pipe length.
- G. The piping shall be installed free of sags and bends.

- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep $\frac{1}{4}$ bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and $\frac{1}{8}$ bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to CDA's "Copper Tube Handbook".
- M. Aboveground PVC piping shall be installed according to ASTM D2665. Underground PVC piping shall be installed according to ASTM D2321.

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.

F. for PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

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. The maximum support spacing for horizontal plastic shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.57 m (15 feet).
- G. 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.
- H. 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.
- I. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- J. 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.
- K. 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.

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MEP

DIVISION 22 00 00

SECTION 22 14 29 - SUMP PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Sump pumps. See schedule on Drawings for pump capacity and head.

1.2 RELATED WORK

- A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- B. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- C. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS. Requirements for commissioning, systems readiness checklist, and training.
- D. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Pump:
 - a. Manufacturer and model.
 - b. Operating speed.
 - c. Capacity.
 - d. Characteristic performance curves.
 - 2. Motor:
 - a. Manufacturer, frame and type.
 - b. Speed.
 - c. Current Characteristics and W (HP).
 - d. Efficiency.
- C. Certified copies of all the factory and construction site test data sheets and reports.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
 - 1. Include complete list 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.

- E. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING 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):
ICS6-93 (2006).....Industrial Control and Systems Enclosures
250-2008.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- C. Underwriters' Laboratories, Inc. (UL):
508-99 (R2008).....Standards For Industrial Control Equipment

PART 2 - PRODUCTS

2.1 SUMP PUMP

- A. Centrifugal, vertical, submersible pump and motor, designed for 140/180 degrees F) maximum water service. Driver shall be electric motor. Support shall be rigid type. Provide perforated, suction strainer. Systems may include one, two, or more pumps with alternator as required by: Contract Documents Pump shall be capable of continuous duty cycle.
1. Pump housings may be cast iron, bronze, aluminum, plastic or stainless steel. Cast iron and aluminum housings for submersible pumps shall be epoxy coated.
- B. Impeller: Brass, bronze or cast iron.
- C. Shaft: Stainless steel or other approved corrosion-resisting metal.
- D. Bearings: As required to hold shaft alignment, anti-friction type for thrust permanently lubricated.
- E. Motor: Maximum 40 degrees C (104 degrees F) ambient temperature rise above the maximum fluid temperature being pumped , drip-proof completely enclosed, voltage and phase as shown in schedule on Electrical drawings conforming to NEMA 250 -Type 4 -Type 6P. Size the motor capacity to operate pump without overloading the motor at any point on the pump curve. Refer to Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- F. Starting Switch: Manually-operated, tumbler type, as specified in Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

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- G. Automatic Control and Level Alarm: Furnish a control panel in a Nema 1 enclosure for indoors or in a Nema 4X enclosure for outdoors. The controls shall be suitable for operation with the electrical characteristics listed on the Electrical drawings. The control panel shall have a level control system with switches to start and stop pumps automatically, and to activate a high water alarm. The level control system will include sensors in the sump that detect the level of the liquid. The sensors may be float type switches, ultrasonic level sensors, transducers, or other appropriate equipment. The high water alarm shall have a red beacon light at the control panel and a buzzer, horn, or bell. The alarm shall have a silencing switch. Provide auxiliary contacts for remote alarming to the Energy Control Center and BAC net compatible open-protocol type interface to DDC Controls System.
1. The circuitry of the control panel shall include:
 - a. power switch to turn on/off the automatic control mechanism
 - b. HOA switches to manually override automatic control mechanism
 - c. run lights to indicate when pumps are powered up
 - d. level status lights to indicate when water in sump has reached the predetermined on/off and alarm levels
 - e. magnetic motor contactors
 - f. disconnect/breaker for each pump
 - g. automatic motor overload protection
 2. Sensors that detect the level of water in the sump shall be so arranged as to allow the accumulation of enough volume of liquid below the normal on level that the pump will run for a minimum cycle time as recommended by the pump manufacturer. Sensors shall be located to activate the alarm adequately before the water level rises to the inlet pipe.
 3. Provide two separate power supplies to the control panel, one for the control/alarm circuitry and one for power to the pump motors. Each power supply is to be fed from its own breaker so that if a pump overload trips a breaker, the alarm system will still function. Each power supply is to be wired in its own conduit.
 4. Wiring from the sump to the control panel shall have separate conduits for the pump power and for the sensor switches. All conduits are to be sealed at the basin and at the control panel to

prevent the intrusion of moisture and of flammable and/or corrosive gases.

H. Provide a check and ball valve in the discharge of each pump.

I. Removal/Disconnect System: In a system utilizing a submersible pump, where sump depth, pump size, or other conditions make removal of the pump unusually difficult or unsafe, a removal/disconnect system shall be provided. The system will consist of a discharge fitting mounted on vertical guide rails attached to the sump. The pump shall be fitted with an adapter fitting that easily connects to/disconnects from the discharge fitting as the pump is raised from or lowered into the sump. The discharge piping will connect to the discharge fitting so that it is not necessary to disconnect any piping in order to remove the pump. Where the sump depth is greater than five feet or other conditions exist to make the removal of the pump difficult or hazardous, the system shall include a rail guided quick disconnect apparatus to allow the pump to be pulled up out of the sump without workers entering the sump and without disconnecting the piping.

PART 3 - EXECUTION

3.1 STARTUP AND TESTING

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. The tests shall include system capacity and all control and alarm functions.
- C. When any defects are detected, correct defects and repeat test.
- D. The commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior to notice.

3.2 COMMISSIONING

- A. Provide commissioning documentation accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS for all inspection, startup, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

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- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.3 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct VA Personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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MEP

DIVISION 22 00 00

SECTION 22 40 00 -PLUMBING FIXTURES

PART 1 - GENERAL

1.1 DESCRIPTION

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):
 - 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)
- C. American Society for Testing and Materials (ASTM):
 - A276-2003.....Stainless and Heat-Resisting Steel Bars and Shapes

D. National Association of Architectural Metal Manufacturers (NAAMM):

NAAMM AMP 500-505

Metal Finishes Manual (1988)

E. 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

F. National Sanitation Foundation (NSF)/American National Standards

Institute (ANSI):

61-03.....Drinking Water System Components-Health Effects

G. 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. Locate stops centrally above or below fixture
in accessible location.

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

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

2.3 ESCUTCHEONS

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 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES

A. (P-804) Hose Bibb (Single faucet, wall mounted to supply pipe: Cast or wrought copper alloy, single faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, mounted on wall 914 mm (36 inches) above floor to concealed supply pipe. Provide faucet with 20 mm (3/4 inch) hose coupling thread on spout and vacuum breaker. Four arm handle on faucet shall be cast, formed or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have bright finish.

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. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4-inch) diameter bolts, and to extend at least 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.
- F. 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.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.
- I. Do not use aerators on lavatories and sinks.

3.2 CLEANING

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

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MEP

DIVISION 23 00 00

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 00 72 00, GENERAL CONDITIONS
- B. Section 01 00 00, GENERAL REQUIREMENTS
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- D. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout
- E. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations
- F. Section 07 92 00, JOINT SEALANTS
- G. Section 09 91 00, PAINTING
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION
- I. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- J. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC
- K. Section 23 07 11, HVAC, PLUMBING, and Boiler Plant Insulation
- L. Section 23 23 00, REFRIGERANT PIPING
- M. Section 23 31 00, HVAC DUCTS and CASINGS
- N. Section 23 34 00, HVAC FANS
- O. Section 23 37 00, AIR OUTLETS and INLETS
- P. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.3 QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC
- B. Flow Rate Tolerance for HVAC Equipment: Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
 - 1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT. Equipment shall be factory-balanced to this tolerance and re-balanced on site, as necessary.
 - 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- D. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 - 3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the Resident Engineer.

4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:

1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located within 50 miles to the site.

F. HVAC Mechanical Systems Welding: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:

1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.

G. Execution (Installation, Construction) Quality:

1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the Resident Engineer for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the Resident Engineer at least two weeks prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received. Failure

to furnish these recommendations is a cause for rejection of the material.

2. Provide complete layout drawings required by Paragraph, SUBMITTALS.

Do not commence construction work on any system until the layout drawings have been approved.

H. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.

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

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

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

E. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient.

F. 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.

G. 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.

H. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

1.5 APPLICABLE PUBLICATIONS

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

B. Air Conditioning, Heating and Refrigeration Institute (AHRI):
430-2009.....Central Station Air-Handling Units

C. American National Standard Institute (ANSI):
B31.1-2007.....Power Piping

D. Rubber Manufacturers Association (ANSI/RMA):
IP-20-2007.....Specifications for Drives Using Classical
V-Belts and Sheaves
IP-21-2009.....Specifications for Drives Using Double-V
(Hexagonal) Belts
IP-22-2007.....Specifications for Drives Using Narrow V-Belts
and Sheaves

E. Air Movement and Control Association (AMCA):
410-96.....Recommended Safety Practices for Air Moving
Devices

F. American Society of Mechanical Engineers (ASME):
Boiler and Pressure Vessel Code (BPVC):
Section I-2007.....Power Boilers
Section IX-2007.....Welding and Brazing Qualifications
Code for Pressure Piping:

B31.1-2007.....Power Piping

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

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

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

E84-10.....Standard Test Method for Surface Burning
Characteristics of Building Materials

E119-09c.....Standard Test Methods for Fire Tests of
Building Construction and Materials

H. Manufacturers Standardization Society (MSS) of the Valve and Fittings
Industry, Inc:

SP-58-2009.....Pipe Hangers and Supports-Materials, Design and
Manufacture, Selection, Application, and
Installation

SP 69-2003.....Pipe Hangers and Supports-Selection and
Application

SP 127-2001.....Bracing for Piping Systems, Seismic - Wind -
Dynamic, Design, Selection, Application

I. National Electrical Manufacturers Association (NEMA):

MG-1-2009.....Motors and Generators

J. National Fire Protection Association (NFPA):

31-06.....Standard for Installation of Oil-Burning
Equipment

54-09.....National Fuel Gas Code

70-08.....National Electrical Code

85-07.....Boiler and Combustion Systems Hazards Code

90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems

101-09.....Life Safety Code

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.

2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.
4. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

1.7 JOB CONDITIONS - WORK IN EXISTING BUILDING

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities, that serve the medical center.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the medical center.
- C. Phasing of Work: Comply with all requirements shown on drawings or specified.
- D. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. No storm water or ground water leakage permitted. Provide daily clean-up of construction

and demolition debris on all floor surfaces and on all equipment being operated by VA.

- E. Acceptance of Work for Government Operation: As new facilities are made available for operation and these facilities are of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
1. All components of an assembled unit need not be products of same manufacturer.
 2. Constituent parts that are alike shall be products of a single manufacturer.
 3. Components shall be compatible with each other and with the total assembly for intended service.
 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

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

2.3 BELT DRIVES

- A. Type: ANSI/RMA standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ANSI/RMA IP-20 and IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ANSI/RMA service factor (not less than 20 percent) in addition to the ANSI/RMA allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
 - 1. Material: Pressed steel, or close grained cast iron.
 - 2. Bore: Fixed or bushing type for securing to shaft with keys.
 - 3. Balanced: Statically and dynamically.
 - 4. Groove spacing for driving and driven pulleys shall be the same.
- I. Drive Types, Based on ARI 435:
 - 1. Provide adjustable-pitch drive as follows:
 - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
 - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
 - 2. Provide fixed-pitch drives for drives larger than those listed above.
 - 3. The final fan speeds required to just meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave or by fan law calculation if a fixed-pitch drive is used initially.

2.4 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor to prevent damage to equipment and injury to personnel. Drive guards may be excluded where

motors and drives are inside factory fabricated air handling unit casings.

- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4-inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gage sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (one-inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, cast iron, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (One inch) diameter hole at each shaft center.

2.5 LIFTING ATTACHMENTS

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; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

2.7 VARIABLE SPEED MOTOR CONTROLLERS

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

- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. All units shall be product of a single manufacturer.
- C. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
- E. Controller shall be provided with the following operating features and accessories:
 - 1. Suitable for variable torque load.
 - 2. Provide thermal magnetic circuit breaker or fused switch with external operator and incoming line fuses. Unit shall be rated for minimum 25,000 AIC. Provide AC input line reactors (3% impedance) filters on incoming power line. Provide output line reactors on line between drive and motor for motors over 50 HP or where the distance between the breaker and motor exceeds 50 feet.

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 and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.

E. Valve Tags and Lists:

1. HVAC and Boiler Plant: Provide for all 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

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

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 Wood Construction: Wood screws or lag bolts.

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

H. 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.

I. 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. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.

J. Pre-insulated Calcium Silicate Shields:

1. Provide 360 degree water resistant high density 965 kPa (140 psi) compressive strength calcium silicate shields encased in galvanized metal.

2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.

3. Shield thickness shall match the pipe insulation.

4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.

- a. Shields for supporting 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.
6. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

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, laundry work rooms, and

animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.

- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.13 DUCT PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

2.14 SPECIAL TOOLS AND LUBRICANTS

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

type, in unopened containers and properly identified as to use for each different application.

2.15 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32-inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025-inch) for up to 80 mm (3-inch pipe), 0.89 mm (0.035-inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.16 ASBESTOS

Materials containing asbestos are not permitted.

PART 3 - EXECUTION

3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors, control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. 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 Resident Engineer where working area space is limited.
 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by Resident Engineer. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to Resident Engineer for approval.
 3. Do not penetrate membrane waterproofing.
- 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. Install steam piping expansion joints as per manufacturer's recommendations.

3.2 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of Paragraph 3.1 apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

3.3 RIGGING

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for Government operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be

Contractor's full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.

- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to Resident Engineer for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

3.4 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Resident Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2-inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
 - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
 - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.

2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
3. Tubing and capillary systems shall be supported in channel troughs.

G. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 150 mm (6 inches) on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
5. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

3.5 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the Resident Engineer. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating facility, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit

debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA Medical Center, and Contractor shall follow all directives of the RE or COTR with regard to rigging, safety, fire safety, and maintenance of operations.

- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.
- D. All valves including gate, globe, ball, butterfly and check, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to Resident Engineer and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.

3.6 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
 - 3. 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.

4. Material And Equipment Not To Be Painted Includes:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gauges and thermometers.
 - j. Glass.
 - k. Name plates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
6. Paint shall withstand the following temperatures without peeling or discoloration:
 - a. Condensate 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.
7. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

3.7 IDENTIFICATION SIGNS

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

B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.

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

3.8 MOTOR AND DRIVE ALIGNMENT

A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.

B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

3.9 LUBRICATION

A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.

B. Equip all devices with required lubrication fittings or devices. Provide a minimum of one liter (one quart) of oil and 0.5 kg (one pound) of grease of manufacturer's recommended grade and type for each different application; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to Resident Engineer in unopened containers that are properly identified as to application.

C. Provide a separate grease gun with attachments for applicable fittings for each type of grease applied.

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

3.10 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specifications will be tested as part of a larger system. Refer to related sections for contractor responsibilities for system commissioning.

3.11 STARTUP AND TEMPORARY OPERATION

Start up equipment as described in equipment specifications. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.12 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS and submit the test reports and records to the Resident Engineer.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

3.13 INSTRUCTIONS TO VA PERSONNEL

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

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MEP

DIVISION 23 00 00

SECTION 23 07 11 - HVAC AND BOILER PLANT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for
 - 1. HVAC piping, ductwork and equipment.
- 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, interstitial space, 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. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
 - 6. FSK: Foil-scrim-kraft facing.
 - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC equipment or piping handling media above 41 degrees C (105 degrees F).
 - 8. Density: kg/m^3 - kilograms per cubic meter (Pcf - pounds per cubic foot).
 - 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
 - 10. Thermal conductance: Heat flow rate through materials.
 - a. Flat surface: Watt per square meter (BTU per hour per square foot).
 - b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).

11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permance of 0.1 perms and vapor barriers shall have a maximum published permance of 0.001 perms.
13. HPS: High pressure steam (415 kPa [60 psig] and above).
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam (103 kPa [15 psig] and below).
18. LPR: Low pressure steam condensate gravity return.
19. PC: Pumped condensate.
20. HWH: Hot water heating supply.
21. HWHR: Hot water heating return.
22. GH: Hot glycol-water heating supply.
23. GHR: Hot glycol-water heating return.
24. FWPD: Feedwater pump discharge.
25. FWPS: Feedwater pump suction.
26. CTPD: Condensate transfer pump discharge.
27. CTPS: Condensate transfer pump suction.
28. VR: Vacuum condensate return.
29. CPD: Condensate pump discharge.
30. R: Pump recirculation.
31. FOS: Fuel oil supply.
32. FOR: Fuel oil return.
33. CW: Cold water.
34. SW: Soft water.
35. HW: Hot water.
36. CH: Chilled water supply.
37. CHR: Chilled water return.
38. GC: Chilled glycol-water supply.
39. GCR: Chilled glycol-water return.

40. RS: Refrigerant suction.

41. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- D. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant piping and fittings.
- E. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.
- F. Section 26 32 13, ENGINE GENERATORS: Exhaust stacks and muffler.

1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Criteria:
 - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4, parts of which are quoted as follows:

4.3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided for in 4.3.3.1.1 or 4.3.3.1.2, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, *Standard Method of Test of Surface Burning Characteristics of Building Materials*.

4.3.3.1.1 Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)

4.3.3.1.2 The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.

4.3.3.2 Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:

(1) UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors

(2) UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors

4.3.3.3 Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

4.3.3.4 Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.

4.3.3.5* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

4.3.10.2.6 Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.

4.3.10.2.6.1 Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4.3.10.2.6.4 Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

5.4.6.4 Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:

- (1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides
 - (2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials
- 2. Test methods: ASTM E84, UL 723, or NFPA 255.
- 3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
- 4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.
- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 - 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
 - a. Insulation materials: Specify each type used and state surface burning characteristics.
 - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
 - c. Insulation accessory materials: Each type used.
 - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.

- e. Make reference to applicable specification paragraph numbers for coordination.

C. Samples:

1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

1.5 STORAGE AND HANDLING OF MATERIAL

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
 - L-P-535E (2)- 99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
 - MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation
 - MIL-A-24179A (1)-87.....Adhesive, Flexible Unicellular-Plastic Thermal Insulation
 - MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier
 - MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass
- D. American Society for Testing and Materials (ASTM):
 - A167-99(2004).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-07.....Standard Specification for Aluminum and
Aluminum-Alloy Sheet and Plate

C411-05.....Standard test method for Hot-Surface
Performance of High-Temperature Thermal
Insulation

C449-07.....Standard Specification for Mineral Fiber
Hydraulic-Setting Thermal Insulating and
Finishing Cement

C533-09.....Standard Specification for Calcium Silicate
Block and Pipe Thermal Insulation

C534-08.....Standard Specification for Preformed Flexible
Elastomeric Cellular Thermal Insulation in
Sheet and Tubular Form

C547-07.....Standard Specification for Mineral Fiber pipe
Insulation

C552-07.....Standard Specification for Cellular Glass
Thermal Insulation

C553-08.....Standard Specification for Mineral Fiber
Blanket Thermal Insulation for Commercial and
Industrial Applications

C585-09.....Standard Practice for Inner and Outer Diameters
of Rigid Thermal Insulation for Nominal Sizes
of Pipe and Tubing (NPS System) R (1998)

C612-10.....Standard Specification for Mineral Fiber Block
and Board Thermal Insulation

C1126-04.....Standard Specification for Faced or Unfaced
Rigid Cellular Phenolic Thermal Insulation

C1136-10.....Standard Specification for Flexible, Low
Permeance Vapor Retarders for Thermal
Insulation

D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven
and Treated) for Roofing and Waterproofing

E84-10.....Standard Test Method for Surface Burning
Characteristics of Building
Materials

E119-09c.....Standard Test Method for Fire Tests of Building
Construction and Materials

E136-09b.....Standard Test Methods for Behavior of Materials
in a Vertical Tube Furnace at 750 degrees C
(1380 F)

E. National Fire Protection Association (NFPA):

90A-09.....Standard for the Installation of Air
Conditioning and Ventilating Systems

96-08.....Standards for Ventilation Control and Fire
Protection of Commercial Cooking Operations

101-09.....Life Safety Code

251-06.....Standard methods of Tests of Fire Endurance of
Building Construction Materials

255-06.....Standard Method of tests of Surface Burning
Characteristics of Building Materials

F. Underwriters Laboratories, Inc (UL):

723.....UL Standard for Safety Test for Surface Burning
Characteristics of Building Materials with
Revision of 09/08

G. Manufacturer's Standardization Society of the Valve and Fitting
Industry (MSS):

SP58-2009.....Pipe Hangers and Supports Materials, Design,
and Manufacture

PART 2 - PRODUCTS

2.1 MINERAL FIBER OR FIBER GLASS

A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m³ (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.

B. ASTM C553 (Blanket, Flexible) Type I, // Class B-3, Density 16 kg/m³ (1 pcf), k = 0.045 (0.31) // Class B-5, Density 32 kg/m³ (2 pcf), k = 0.04 (0.27) // at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.

C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1, k = 0.037 (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

2.2 MINERAL WOOL OR REFRACTORY FIBER

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

2.3 CELLULAR GLASS CLOSED-CELL

- A. Comply with Standard ASTM C177, C518, density 120 kg/m³ (7.5 pcf) nominal, k = 0.033 (0.29) at 24 degrees C (75 degrees F).
 B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

2.4 FLEXIBLE ELASTOMERIC CELLULAR THERMAL

ASTM C177, C518, k = 0.039 (0.27) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

2.5 CALCIUM SILICATE

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
 B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
 C. Equipment Insulation: ASTM C533, Type I and Type II
 D. Characteristics:

Insulation Characteristics		
ITEMS	TYPE I	TYPE II
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m ³ (lb/ ft ³)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft ² degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

2.6 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance \leq 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed

ductwork, casings and equipment, and for pipe insulation jackets.

Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.

- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.
- D. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity areas. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- E. 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 and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of

same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

2.7 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]), cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m³ (3.0 pcf).

2.8 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.

2.9 MECHANICAL FASTENERS

A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.

B. Staples: Outward clinching monel or galvanized steel.

C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.

D. Bands: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

2.10 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. 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.

2.11 FIRESTOPPING MATERIAL

Other than pipe and duct insulation, refer to Section 07 84 00
FIRESTOPPING.

2.12 FLAME AND SMOKE

Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for

application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.

- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor retarder over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. 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, and ventilation exhaust air shafts.

4. Equipment: Expansion tanks, flash tanks, hot water pumps.
5. In hot piping: Unions, flexible connectors, control valves, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.
- I. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- J. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- K. 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
- L. Freeze protection of above grade outdoor piping (over heat tracing tape): 26 mm (1 inch) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1 inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up to cooling towers and condenser water piping and chilled water piping as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- M. Provide vapor barrier jackets over insulation as follows:
 1. All piping and ductwork exposed to outdoor weather and unconditioned spaces.
 2. All interior piping and ducts conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.)in high humidity areas.
- N. Provide metal jackets over insulation as follows:
 1. All piping and ducts exposed to outdoor weather.

2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

3.2 INSULATION INSTALLATION

A. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
2. Underground Piping Other than or in lieu of that Specified in Section 23 21 13, HYDRONIC PIPING and Section 33 63 00, STEAM ENERGY DISTRIBUTION: Type II, factory jacketed with a 3 mm laminate jacketing consisting of 3000 mm x 3000 mm (10 ft x 10 ft) asphalt impregnated glass fabric, bituminous mastic and outside protective plastic film.
 - a. 75 mm (3 inches) thick for hot water piping.
 - b. As scheduled at the end of this section for chilled water piping.
 - c. Underground piping: Apply insulation with joints tightly butted. Seal longitudinal self-sealing lap. Use field fabricated or factory made fittings. Seal butt joints and fitting with jacketing as recommended by the insulation manufacturer. Use 100 mm (4 inch) wide strips to seal butt joints.
 - d. Provide expansion chambers for pipe loops, anchors and wall penetrations as recommended by the insulation manufacturer.
 - e. Underground insulation shall be inspected and approved by the Resident Engineer as follows:
 - 1) Insulation in place before coating.
 - 2) After coating.
 - f. Sand bed and backfill: Minimum 75 mm (3 inches) all around insulated pipe or tank, applied after coating has dried.
3. Exposed domestic water fire protection piping and other. Provide vapor barrier and aluminum jacket.

B. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats

of weather resistant finish as recommended by the insulation manufacturer.

2. Pipe and tubing insulation:

- a. Use proper size material. Do not stretch or strain insulation.
- b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.

3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.

4. Pipe insulation: nominal thickness in millimeters (inches as specified in the schedule at the end of this section.

C. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant.
2. Engine Exhaust Insulation for Emergency Generator and Diesel Driven Fire Pump: Type II, Class D, 65 mm (2 1/2 inch) nominal thickness. Cover exhaust completely from engine through roof or wall construction, including muffler. Secure with 16 AWG galvanized annealed wire or 0.38 x 12 mm 0.015 x 1/2 IN wide galvanized bands on 300 mm 12 IN maximum centers. Anchor wire and bands to welded pins, clips or angles. Apply 25 mm 1 IN hex galvanized wire over insulation. Fill voids with 6 mm 1/4 IN insulating cement.

3.3 PIPE INSULATION SCHEDULE

Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)					
		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration) Domestic & FP	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
(40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration) (condensate drains)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

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MEP

DIVISION 23 00 00

SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field refrigerant piping for direct expansion HVAC systems.
- B. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.
Install as designed.
- C. Definitions:
 - 1. Refrigerating system: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
 - a. Low side means the parts of a refrigerating system subjected to evaporator pressure.
 - b. High side means the parts of a refrigerating system subjected to condenser pressure.
 - 2. Brazed joint: A gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

1.2 RELATED WORK

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION:
General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION:
Requirements for piping insulation.

1.3 QUALITY ASSURANCE

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
 - 1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
 - a. Tubing and fittings
 - b. Valves
 - c. Strainers
 - d. Moisture-liquid indicators
 - e. Filter-driers
 - f. Flexible metal hose
 - g. Liquid-suction interchanges
 - h. Oil separators (when specified)
 - i. Gages
 - j. Pipe and equipment supports
 - k. Refrigerant and oil
 - l. Pipe/conduit roof penetration cover
 - m. Soldering and brazing materials
 - 2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.

- D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning, Heating, and Refrigeration Institute (ARI/AHRI):
495-1999 (R2002).....Standard for Refrigerant Liquid Receivers
730-2005.....Flow Capacity Rating of Suction-Line Filters
and Suction-Line Filter-Driers
750-2007.....Thermostatic Refrigerant Expansion Valves
760-2007.....Performance Rating of Solenoid Valves for Use
with Volatile Refrigerants
- C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
ANSI/ASHRAE 15-2007.....Safety Standard for Refrigeration Systems
(ANSI)
ANSI/ASHRAE 17-2008.....Method of Testing Capacity of Thermostatic
Refrigerant Expansion Valves (ANSI)
63.1-95 (RA 01).....Method of Testing Liquid Line Refrigerant
Driers (ANSI)
- D. American National Standards Institute (ANSI):
ASME (ANSI)A13.1-2007...Scheme for Identification of Piping Systems
Z535.1-2006.....Safety Color Code
- E. American Society of Mechanical Engineers (ASME):
ANSI/ASME B16.22-2001 (R2005)
Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
ANSI/ASME B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged
Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)

ANSI/ASME B31.5-2006....Refrigeration Piping and Heat Transfer
Components (ANSI)

ANSI/ASME B40.100-2005..Pressure Gauges and Gauge Attachments
ANSI/ASME B40.200-2008..Thermometers, Direct Reading and Remote Reading
- F. American Society for Testing and Materials (ASTM)

A126-04.....Standard Specification for Gray Iron Castings
for Valves, Flanges, and Pipe FittingsB32-08

Standard Specification for Solder Metal

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

B88M-05.....Standard Specification for Seamless Copper
Water Tube (Metric)

B280-08.....Standard Specification for Seamless Copper Tube
for Air Conditioning and Refrigeration Field
Service

G. American Welding Society, Inc. (AWS):

Brazing Handbook

A5.8/A5.8M-04.....Standard Specification for Filler Metals for
Brazing and Braze Welding

H. Federal Specifications (Fed. Spec.)

Fed. Spec. GG

I. Underwriters Laboratories (U.L.):

U.L.207-2009.....Standard for Refrigerant-Containing Components
and Accessories, Nonelectrical

U.L.429-99 (Rev.2006)...Standard for Electrically Operated Valves

PART 2 - PRODUCTS

2.1 PIPING AND FITTINGS

- A. Refrigerant Piping: For piping up to 100 mm (4 inch) use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer. For piping over 100 mm (4 inch) use A53 Black SML steel.
- B. Water and Drain Piping: Copper water tube, ASTM B88M, Type B or C (ASTM B88, Type M or L). Optional drain piping material: Schedule 80 flame retardant Polypropylene plastic.
- C. Fittings, Valves and Accessories:
1. Copper fittings: Wrought copper fittings, ASME B16.22.
 - a. Brazed Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
 - b. Solder Joints, water and drain: 95-5 tin-antimony, ASTM B32 (95TA).

2. Steel fittings: ASTM wrought steel fittings.
 - a. Refrigerant piping - Welded Joints.
3. Flanges and flanged fittings: ASME B16.24.
4. Refrigeration Valves:
 - a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
 - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
 - c. Solenoid Valves: Comply with ARI 760 and UL 429, UL-listed, two-position, direct acting or pilot-operated, moisture and vapor-proof type of corrosion resisting materials, designed for intended service, and solder-end connections. Fitted with suitable NEMA 250 enclosure of type required by location and normally closed holding coil.
 - d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
 - e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
5. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines DN 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.

6. Refrigerant Moisture/Liquid Indicators: Double-ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
7. Refrigerant Filter-Dryers: UL listed, angle or in-line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter driers with replaceable filters shall be furnished with one spare element of each type and size.
8. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each unit.

2.2 PIPE SUPPORTS

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

2.3 REFRIGERANTS AND OIL

- A. Provide EPA approved refrigerant and oil for proper system operation.

2.4 PIPE INSULATION FOR DX HVAC SYSTEMS

- Refer to specification Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
 1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
 2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
 3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems

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- in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
4. Use copper tubing in protective conduit when installed below ground.
 5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.
- B. Joint Construction:
1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
 - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
 - b. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
 - c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
 - d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
- C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
- D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs) of refrigerant.
- E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

3.2 SIGNS AND IDENTIFICATION

- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
- B. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI

Z535.1, having letters not less than 13 mm (1/2 inch) in height designating:

1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

3.3 FIELD QUALITY CONTROL

Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- A. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.

1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.
2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.

- B. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure

relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.

3.4 SYSTEM TEST AND CHARGING

A. System Test and Charging: As recommended by the equipment manufacturer or as follows:

1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.
3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) 665 mPa (2245.6 inches of mercury at 60 degrees F) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

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MEP

DIVISION 23 00 00

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 fume hoods, kitchen hood exhaust (grease) 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, exposed to weather.

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. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- E. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- F. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.
- G. 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. Duct liner.
 - c. Sealants and gaskets.
 - d. Access doors.
 - 2. Volume dampers, back draft dampers.
 - 3. Upper hanger attachments.
 - 4. Fire dampers, fire doors, and smoke dampers with installation instructions.
 - 5. Sound attenuators, including pressure drop and acoustic performance.
 - 6. Flexible ducts and clamps, with manufacturer's installation instructions.
 - 7. Flexible connections.
 - 8. Instrument test fittings.
 - 9. Details and design analysis of alternate or optional duct systems.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 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. American Society of Civil Engineers (ASCE):

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- ASCE7-05.....Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
- A167-99(2009).....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- A653-09.....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
- A1011-09a.....Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
- B209-07.....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C1071-05e1.....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
- E84-09a.....Standard Test Method for Surface Burning Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
- 90A-09.....Standard for the Installation of Air Conditioning and Ventilating Systems
- 96-08.....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
- 2nd Edition - 2005.....HVAC Duct Construction Standards, Metal and Flexible
- 1st Edition - 1985.....HVAC Air Duct Leakage Test Manual
- 6th Edition - 2003.....Fibrous Glass Duct Construction Standards
- F. Underwriters Laboratories, Inc. (UL):
- 181-08.....Factory Made Air Ducts and Air Connectors
- 555-06Standard for Fire Dampers
- 555S-06Standard 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:
 - 0 to 50 mm (2 inch)
 - > 50 mm to 75 mm (2 inch to 3 inch)
 - > 75 mm to 100 mm (3 inch to 4 inch)Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide

by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.

- E. 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.
- F. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

2.3 DUCT LINER (WHERE INDICATED ON DRAWINGS)

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Duct liner is only permitted to be used for return, relief and general exhaust ducts. Duct liner is not permitted for outside air ducts, supply air ducts or any other positive pressure ductwork (provide exterior insulation only that serves normally occupied areas).
- C. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.

2.4 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 and humidifier.
 - 2. Each fire damper (for link service), smoke damper and automatic control damper.
 - 3. Each duct mounted smoke detector.
- 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).

2.5 FIRE DAMPERS

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent

free opening with no part of the blade stack or damper frame in the air stream.

- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
 - 1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
 - 2. Submit manufacturer's installation instructions conforming to UL rating test.

2.6 SMOKE DAMPERS

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).
- B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.
- C. Minimum requirements for dampers:
 - 1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
 - 2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
 - 3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for minimum noise generation and pressure drop are preferred for duct mounted dampers.
 - 4. Shafts: Galvanized steel.
 - 5. Bearings: Nylon, bronze sleeve or ball type.
 - 6. Hardware: Zinc plated.
 - 7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.

- D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

2.8 FIRESTOPPING MATERIAL

Refer to Section 07 84 00, FIRESTOPPING.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
 2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
 3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
 4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to

swing against air pressure so that pressure helps to maintain a tight seal.

- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. 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. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- 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. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Resident Engineer on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.
- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

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Issue for Bid, 08-8-2011

HVAC Ducts & Casings

3.3 OPERATING AND PERFORMANCE TESTS

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM
GENERATION

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MEP

DIVISION 23 00 00

SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.
- D. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- E. 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 261, and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
 - 1. Testing and Rating: AMCA 210.
 - 2. Sound Rating: AMCA 300.
- E. 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
- F. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- F. Corrosion Protection:

1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of: ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.

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.
 4. Power roof and wall ventilators.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Belt guards.
- F. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.
- G. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Movement and Control Association International, Inc. (AMCA):
 - 99-86.....Standards Handbook
 - 210-06.....Laboratory Methods of Testing Fans for
Aerodynamic Performance Rating
 - 261-09.....Directory of Products Licensed to bear the AMCA
Certified Ratings Seal - Published Annually
 - 300-08.....Reverberant Room Method for Sound Testing of
Fans
- C. American Society for Testing and Materials (ASTM):
 - B117-07a.....Standard Practice for Operating Salt Spray
(Fog) Apparatus

- D1735-08.....Standard Practice for Testing Water Resistance
of Coatings Using Water Fog Apparatus
- D3359-08.....Standard Test Methods for Measuring Adhesion by
Tape Test
- G152-06.....Standard Practice for Operating Open Flame
Carbon Arc Light Apparatus for Exposure of Non-
Metallic Materials
- G153-04.....Standard Practice for Operating Enclosed Carbon
Arc Light Apparatus for Exposure of Non-
Metallic Materials
- D. National Fire Protection Association (NFPA):
- NFPA 96-08.....Standard for Ventilation Control and Fire
Protection of Commercial Cooking Operations
- E. National Sanitation Foundation (NSF):
- 37-07.....Air Curtains for Entrance Ways in Food and Food
Service Establishments
- F. Underwriters Laboratories, Inc. (UL):
- 181-2005.....Factory Made Air Ducts and Air Connectors

1.6 EXTRA MATERIALS

- A. Provide one additional set of belts for all belt-driven fans.

PART 2 - PRODUCTS

2.1 POWER WALL VENTILATOR

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Type: Centrifugal fan, backward inclined blades.
- C. Construction: Steel or aluminum, completely weatherproof, for wall 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.

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.

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.

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DIVISION 26 00 00

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. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors are prohibited.

1.2 MINIMUM REQUIREMENTS

- A. References to the International Building Code (IBC), National Electrical Code (NEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.
- B. Drawings and other specification sections shall govern in those instances where requirements are greater than those specified in the above standards.

1.3 TEST STANDARDS

- A. All materials and equipment shall be listed, labeled or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified or otherwise determined to meet safety requirements of a nationally recognized testing laboratory. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards,

such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.

B. Definitions:

1. Listed; Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production or listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.
2. Labeled; Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.
3. Certified; equipment or product which:
 - a. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner.
 - b. Production of equipment or product is periodically inspected by a nationally recognized testing laboratory.
 - c. Bears a label, tag, or other record of certification.
4. Nationally recognized testing laboratory; laboratory which is approved, in accordance with OSHA regulations, by the Secretary of Labor.

1.4 QUALIFICATIONS (PRODUCTS AND SERVICES)

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

2. The Government reserves the right to require the Contractor to submit a list of installations where the products have been in operation before approval.

C. Service Qualifications: There shall be a permanent service organization maintained or trained by the manufacturer which will render satisfactory service to this installation within four hours of receipt of notification that service is needed. Submit name and address of service organizations.

1.5 APPLICABLE PUBLICATIONS

Applicable publications listed in all Sections of Division are the latest issue, unless otherwise noted.

1.6 MANUFACTURED PRODUCTS

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts shall be available.
- B. When more than one unit of the same class or type of equipment is required, such units shall be the product of a single manufacturer.
- C. Equipment Assemblies and Components:
 1. Components of an assembled unit need not be products of the same manufacturer.
 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 3. Components shall be compatible with each other and with the total assembly for the intended service.
 4. Constituent parts which are similar shall be the product of a single manufacturer.
- D. Factory wiring shall be identified on the equipment being furnished and on all wiring diagrams.
- E. When Factory Testing Is Specified:
 1. The Government shall have the option of witnessing factory tests. The contractor shall notify the VA through the 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

Where variations from the contract requirements are requested in accordance with Section 00 72 00, GENERAL CONDITIONS and Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, the connecting work and related components shall include, but not be limited to additions or changes to branch circuits, circuit protective devices, conduits, wire, feeders, controls, panels and installation methods.

1.8 EQUIPMENT PROTECTION

- A. Equipment and materials shall be protected during shipment and storage against physical damage, vermin, dirt, corrosive substances, fumes, moisture, cold and rain.
 1. Store equipment indoors in clean dry space with uniform temperature to prevent condensation. Equipment shall include but not be limited to switchgear, switchboards, panelboards, transformers, motor control centers, motor controllers, uninterruptible power systems, enclosures, controllers, circuit protective devices, cables, wire, light fixtures, electronic equipment, and accessories.
 2. During installation, equipment shall be protected against entry of foreign matter; and be vacuum-cleaned both inside and outside before testing and operating. Compressed air shall not be used to clean equipment. Remove loose packing and flammable materials from inside equipment.
 3. Damaged equipment shall be, as determined by the 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/cm²), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

1.12 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 - 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 - 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 - 3. Submit each section separately.
- E. The submittals shall include the following:
 - 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.
 - 2. 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

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

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.

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MEP

DIVISION 26 00 00

SECTION 26 05 13 - MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of medium voltage cables, splices, and terminations.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirement and items that are common to more than one section of Division 26.
- B. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.
- C. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for medium voltage cables.
- D. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes and ducts for medium voltage cables.
- E. Section 31 20 00, EARTH MOVING: Bedding of conduits.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Medium voltage cables shall be thoroughly tested at the factory per NEMA WC 74 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:
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include product and installation information for cables, splices, terminations, and fireproofing tape.

C. Samples: After approval and prior to installation, furnish the Resident Engineer with a minimum 12 in [300 mm] length of each type and size of cable, along with the tag from the reel from which the sample was taken. The sample shall contain the manufacturer's markings, showing all cable jacket information.

D. Certifications:

1. Factory Test Reports: Prior to installation of the cables, deliver four copies of the manufacturers certified NEMA WC 71 or WC 74 standard factory test reports to the Resident Engineer. Certified copies of test data shall show conformance with the referenced standards and shall be approved prior to delivery of cable.
2. Compatibility: Provide certification from the cable manufacturer that the splices and terminations are approved for use with the cable.
3. Field Test Reports: Test reports shall comply with the paragraph entitled "Acceptance Checks and Tests." After testing, submit four certified copies to the Resident Engineer of each of the graphs specified under field testing.
4. After splices and terminations have been installed and tested, deliver four copies of a certificate by the contractor to the Resident Engineer which includes the following:
 - a. A statement that the materials, detail drawings, and printed instructions used are those contained in the kits approved for this contract.
 - b. A statement that each splice and each termination was completely installed in a single continuous work period by a single qualified worker without any overnight interruption.
 - c. A statement that field-made splices and terminations conform to the following requirements:
 - 1) Pencil the cable insulation precisely.
 - 2) Connector installations:
 - a) Use tools that are designed for the connectors being installed.
 - b) Round and smooth the installed connectors to minimize localized voltage stressing of the insulating materials.
 - 3) Remove contaminants from all surfaces within the splices and terminations before installing the insulating materials.

- 4) Solder block throughout stranded grounding wires that might penetrate the splicing and terminating materials.
 - 5) Use mirrors to observe the installation of materials on the backsides of the splices and terminations.
 - 6) Eliminate air voids throughout the splices and terminations.
 - 7) Stretch each layer of tape properly during installation.
 - d. List all the materials purchased and installed for the splices and terminations for this contract, including the material descriptions, manufacturers' names, catalog numbers, and total quantities.
- E. Installer Approval:
1. Employees who install splices and terminations and test the cables shall have not fewer than five years of experience splicing and terminating cables equivalent to those being spliced and terminated, including experience with the materials in the kits.
 2. Furnish satisfactory proof of such experience for each employee who splices or terminates the cables.

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:
- American Society for Testing and Materials (ASTM):
- B3-01 (R2007).....Standard Specification for Soft or Annealed Copper Wire
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
- 386-95 (R2001).....Separable Insulated Connector Systems for Power Distribution Systems above 600 V
- 400-01.....Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
- 400.2-05.....Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
- 400.3-06.....Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment
- 404-00.....Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500-500,000 Volts
- C. National Electrical Manufacturers Association (NEMA):

WC 74-06.....5-46 KV Shielded Power Cable for Use in the
Transmission and Distribution of Electrical
Energy (ICEA S-93-969)

D. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

E. Underwriters Laboratories (UL):

1072-06 Medium-Voltage Power Cables

1.7 SHIPMENT AND STORAGE

- A. Cable shall be shipped on reels such that it is protected from mechanical injury. Each end of each length of cable shall be hermetically sealed with manufacturer's end caps and securely attached to the reel.
- B. Cable stored and/or cut on site shall have the ends turned down, and sealed with cable manufacturer's standard cable end seals, or field-installed heat-shrink cable end seals.

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CABLE

- A. Medium voltage cable shall be in accordance with the NEC and NEMA WC 71, WC 74, and UL 1072.
- B. Single conductor stranded copper conforming to ASTM B3.
- C. Voltage Rating:
 - 15,000 V cable shall be used on all distribution systems with voltages ranging from 5,000 V to 15,000 V.
- D. Insulation:
 - 1. Insulation level shall be 133%.
 - 2. Types of insulation:
 - a. Cable type abbreviation, EPR: Ethylene propylene rubber insulation shall be thermosetting, light and heat stabilized.
 - b. Cable type abbreviation, CCLP: Polyethylene insulation shall be thermosetting, light and heat stabilized, and chemically cross-linked.
 - c. In wet locations, anti-tree CCLP or EPR shall be used.
 - d. Cable type abbreviation, XLPE: cross-linked polyethylene insulated shielded shall be thermosetting, light and heat stabilized and chemically cross-linked.
- E. Conductors and insulation shall be wrapped separately with semi-conducting tape.

- F. Insulation shall be wrapped with non-magnetic, metallic shielding tape, helically-applied over semi-conducting insulation shield.
- G. Heavy duty, overall protective jacket of chlorosulphonated polyethylene or polyvinyl chloride shall enclose every cable. The manufacturer's name, cable type and size, and other pertinent information shall be marked or molded clearly on the overall protective jacket.
- H. Cable temperature ratings for continuous operation, emergency overload operation, and short circuit operation shall be not less than the NEC, NEMA WC 71, or NEMA WC 74 standard for the respective cable.

2.2 SPLICES AND TERMINATIONS

- A. The materials shall be compatible with the cables.
- B. In locations where moisture might be present, the splices shall be watertight. In manholes and handholes, the splices shall be submersible.
- C. Where the Government determines that unsatisfactory splices and terminations have been installed, the contractor shall replace the unsatisfactory splices and terminations with approved material at no additional cost to the Government.
- D. Splices and Terminations:
 - 1. Materials shall be designed for the cables being spliced and terminated, and shall be suitable for the prevailing environmental conditions.
 - 2. Splices:
 - a. Shall comply with IEEE 404. Include all components required for complete splice, with detailed instructions.
 - b. Heat-shrink splice: Uniform cross-section, polymeric splicing kit with outer heat-shrink jacket.
 - c. Cold-shrink splice: Premolded, cold-shrink-rubber, in-line splicing kit.
 - 3. Terminations:
 - a. Shall comply with IEEE 48. Include shield ground strap for shielded cable terminations.
 - b. Class 3 terminations for outdoor use: Kit with stress cone and compression-type connector.
 - c. Load-break terminations for indoor and outdoor use: Elbow-type unit with test point and 200-A load make/break and continuous-current rating.

2.3 FIREPROOFING TAPE

Fireproofing tape shall be flexible, non-corrosive, self-extinguishing, arcproof, and fireproof intumescent elastomer. Securing tape shall be glass cloth electrical tape not less than 7 mils [0.18 mm] thick, and 0.75 in [19 mm] wide.

PART 3 - EXECUTION

3.1 GENERAL

- A. Installation shall be in accordance with the NEC, as shown on the drawings, and per cable manufacturer's instructions.
- B. Cable shall be installed in conduit above grade and duct bank below grade. All cables of a feeder shall be pulled simultaneously.
- C. Splice the cables only in manholes and accessible pullboxes.
- D. Ground shields in accordance with Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- E. Cable maximum pull length, maximum pulling tension, and minimum bend radius shall conform with the recommendations of the cable manufacturer.
- F. Use suitable lubricating compounds on the cables to prevent pulling damage. Provide compounds that are not injurious to the cable jacket and do not harden or become adhesive.
- G. Seal the cable ends prior to pulling, to prevent the entry of moisture or lubricant.

3.2 PROTECTION DURING SPLICING OPERATIONS

Blowers shall be provided to force fresh air into manholes where free movement or circulation of air is obstructed. Waterproof protective coverings shall be available on the work site to provide protection against moisture while a splice is being made. Pumps shall be used to keep manholes dry during splicing operations. Under no conditions shall a splice or termination be made that exposes the interior of a cable to moisture. A manhole ring at least 6 in [150 mm] above ground shall be used around the manhole entrance to keep surface water from entering the manhole. Unused ducts shall be plugged and water seepage through ducts in use shall be stopped before splicing.

3.3 PULLING CABLES IN DUCTS AND MANHOLES

- A. Cables shall be pulled into ducts with equipment designed for this purpose, including power-driven winches, cable-feeding flexible tube guides, cable grips, pulling eyes, and lubricants. A sufficient number

of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable.

- B. Cable reels shall be set up at the side of the manhole opening and above the duct or hatch level, allowing cables to enter through the opening without reverse bending. Flexible tube guides shall be installed through the opening in a manner that will prevent cables from rubbing on the edges of any structural member.
- C. Cable shall be unreeled from the top of the reel. Pay-out shall be carefully controlled. Cables to be pulled shall be attached through a swivel to the main pulling wire by means of a suitable cable grip and pulling eye.
- D. Woven-wire cable grips shall be used to grip the cable end when pulling small cables and short straight lengths of heavier cables.
- E. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure.
- F. Cables shall be liberally coated with a suitable lubricant as they enter the tube guide or duct. Rollers, sheaves, or tube guides around which the cable is pulled shall conform to the minimum bending radius of the cable.
- G. Cables shall be pulled into ducts at a reasonable speed. Cable pulling using a vehicle shall not be permitted. Pulling operations shall be stopped immediately at any indication of binding or obstruction, and shall not be resumed until the potential for damage to the cable is corrected. Sufficient slack shall be provided for free movement of cable due to expansion or contraction.
- H. Splices in manholes shall be firmly supported on cable racks. No splices shall be pulled in ducts. Cable ends shall overlap at the ends of a section to provide sufficient undamaged cable for splicing.
- I. Cables cut in the field shall have the cut ends immediately sealed to prevent entrance of moisture.

3.4 SPLICES AND TERMINATIONS

- A. Install the materials as recommended by the manufacturer, including precautions pertaining to air temperature and humidity during installation.
- B. Installation shall be accomplished by qualified personnel trained to accomplish medium voltage equipment installations. All manufacturer's instructions shall be followed precisely.

- C. Splices in manholes shall be located midway between cable racks on walls of manholes, and supported with cable arms at approximately the same elevation as the enclosing duct.

3.5 FIREPROOFING

- A. Cover all cable segments exposed in manholes and pull-boxes with fireproofing tape.
- B. Apply the tape in a single layer, wrapped in a half-lap manner, or as recommended by the manufacturer. Extend the tape not less than 1 in [25 mm] into each duct.
- C. At each end of a taped cable section, secure the fireproof tape in place with glass cloth tape.

3.6 CIRCUIT IDENTIFICATION OF FEEDERS

In each manhole and pullbox, install permanent tags on each circuit's cables to clearly designate 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. Position the tags so they will be easy to read after the fireproofing tape is installed.

3.7 ACCEPTANCE CHECKS AND TESTS

- A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and electrical inspections.
- B. Test equipment and labor and technical personnel shall be provided as necessary to perform the acceptance tests. Arrangements shall be made to have tests witnessed by the Resident Engineer.
- C. Visual Inspection:
 - 1. Inspect exposed sections of cables for physical damage.
 - 2. Inspect shield grounding, cable supports, splices, and terminations.
 - 3. Verify that visible cable bends meet manufacturer's minimum published bending radius.
 - 4. Verify installation of fireproofing tape and identification tags.
- D. Electrical Tests:
 - 1. Acceptance tests shall be performed on new and service-aged cables as specified herein.
 - 2. Test new cable after installation, splices, and terminations have been made, but before connection to equipment and existing cable.
- E. Service-Aged Cable Tests:
 - 1. Maintenance tests shall be performed on service-aged cable interconnected to new cable.

2. After new cable test and connection to an existing cable, test the interconnected cable. Disconnect cable from all equipment that could be damaged by the test.

F. Insulation-Resistance Test: Test all new and service-aged cables with respect to ground and adjacent conductors.

1. Test data shall include megohm readings and leakage current readings. Cable shall not be energized until insulation-resistance test results have been approved by the Resident Engineer. Test voltages and minimum acceptable resistance values shall be:

<u>Voltage Class</u>	<u>Test Voltage</u>	<u>Min. Insulation Resistance</u>
5kV	2,500 VDC	1,000 megohms
15kV	2,500 VDC	5,000 megohms
25kV	5,000 VDC	20,000 megohms
35kV	15,000 VDC	100,000 megohms

2. Provide a comprehensive report that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and identifies the insulation resistance and leakage current results for each cable section tested. The report shall provide conclusions and recommendations for corrective action.

G. Online Partial Discharge Test: Comply with IEEE 400 and 400.3. Test all new and service-aged cables. Perform tests after cables have passed the insulation-resistance test, and after successful energization.

1. Testing shall use a time or frequency domain detection process, incorporating radio frequency current transformer sensors with a partial discharge detection range of 10 kHz to 300 MHz.
2. Provide a comprehensive report that describes the identification and location of cables tested, the test equipment used, and the date tests were performed; identifies the persons who performed the tests; and numerically and graphically identifies the magnitude of partial discharge detected for each cable section tested. The report shall provide conclusions and recommendations for corrective action.

H. Final Acceptance: Final acceptance shall depend upon the satisfactory performance of the cables under test. No cable shall be energized until recorded test data have been approved by the Resident Engineer. Final test reports shall be provided to the Resident Engineer.

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MEP

DIVISION 26 00 00

SECTION 26 05 21 -LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW)

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of the low voltage power and lighting wiring.

1.2 RELATED WORK

- A. Section 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.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Low voltage cables shall be thoroughly tested at the factory per NEMA WC-70 to ensure that there are no electrical defects. Factory tests shall be certified.

1.5 SUBMITTALS

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

- 1. Manufacturer's Literature and Data: Showing each cable type and rating.
- 2. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by designation only.
- B. American Society of Testing Material (ASTM):
 - D2301-04.....Standard Specification for Vinyl Chloride
Plastic Pressure-Sensitive Electrical
Insulating Tape
- C. National Fire Protection Association (NFPA):
 - 70-08.....National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
 - WC 70-09.....Power Cables Rated 2000 Volts or Less for the
Distribution of Electrical Energy
- E. Underwriters Laboratories, Inc. (UL):
 - 44-05.....Thermoset-Insulated Wires and Cables
 - 83-08.....Thermoplastic-Insulated Wires and Cables
 - 467-071.....Electrical Grounding and Bonding Equipment
 - 486A-486B-03.....Wire Connectors
 - 486C-04.....Splicing Wire Connectors
 - 486D-05.....Sealed Wire Connector Systems
 - 486E-94.....Equipment Wiring Terminals for Use with
Aluminum and/or Copper Conductors
 - 493-07.....Thermoplastic-Insulated Underground Feeder and
Branch Circuit Cable
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 1479-03.....Fire Tests of Through-Penetration Fire Stops

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Conductors and cables shall be in accordance with NEMA WC-70 and as specified herein.
- B. Single Conductor:
 - 1. Shall be annealed copper.
 - 2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller.
 - 3. Shall be minimum size No. 12 AWG, except where smaller sizes are allowed herein.

C. Insulation:

1. XHHW-2 or THHN-THWN shall be in accordance with NEMA WC-70, UL 44, and UL 83.

D. Color Code:

1. Secondary service feeder and branch circuit conductors shall be color-coded as follows:

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

- a. Lighting circuit "switch legs" and 3-way switch "traveling wires" shall have color coding that is unique and distinct (e.g., pink and purple) from the color coding indicated above. The unique color codes shall be solid and in accordance with the NEC.
Coordinate color coding in the field with the Resident Engineer.
2. Use solid color insulation or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase, neutral, and ground conductors.
3. Conductors No. 8 AWG and larger shall be color-coded using one of the following methods:
 - a. Solid color insulation or solid color coating.
 - b. Stripes, bands, or hash marks of color specified above.
 - c. Color as specified using 0.75 in [19 mm] wide tape. Apply tape in half-overlapping turns for a minimum of 3 in [75 mm] for terminal points, and in junction boxes, pull-boxes, troughs, and manholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable, stating size and insulation type.
4. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

2.2 SPLICES AND JOINTS

- A. In accordance with UL 486A, C, D, E, and NEC.
- B. Aboveground Circuits (No. 10 AWG and smaller):

1. Connectors: Solderless, screw-on, reusable pressure cable type, rated 600 V, 220° F [105° C], with integral insulation, approved for copper 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 Resident Engineer.
 - 4. All cables in a single conduit shall be pulled simultaneously.
 - 5. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- I. No more than three single-phase branch circuits shall be installed in any one conduit.

3.2 SPLICE INSTALLATION

- A. Splices and terminations shall be mechanically and electrically secure.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque values.
- C. Where the Government determines that unsatisfactory splices or terminations have been installed, remove the devices and install approved devices at no additional cost to the Government.

3.3 FEEDER IDENTIFICATION

- A. In each interior pull-box and junction box, install metal tags on all circuit cables and wires to clearly designate their circuit identification and voltage. The tags shall be the embossed brass type,

1.5 in [40 mm] in diameter and 40 mils thick. Attach tags with plastic ties.

3.4 EXISTING WIRING

Unless specifically indicated on the plans, existing wiring shall not be reused for a new installation.

3.5 CONTROL AND SIGNAL WIRING INSTALLATION

- A. Unless otherwise specified in other sections, install wiring and connect to equipment/devices to perform the required functions as shown and specified.
- B. Except where otherwise required, install a separate power supply circuit for each system so that malfunctions in any system will not affect other systems.
- C. Where separate power supply circuits are not shown, connect the systems to the nearest panel boards of suitable voltages, which are intended to supply such systems and have suitable spare circuit breakers or space for installation.

3.6 CONTROL AND SIGNAL SYSTEM WIRING IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.7 ACCEPTANCE CHECKS AND TESTS

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices, such as fixtures, motors, or appliances. Test each conductor with respect to adjacent conductors and to ground. Existing conductors to be 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.

Michael E. DeBakey VA Medical Center

Issue for Bid, 08-8-2011

Parking Garage A Phase 1

VA Project No. 580-317

Low-Voltage Electrical Power Conductors & Cables

HOK Project No. 10.10019.00

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MEP

DIVISION 26 00 00

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 41 00, FACILITY LIGHTNING PROTECTION: Requirements for lightning protection.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present enough information to determine compliance with drawings and specifications.
 - 2. Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.
- C. Test Reports: Provide certified test reports of ground resistance.

D. Certifications: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:

1. Certification that the materials and installation are in accordance with the drawings and specifications.
2. Certification by the contractor that the complete installation has been properly installed and tested.

1.5 APPLICABLE PUBLICATIONS

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

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

B1-07.....Standard Specification for Hard-Drawn Copper Wire

B3-07.....Standard Specification for Soft or Annealed Copper Wire

B8-04.....Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

C2-07.....National Electrical Safety Code

C. National Fire Protection Association (NFPA):

70-08.....National Electrical Code (NEC)

99-2005.....Health Care Facilities

D. Underwriters Laboratories, Inc. (UL):

44-05Thermoset-Insulated Wires and Cables

83-08Thermoplastic-Insulated Wires and Cables

467-07Grounding and Bonding Equipment

486A-486B-03Wire 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

Concrete encased electrode shall be No. 4 AWG bare copper wire, installed per NEC.

2.4 MEDIUM VOLTAGE SPLICES AND TERMINATIONS

Components shall meet or exceed UL 467 and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

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. 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.

2.6 EQUIPMENT RACK AND CABINET GROUND BARS

Provide solid copper ground bars designed for mounting on the framework of open or cabinet-enclosed equipment racks with minimum dimensions of 0.375 in [4 mm] thick x 0.75 in [19 mm] wide.

2.7 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g., backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.8 GROUNDING BUS

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

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 MEDIUM VOLTAGE EQUIPMENT AND CIRCUITS

- A. Duct Banks and Manholes: Provide an insulated equipment grounding conductor in each duct containing medium voltage conductors, sized per NEC except that minimum size shall be 2 AWG [25 mm²]. Bond the equipment grounding conductors to the switchgear ground bus, to all manhole hardware and ground rods, to the cable shielding grounding provisions of medium-voltage cable splices and terminations, and to equipment enclosures.
- B. Pad-Mounted Transformers:
 - 1. Provide a driven ground rod and bond with a grounding electrode conductor to the transformer grounding pad.
 - 2. Ground the secondary neutral.
- C. Lightning Arresters: Connect lightning arresters to the equipment ground bus or ground rods as applicable.

3.4 SECONDARY VOLTAGE EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - 1. Provide a grounding electrode conductor sized per NEC between the service equipment ground bus and all metallic water pipe systems, building steel, and supplemental or made electrodes. Provide jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to UL 467.
 - 2. Provide a supplemental ground electrode and bond to the grounding electrode system.
- C. Service Disconnect (Separate Individual Enclosure): Provide a ground bar bolted to the enclosure with lugs for connecting the various grounding conductors.
- D. Panelboards:
 - 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.
- E. 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.

3.5 RACEWAY

- A. Conduit Systems:
 - 1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.

2. Non-metallic conduit systems, except non-metallic feeder conduits that carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment, shall contain an equipment grounding conductor.
 3. 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. Wireway Systems:
1. Bond the metallic structures of wireway to provide 100% electrical continuity throughout the wireway system, by connecting a No. 6 AWG [16 mm²] bonding jumper at all intermediate metallic enclosures and across all section junctions.
 2. Install insulated No. 6 AWG [16 mm²] bonding jumpers between the wireway system, bonded as required above, and the closest building ground at each end and approximately every 50 ft [16 M].
 3. Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground or bond metallic wireway at each end for all intermediate metallic enclosures and across all section junctions.
 4. Use insulated No. 6 AWG [16 mm²] bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 49 ft [15 M].
- E. Receptacles shall not be grounded through their mounting screws. Ground receptacles with a jumper from the receptacle green ground terminal to

the device box ground screw and a jumper to the branch circuit equipment grounding conductor.

F. Ground lighting fixtures to the equipment grounding conductor of the wiring system when the green ground is provided; otherwise, ground the fixtures through the conduit systems. Fixtures connected with flexible conduit shall have a green ground wire included with the power wires from the fixture through the flexible conduit to the first outlet box.

G. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.

3.6 OUTDOOR METALLIC FENCES AROUND ELECTRICAL EQUIPMENT

A. Outdoor Metallic Fences Around Electrical Equipment: Fences shall be grounded with a ground rod at each fixed gate post and at each corner post. Drive ground rods until the top is 12 in [300 mm] below grade. Attach a No. 4 AWG [25 mm²] copper conductor by exothermic weld to the ground rods, and extend underground to the immediate vicinity of fence post. Lace the conductor vertically into 12 in [300 mm] of fence mesh and fasten by two approved bronze compression fittings, one to bond the wire to post and the other to bond the wire to fence. Each gate section shall be bonded to its gatepost by a 0.375 in x 1 in [3 mm x 25 mm] flexible, braided copper strap and ground post clamps. Clamps shall be of the anti-electrolysis type.

3.7 CORROSION INHIBITORS

When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.

3.8 CONDUCTIVE PIPING

A. Bond all conductive piping systems, interior and exterior, to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

B. In operating rooms and at intensive care and coronary care type beds, bond the gases and suction piping at the outlets directly to the room or patient ground bus.

3.9 LIGHTNING PROTECTION SYSTEM

Bond the lightning protection system to the electrical grounding electrode system.

3.10 ELECTRICAL ROOM GROUNDING

Building Earth Ground Busbars: Provide ground busbar and mounting hardware at each electrical room and connect to pigtail extensions of the building grounding ring.

3.11 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 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. 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.

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MEP

DIVISION 26 00 00

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 06 10 00, ROUGH CARPENTRY: Mounting board for telephone closets.
- B. Section 07 60 00, FLASHING AND SHEET METAL: Fabrications for the deflection of water away from the building envelope at penetrations.
- C. Section 07 84 00, FIRESTOPPING: Sealing around penetrations to maintain the integrity of fire rated construction.
- D. Section 07 92 00, JOINT SEALANTS: Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building.
- E. Section 09 91 00, PAINTING: Identification and painting of conduit and other devices.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- G. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

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

- A. Manufacturer's Literature and Data: Showing each cable type and rating.
The specific item proposed and its area of application shall be identified on the catalog cuts.
- B. Shop Drawings:
 - 1. Size and location of main feeders.
 - 2. Size and location of panels and pull-boxes.
 - 3. Layout of required conduit penetrations through structural elements.
- C. Certifications:
 - 1. Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
 - a. Certification by the manufacturer that the material conforms to the requirements of the drawings and specifications.
 - b. Certification by the contractor that the material has been properly installed.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American National Standards Institute (ANSI):
 - C80.1-05.....Electrical Rigid Steel Conduit
 - C80.3-05.....Steel Electrical Metal Tubing
 - C80.6-05.....Electrical Intermediate Metal Conduit
- C. National Fire Protection Association (NFPA):
 - 70-08.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 1-05.....Flexible Metal Conduit
 - 5-04.....Surface Metal Raceway and Fittings
 - 6-07.....Electrical Rigid Metal Conduit - Steel
 - 50-95.....Enclosures for Electrical Equipment
 - 360-093.....Liquid-Tight Flexible Steel Conduit
 - 467-07.....Grounding and Bonding Equipment
 - 514A-04.....Metallic Outlet Boxes
 - 514B-04.....Conduit, Tubing, and Cable Fittings
 - 514C-96.....Nonmetallic Outlet Boxes, Flush-Device Boxes
and Covers

651-05.....Schedule 40 and 80 Rigid PVC Conduit and
Fittings

651A-00.....Type EB and A Rigid PVC Conduit and HDPE
Conduit

797-07.....Electrical Metallic Tubing

1242-06.....Electrical Intermediate Metal Conduit - Steel

E. National Electrical Manufacturers Association (NEMA):

TC-2-03.....Electrical Polyvinyl Chloride (PVC) Tubing and
Conduit

TC-3-04.....PVC Fittings for Use with Rigid PVC Conduit and
Tubing

FB1-07.....Fittings, Cast Metal Boxes and Conduit Bodies
for Conduit, Electrical Metallic Tubing and
Cable

PART 2 - PRODUCTS

2.1 MATERIAL

A. Conduit Size: In accordance with the NEC, but not less than 0.5 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. Setscrew couplings and connectors: Use setscrews of case-hardened steel with hex head and cup point, to firmly seat in wall of conduit for positive grounding.
 - 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 NEMA FB1.
 - b. Only steel or malleable iron materials are acceptable.

- c. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
- 6. Direct burial plastic conduit fittings:
 - Fittings shall meet the requirements of UL 514C and NEMA TC3.
- 7. Surface metal raceway fittings: As recommended by the raceway manufacturer. Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, conduit entry fittings, accessories, and other fittings as required for complete system.
- 8. Expansion and deflection couplings:
 - a. Conform to UL 467 and UL 514B.
 - b. Accommodate a 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 Resident Engineer 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 Resident Engineer 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 otherwise 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. 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.
 10. Flashing of penetrations of the roof membrane is specified in Section 07 60 00, FLASHING AND SHEET METAL.
 11. Conduit bodies shall only be used for changes in direction, and shall not contain splices.
 12. Flexible conduit or cable is permitted only for final connections to motors or recessed lighting fixtures in length of 6' (six feet) or less.
- 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 Resident Engineer.

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 Resident Engineer 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.
3. Align and run conduit parallel or perpendicular to the building lines.
4. Connect recessed lighting fixtures to conduit runs with maximum 6 ft [1.8 M] of flexible metal conduit extending from a junction box to the fixture.
5. Tightening setscrews with pliers is prohibited.

3.4 EXPOSED WORK INSTALLATION

- #### **A. Conduit for Conductors 600 V and Below: Rigid steel, IMC, or EMT.**
- Mixing different types of conduits indiscriminately in the system is prohibited.

- B. Align and run conduit parallel or perpendicular to the building lines.
- C. Install horizontal runs close to the ceiling or beams and secure with conduit straps. Install conduit tight to horizontal surfaces in public areas. Exposed conduit suspended in air will not be permitted.
Coordinate conduit sleeves with structure as required.
- D. Support horizontal or vertical runs at not over 8 ft [2.4 M] intervals.
- E. Surface metal raceways: Use only where shown.
- F. Painting:
 - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 - 2. Paint all conduits containing cables rated over 600 V safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. In addition, paint legends, using 2 in [50 mm] high black numerals and letters, showing the cable voltage rating.
Provide legends where conduits pass through walls and floors and at maximum 20 ft [6 M] intervals in between.

3.5 HAZARDOUS LOCATIONS

- A. Use rigid steel conduit only, notwithstanding requirements otherwise specified in this or other sections of these specifications.
- B. Install UL approved sealing fittings that prevent passage of explosive vapors in hazardous areas equipped with explosion-proof lighting fixtures, switches, and receptacles, as required by the NEC.

3.6 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.

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."

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VA Project No. 580-317
HOK Project No. 10.10019.00

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Raceway & Boxes For Electrical Systems

G. On all branch circuit junction box covers, identify the circuits with
black marker.

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DIVISION 26 00 00

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 Resident Engineer for approval prior to construction.
- C. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. American Concrete Institute (ACI):
- Building Code Requirements for Structural Concrete
318/318M-05.....Building Code Requirements for Structural
Concrete & Commentary
SP-66-04.....ACI Detailing Manual
- C. American National Standards Institute (ANSI):
- 77-07.....Underground Enclosure Integrity
- D. 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.
- E. Institute of Electrical and Electronic Engineers (IEEE):
- C2-07National Electrical Safety Code

F. 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

G. National Fire Protection Association (NFPA):

- 70-08.....National Electrical Code (NEC)

H. 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

I. U.S. General Services Administration (GSA):

- A-A-60005-1998.....Frames, Covers, Gratings, Steps, Sump and Catch
Basin, Manhole

1.6 STORAGE

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. Concrete Pullboxes: Shall be monolithically-poured reinforced concrete.

2.2 DUCTS

- A. Number and sizes shall be as shown on drawings.
- B. Ducts (concrete-encased):
 - 1. Plastic Duct:
 - a. UL 651 and 651A Schedule 40 PVC.
 - b. Duct shall be suitable for use with 194° F [90° C] rated conductors.
 - 2. Conduit Spacers: Prefabricated plastic.

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

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

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.
- C. Ground Rods in Manholes: Drive a ground rod into the earth, through the floor sleeve, after the manhole is set in place. Fill the sleeve with sealant to make a watertight seal. Rods shall protrude approximately 4 in [100 mm] above the manhole floor.
- D. Grounding in Manholes:

1. Install a No. 3/0 AWG [95 mm²] bare copper ring grounding conductor around the inside perimeter of the manhole and anchor to the walls with metallic cable clips.
2. Connect the ring grounding conductor to the ground rod by an exothermic welding process.
3. Bond the ring grounding conductor to the duct bank equipment grounding conductors, the exposed non-current carrying metal parts of racks, sump covers, and like items in the manholes with a minimum No. 6 AWG [16 mm²] bare copper jumper.

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. For Concrete-Encased Ducts:
 1. After excavation of the trench, stakes shall be driven in the bottom of the trench at 4 ft [1.2 M] intervals to establish the grade and route of the duct bank.
 2. Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts toward buildings wherever possible.
 3. The walls of the trench may be used to form the side walls of the duct bank, provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.
 4. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth, and appropriate warning tape installed.
- F. 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. Concrete-Encased Ducts and Conduits:

1. Install concrete-encased ducts for medium-voltage systems, low-voltage systems, and signal systems, unless otherwise shown on the drawings.
2. Duct lines shall consist of single or multiple duct assemblies encased in concrete. Ducts shall be uniform in size and material throughout the installation.
3. Tops of concrete-encased ducts 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.
 - c. Conduits crossing under grade slab construction joints shall be installed a minimum of 4 ft [1.2 M] below slab.
4. Extend the concrete envelope encasing the ducts not less than 3 in [75 mm] beyond the outside walls of the outer ducts and conduits.
5. Within 10 ft [3 M] of building manhole and pullbox wall penetrations, install reinforcing steel bars at the top and bottom of each concrete envelope to provide protection against vertical shearing.
6. Install reinforcing steel bars at the top and bottom of each concrete envelope of all ducts underneath roadways and parking areas.
7. Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, pullboxes, ducts, conduits, and concrete envelopes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions.
8. Conduit joints in concrete may be placed side by side horizontally, but shall be staggered at least 6 in [150 mm] vertically.

9. Pour each run of concrete envelope between manholes or other terminations in one continuous pour. If more than one pour is necessary, terminate each pour in a vertical plane and install 0.75 in [19 mm] reinforcing rod dowels extending 18 in [450 mm] into concrete on both sides of joint near corners of envelope.
10. Pour concrete so that open spaces are uniformly filled. Do not agitate with power equipment unless approved by Resident Engineer.
11. Duct Bank Markers:
 - a. Duct bank markers shall be located at the ends of duct banks except at manholes or pullboxes at approximately every 200 ft [60 M] along the duct run and at each change in direction of the duct run. Markers shall be placed 2 ft [0.6 M] to the right of the duct bank, facing the longitudinal axis of the run in the direction of the electrical load.
 - b. The letter "D" with two arrows shall be impressed or cast on top of the marker. One arrow shall be located below the letter and shall point toward the ducts. The second arrow shall be located adjacent to the letter and shall point in a direction parallel to the ducts. The letter and arrow adjacent to it shall each be approximately 2 in [75 mm] long. The letter and arrows shall be V-shaped, and shall have a width of stroke at least 0.75 in [6 mm] at the top and a depth of 0.25 in [6 mm].
 - c. In paved areas, the top of the duct markers shall be flush with the finished surface of the paving.
 - d. Where the duct bank changes direction, the arrow located adjacent to the letter shall be cast or impressed with an angle in the arrow equivalent to the angular change of the duct bank.
- C. Concrete-Encased 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 Resident Engineer.
- 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 Manholes: Ducts connecting to manholes shall be flared to have an enlarged cross-section to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 in [300 mm] in each direction. Perimeter of the duct bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct and the wall of the manhole. Use vibrators when this portion of the encasement is poured to ensure a seal between the envelope and the wall of the structure.
- H. 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.
- I. 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.
- J. 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.

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MEP

DIVISION 26 00 00

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 point of connection of new work to the existing system, and shall include the first up stream overcurrent protection device, for both the normal and emergency 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 24 16, PANEL BOARDS: Low-voltage panelboards.

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 Resident Engineer:
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. Generator kW and Transformer kVA and voltage ratings, percent impedance, X/R ratios, and wiring connections.
- d. Voltage at each bus.
- e. Identification of each bus, matching the identification on the construction drawings.
- f. 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.

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MEP

DIVISION 26 00 00

SECTION 26 09 23 - LIGHTING CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

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 24 26 16, PANELBOARDS: panelboard enclosure and interior bussing used for lighting control panels.
- F. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Product Data: For each type of lighting 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-48Guide 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

773ANonindustrial Photoelectric Switches for
Lighting Control

98.....Enclosed and Dead-Front Switches

917.....Clock Operated Switches

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED PHOTOELECTRIC SWITCHES

- A. Solid-state, light-level sensor unit, with separate relay unit.
 - 1. Sensor Output: Contacts rated to operate the associated relay.
Sensor shall be powered from the relay unit.
 - 2. Relay Unit: Dry contacts rated for 20A ballast load at 120V and 277V, for 13A tungsten at 120V, and for 1 hp at 120V.
 - 3. Monitoring Range: //10 to 200 fc [108 to 2152 lx]// //100 to 1000 fc [1080 to 10 800 lx]//, with an adjustment for turn-on and turn-off levels.
 - 4. Time Delay: Adjustable from 5 to 300 seconds, with deadband adjustment.
 - 5. Indicator: Two LEDs to indicate the beginning of on-off cycles.

2.2 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.

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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.

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 5 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.

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.

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- 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.

3.3 FOLLOW-UP VERIFICATION

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.

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MEP

DIVISION 20 00 00

SECTION 26 12 19 - PAD-MOUNTED, LIQUID-FILLED, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and connection of pad-mounted transformers.
- B. Pad-mounted transformers shall be complete, outdoor type, continuous duty, integral assembly, grounded, tamper-resistant, and weatherproof, with liquid-immersed transformers.

1.2 RELATED WORK

- A. Section 09 06 00, SCHEDULE FOR FINISHES: Finishes for electrical equipment.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- C. Section 26 05 13, MEDIUM-VOLTAGE CABLES: Medium-voltage cables.
- 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 currents.
- E. Section 26 05 41, UNDERGROUND ELECTRICAL CONSTRUCTION: Manholes, pull-boxes, and duct lines for underground raceway systems.
- F. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Short-circuit and coordination study.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 FACTORY TESTS

Transformers shall be thoroughly tested at the factory to ensure that there are no electrical or mechanical defects. Tests shall be conducted as per UL and ANSI Standards. Factory tests shall be certified. The following tests shall be performed:

- 1. Perform insulation-resistance tests, winding-to-winding and each winding-to-ground.
- 2. Perform turns-ratio tests at all tap positions.

1.5 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, nameplate data, impedance, outline drawing with dimensions and front, top, and side views, weight, mounting details, decibel rating, termination information, temperature rise, no-load and full-load losses, regulation, overcurrent protection, connection diagrams, and accessories.
 - 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, wiring diagrams, and information for ordering replacement parts.
 - a. Identify terminals on wiring diagrams to facilitate installation, maintenance, and operation.
 - b. Indicate on wiring diagrams the internal wiring for each piece of equipment and interconnections between the pieces of equipment.
 - c. Approvals will be based on complete submissions of manuals, together with shop drawings.
 - 2. Two weeks prior to the final inspection, submit four copies of the final up-dated maintenance and operation manuals to the Resident Engineer.
 - a. Update the manual to include any information necessitated by shop drawing approval.
 - b. Show all terminal identification.
 - c. Include information for testing, repair, trouble-shooting, assembly, disassembly, and recommended maintenance intervals.
 - d. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
 - e. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

D. Certifications:

- Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.6 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. American Concrete Institute (ACI):
- 318-05.....Building Code Requirements for Structural Concrete
- C. American National Standards Institute (ANSI):
- C37.47-00.....High Voltage Current-Limiting Type Distribution Class Fuses and Fuse Disconnecting Switches
- C57.12.00-00.....General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers
- C57.12.25-90.....Transformers-Pad-Mounted, Compartmental-Type, Self Cooled, Single-Phase Distribution Transformers with Separable Insulated High Voltage Connectors; High Voltage, 34500 Grd Y/19920 Volts and Below; Low-Voltage 240/120 Volts; 167 kVA and Smaller Requirements
- C57.12.28-05.....Pad-Mounted Equipment Enclosure Integrity
- C57.12.29-99.....Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
- C57.12.34-04.....Pad-Mounted, Compartmental-Type, Self Cooled, Three-Phase Distribution Transformers, 2500kVA and Smaller - High Voltage 34500 Grd Y/19920 Volts and Below; Low-Voltage 480 Volts and Below
- D. American Society for Testing and Materials (ASTM):
- D3487-08.....Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus

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- E. Institute of Electrical and Electronic Engineers (IEEE):
- C2-07.....National Electrical Safety Code
 - C62.11-99.....Metal-Oxide Surge Arresters for Alternating
Current Power Circuits
 - 48-09.....Test Procedures and Requirements for
Alternating Current Cable Terminations Used on
Shielded Cables Having Laminated Insulation
Rated 2.5kV Through 765kV or Extruded
Insulation Rated 2.5kV Through 500kV
 - 386-06.....Standard for Separable Insulated Connector
Systems for Power Distribution Systems Above
600V
 - 592-96.....Standard for Exposed Semiconducting Shields on
High Voltage Cable Joints and Separable
Insulated Connectors
- F. National Electrical Manufacturers Association (NEMA):
- C57.12.26-87.....Pad-Mounted, Compartmental-Type, Self-Cooled,
Three-Phase Distribution Transformers for Use
with Separable Insulated High-Voltage
Connectors, High-Voltage, 34500 Grd Y/19920
Volts and Below; 2500 kVA and Smaller
 - LA1-92.....Surge Arresters
 - TP1-02.....Guide for Determining Energy Efficiency for
Distribution Transformers
 - TR1-00.....Transformers, Regulators, and Reactors
- G. National Fire Protection Association (NFPA):
- 70-08.....National Electrical Code (NEC)
- H. Underwriters Laboratories Inc. (UL):
- 467-07.....Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 EQUIPMENT, GENERAL

- A. Equipment shall be in accordance with ANSI, ASTM, IEEE, NEMA, NFPA, UL,
as shown on the drawings, and as specified herein. The transformer
shall be assembled as an integral unit by a single manufacturer.
- B. Ratings shall not be less than shown on the drawings.

- C. Provide transformers designed to withstand the mechanical stresses caused by rough handling during shipment in addition to the electrical and mechanical stresses that may occur during operation.
- D. Completely fabricate transformers at the factory so that only the external cable connections are required at the job site.
- E. Thoroughly clean, phosphatize, and finish all the metal surfaces at the factory with a rust-resistant primer and dark green enamel finish coat, except where a different color is specified in Section 09 06 00, SCHEDULE FOR FINISHES. All surfaces of the unit that will be in contact with the concrete pad shall be treated with corrosion-resistant compounds and epoxy resin or a rubberized sealing compound.

2.2 COMPARTMENTS

A. Construction:

- 1. Enclosures shall be in accordance with ANSI C57.12.28.
- 2. The medium- and low-voltage compartments shall be separated with a steel barrier that extends the full height and depth of the compartments.
- 3. The compartments shall be constructed of sheet steel (gauge to meet ANSI requirements) with bracing, reinforcing gussets, and jig-welding to ensure rectangular rigidity.
- 4. Use cadmium or zinc plated bolts, nuts, and washers.
- 5. Sufficient space shall be provided for equipment, cabling, and terminations within the compartments.
- 6. Affix transformer nameplate permanently within the low-voltage compartment. Voltage and kVA rating, connection configuration, impedance, date of manufacture, and serial number shall be shown on the nameplate.

B. Doors:

- 1. Provide a separate door for each compartment with provisions for a single padlock to secure all doors. Provide each compartment door with open-position doorstops and corrosion-resistant tamperproof hinges welded in place. The medium-voltage compartment door shall be mechanically prevented from opening unless the low-voltage compartment door is open.
- 2. The secondary compartment door shall have a one-piece steel handle and incorporate three-point locking mechanisms.

3. Provide a 2 in [50 mm] size padlock for each assembly, as approved by the Resident Engineer. Padlocks shall be keyed to the Resident Engineer's established key set. Firmly attach the padlock to the door assembly by a chain.

2.3 BIL RATING

- A. 15 kV class equipment shall have a minimum 95 kV BIL rating.

2.4 TRANSFORMER FUSE ASSEMBLY

The primary fuse assembly shall be load-break combination fuse and dry-well fuse holder rated for system voltage, rated for 10 load makes and 10 load breaks, with rated 200 amp load current at 75% power factor, 10,000 symmetrical A close-in on fault duty, and 95 kV BIL. The entire fuse assembly shall be removable through the use of hot stick.

1. The fuses shall be concealed, hot stick removable, 50,000 A symmetrical interrupting, non-expulsion, current-limiting primary distribution type, of the size and voltage class as shown on the drawings. The fuses shall operate within the fuse holder as a unit disconnecting means. Fuses shall be in accordance with ANSI C37.47.
2. Transformers shall not have internal "weak link" fuses that require transformer tank cover removal for replacement.
3. For units above 500 kVA using fusing above the 50 A 15 kV and 100 A 5 kV application, a clip-mounted arrangement of the current limiting fuses (i.e., live-front configuration) is required.

2.5 PRIMARY CONNECTIONS

- A. Primary connections shall be //200 A dead-front load break 600 A dead break wells and inserts for cable sizes shown on the drawings.

2.6 MEDIUM-VOLTAGE SWITCH

- A. The transformer primary disconnect switch for radial feeds shall be an oil-immersed, internal, gang-operated, load-interrupter type, rated 200 A, with a close-in on fault duty of 5,000 A symmetrical at voltage as shown on the drawings. The switch is to be a two-position, on-off, manual switch located in the medium-voltage compartment and hot-stick-operated.

1. Continuous current 200 A. A built-in switch with momentary current 10,000 A symmetrical (2 seconds). Make and latch 6,000 A symmetrical.

2.7 MEDIUM-VOLTAGE TERMINATIONS

- A. Terminate the medium voltage cables in the primary compartment with loadbreak premolded rubber elbow connectors, suitable for submersible applications. Elbow connectors shall have a minimum of 0.125 in [3 mm] semi-conductive shield material covering the housing. The separable connector system shall include the loadbreak elbow, the bushing insert, and the bushing well. Separable connectors shall comply with the requirements of IEEE 386, and shall be interchangeable between suppliers. Loadbreak elbow and bushing insert shall be from the same manufacturer. Allow sufficient slack in medium-voltage cable, ground, and drain wires to permit elbow connectors to be moved to their respective parking stands. Elbow connectors shall be rated as follows:
 - 1. Voltage: 15kV phase-to-phase.
 - 2. Continuous current: 200 A RMS.
- A. Ground metallic cable shields with a device designed for that purpose, consisting of a solderless connector enclosed in watertight rubber housing covering the entire assembly.
- B. Provide insulated cable supports to relieve any strain imposed by cable weight or movement.

2.8 LOW-VOLTAGE EQUIPMENT

- A. Mount the low voltage bushings and hot stick in the low voltage compartment.
- B. The low-voltage leads shall be brought out of the tank by epoxy pressure tight bushings, and shall be standard arrangement per ANSI.
- C. Tin-plate the low-voltage neutral terminal and isolate from the transformer tank. Provide a removable ground strap sized in accordance with the NEC and connect between the neutral and ground pad.

2.9 TRANSFORMERS

- A. Transformers shall be three-phase, liquid-immersed, isolated winding, and self-cooled by natural convection.
- B. The kVA ratings shown on the drawings are for continuous duty without the use of cooling fans.
- C. Temperature rises shall not exceed the NEMA TR1 standards of 149° F [65° C] by resistance, and 180° F [80° C] hotspot at rated kVA.
- D. Transformer insulating material shall be less flammable, silicone-based dielectric, and UL listed as complying with NFPA 70 requirements for

fire point of not less than 600° F [300 C] when tested according to ASTM D 92. Liquid shall have low toxicity and be nonhazardous.

E. Transformer impedance shall be not less than 4.5% for sizes 150 kVA and larger. Impedance shall be as shown on the drawings.

F. Sound levels shall conform to NEMA TR1 standards.

G. Primary and Secondary Windings for Three-Phase Transformers:

1. Primary windings shall be delta-connected.

2. Secondary windings shall be wye-connected, except where otherwise indicated on the drawings. Provide isolated neutral bushings for secondary wye-connected transformers.

3. Secondary leads shall be brought out through pressure-tight epoxy bushings.

H. Primary windings shall have four 2.55 full-capacity voltage taps; two taps above and two taps below rated voltage.

I. Core and Coil Assemblies:

1. Cores shall be grain-oriented, non-aging, and silicon steel to minimize losses.

2. Core and coil assemblies shall be rigidly braced to withstand the stresses caused by rough handling during shipment, and stresses caused by any possible short-circuit currents.

3. Coils shall be continuous-winding type without splices except for taps. Material shall be copper.

4. Coil and core losses shall be optimum for efficient operation.

5. Primary, secondary, and tap connections shall be brazed or pressure type.

6. Provide end fillers or tiedowns for coil windings.

J. The transformer tank, cover, and radiator gauge thickness shall not be less than that outlined in ANSI.

K. Accessories:

1. Provide standard NEMA features, accessories, and the following:

a. No-load tap changer (Provide warning sign).

b. Lifting, pulling, and jacking facilities.

c. Globe-type valve for oil filtering and draining, including sampling device.

d. Pressure relief valve.

e. Liquid level gauge and filling plug.

f. A grounding pad in the medium- and low-voltage compartments.

- g. A diagrammatic nameplate and operating instructions enclosed by a transparent cover located in the low-voltage compartment.
 - h. Dial-type liquid thermometer with a maximum reading pointer and an external reset.
 - i. Hot stick. Securely fasten hot stick within low-voltage compartment.
2. The accessories shall be made accessible within the compartments without disassembling trims and covers.
- L. Transformers shall meet the minimum energy efficiency values per NEMA TP1:

KVA	(%)
75	98.1
112.5	98.3
150	99.0
225	99.0
300	99.0
500	99.1
750	99.2
1000	99.2
1500	99.3
2000	99.4
2500	99.4

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install transformers as shown on the drawings, in accordance with the NEC, and as recommended by the manufacturer.
- B. Foundation:
 - 1. Provide foundation of reinforced concrete, Type C, 21mPa (3000 psi minimum, 28 day compressive strength), complying with the ACI 318.
 - 2. Locate the top of foundation pads 6 in [150 mm] above the adjacent finished grade, unless otherwise shown on the drawings. Refer to drawings for size, location, and structural steel reinforcing required.

3. Grade the adjacent terrain so that surface water will flow away from the foundation.
4. Anchor transformers with cadmium- or zinc-plated bolts, nuts, and washers. Bolts shall not be less than 0.5 in [12 mm] diameter.

C. Grounding:

1. Ground each transformer in accordance with the requirements of the NEC. Install ground rods per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS, to maintain a maximum resistance of 5 ohms to ground.
2. Connect the ground rod to the ground pads in the medium- and low-voltage compartments, and to the secondary and primary neutral with not less than a No. 2/0 AWG bare copper conductor.
3. Independently connect cable shield grounding devices ground wires to ground with sufficient slack to permit elbow connector operation. Connect elbow connectors with a No. 14 AWG bare copper drain wire from its grounding eye to the related cable shield grounding device ground wire. Do not connect drain wires in any manner that could permit circulating currents, or cable fault currents, to pass through them.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Perform tests in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections.

B. Transformers:

1. Compare equipment nameplate data with specifications and approved shop drawings.
2. Inspect physical and mechanical condition. Check for damaged or cracked bushings and liquid leaks.
3. Verify that control and alarm settings on temperature indicators are as specified.
4. Inspect all field-installed bolted electrical connections, using the calibrated torque-wrench method to verify tightness of accessible bolted electrical connections, or perform thermographic survey after energization under load.
5. Verify correct liquid level in transformer tank.
6. Perform specific inspections and mechanical tests as recommended by manufacturer.

7. Verify correct equipment grounding per the requirements of Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

8. Verify the presence of transformer surge arresters, if provided.

9. Verify that the tap-changer is set at specified ratio.

3.3 FOLLOW-UP VERIFICATION

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.

3.4 SPARE PARTS

Deliver the following spare parts for the project to the Resident Engineer two weeks prior to final inspection:

1. Six stand-off insulators.

2. Six insulated protective caps.

3. One spare set of medium-voltage fuses for each size fuse used in the project.

3.5 INSTRUCTIONS

The contractor shall instruct maintenance personnel, for not less than one 2-hour period, on the maintenance and operation of the equipment on the date requested by the Resident Engineer.

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MEP

DIVISION 26 00 00

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of dry-type general-purpose transformers.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items 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 fault currents.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlet boxes.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. 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 Resident Engineer two weeks prior to final inspection.

D. Certifications: Two weeks prior to the final inspection, submit four copies of the following to the Resident Engineer:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the 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

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

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.

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MEP

DIVISION 26 00 00

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 DESCRIPTION

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 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 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.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Sufficient information, 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 Resident Engineer two weeks prior to final inspection.

D. Certification: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:

1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

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

B. National Electrical Manufacturers Association (NEMA):

PB-1-06.....Panelboards

250-08.....Enclosures for Electrical Equipment (1000V
Maximum)

C. National Fire Protection Association (NFPA):

70-2005National 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 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

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 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

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. 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.
- E. Rust and scale shall be removed from the inside of existing backboxes where new panelboards are to be installed. Paint inside of backboxes with rust-preventive paint before the new panelboard interior is installed. Provide new trim and doors for these panelboards. Covers shall fit tight to the box with no gaps between the cover and the box.

3.2 ACCEPTANCE CHECKS AND TESTS

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

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.

Michael E. DeBakey VA Medical Center
Parking Garage A Phase 1
VA Project No. 580-317
HOK Project No. 10.10019.00

Issue for Bid, 08-8-2011

Panelboards

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MEP

DIVISION 26 00 00

SECTION 26 27 26 -WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation and connection of wiring devices.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one section of Division 26.
- B. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and outlets boxes.
- C. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, construction materials, grade and termination information.
- C. Manuals: Two weeks prior to final inspection, deliver four copies of the following to the 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 6Wiring 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. Safety Type Duplex Receptacles:
 - a. Bodies shall be gray in color.
 - 1) Shall permit current to flow only while a standard plug is in the proper position in the receptacle.
 - 2) Screws exposed while the wall plates are in place shall be the tamperproof type.
6. Duplex Receptacles (not hospital grade): Shall be the same as hospital grade duplex receptacles except for the "hospital grade" listing and as follows.
 - a. Bodies shall be brown phenolic compound supported by a plated steel mounting strap having plaster ears.
- C. Receptacles; 20, 30 and 50 ampere, 250 volts: Shall be complete with appropriate cord grip plug. Devices shall meet UL 231.

2.2 TOGGLE SWITCHES

- A. Toggle Switches: Shall be totally enclosed tumbler type with bodies of phenolic compound. Toggle handles shall be ivory in color unless

otherwise specified. The rocker type switch is not acceptable and will not be approved.

1. Switches installed in hazardous areas shall be explosion proof type in accordance with the NEC and as shown on the drawings.
2. Shall be single unit toggle, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding mounting strap with break-off plaster 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 smooth nylon. Oversize plates are not acceptable.
- B. Color shall be white unless otherwise specified.
- C. 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.
- D. For receptacles or switches mounted adjacent to each other, wall plates shall be common for each group of receptacles or switches.
- E. In psychiatric areas, wall plates shall be 302 stainless steel, have tamperproof screws and beveled edges.
- F. Wall plates for data, telephone or other communication outlets shall be as specified in the associated specification.
- G. 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.

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- 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.

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MEP

DIVISION 26 00 00

SECTION 26 29 11 -MOTOR STARTERS

PART 1 - GENERAL

1.1 DESCRIPTION

All motor starters and variable speed motor controllers, including installation and connection (whether furnished with the equipment specified in other Divisions or otherwise), shall meet these specifications.

1.2 RELATED WORK

- A. Other sections which specify motor driven equipment, except elevator motor controllers.
- 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

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.

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- 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 (solid state 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. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the existing centers or panelboards.
- E. Additional requirements for specific motor controllers, as indicated in other sections, shall also apply.
- F. 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, red pilot light, auxiliary contact // and toggle operator. Coordinate auxiliary contact type (NO, NC) with building control system and fire alarm requirements.
- 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 auxiliary contact and toggle operator. Coordinate auxiliary contact requirement with building control system and fire alarm requirements.

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:
 - Elevation: 0-1000 feet AMSL
 - Temperatures: Maximum +90°F Minimum -10°F
 - Relative Humidity: 95%
 - Drive Location: Air conditioned Building
- E. Controllers shall have the following features:
 - 1. Isolated power for control circuits.
 - 2. Manually re-settable motor overload protection for each phase.
 - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.

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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. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.//
 10. 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.

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- 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-485.
- M. Embedded BAS Protocols for Network Communications: As specified in Division 22.

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- N. Bypass Operation: Manually transfers motor between power converter output and bypass circuit, manually, automatically, or both. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- O. Bypass Controller: Provide contactor-style bypass, arranged to isolate the power converter input and output and permit safe testing of the power converter, both energized and de-energized, while motor is operating in bypass mode. Motor overload protection shall be provided.
1. Bypass Contactor: Load-break NEMA-rated contactor.
 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

2.7 MOTOR CONTROL STATIONS

- A. Shall have the following features:
1. Designed for suitably fulfilling the specific control functions for which each station is being installed.
 2. Coordinate the use of momentary contacts and maintained contacts with the complete motor control systems to insure safety for people and equipment.
 3. Each station shall have two pilot lights behind red and green jewels and a circuit to its motor controller. Connect the lamps so they will be energized as follows:
 - a. Red while the motor is running.
 - b. Green while the motor is stopped.
 4. Where two or more stations are mounted adjacent to each other, install a common wall plate, except where the designs of the stations make such common plates impracticable.
 5. Identify each station with a permanently attached individual nameplate, of laminated black phenolic resin with a white core and engraved lettering not less than 6 mm (1/4-inch) high. Identify the

motor by its number or other designation and indicate the function fulfilled by the motor.

B. Components of Motor Control Circuits:

1. Shall also be designed and arranged so that accidental faulting or grounding of the control conductors will not be able to start the motors.
2. Use of locking type STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, will not be permitted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's recommendations, the NEC, NEMA and as shown on the drawings.
- B. 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.
- C. 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.
- D. 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.
- E. Install manual motor starters in flush enclosures in finished areas.
- F. 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.

3.3 ACCEPTANCE CHECKS AND TESTS

A. Perform in accordance with the manufacturer's recommendations. Include the following visual and mechanical inspections and electrical tests:

1. Visual and Mechanical Inspection

- a. Compare equipment nameplate data with specifications and approved shop drawings.
- b. Inspect physical, electrical, and mechanical condition.
- c. Inspect contactors.
- d. Clean motor starters and variable speed motor controllers.
- e. Verify overload element ratings are correct for their applications.
- f. If motor-running protection is provided by fuses, verify correct fuse rating.
- g. Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data.

2. Variable speed motor controllers:

- a. Final programming and connections to variable speed motor controllers shall be by a factory-trained technician. Set all programmable functions of the variable speed motor controllers to meet the requirements and conditions of use.
- b. Test all control and safety features of the variable frequency drive.

3.4 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the motor starters and variable speed motor controllers are in good operating condition and properly performing the intended functions.

3.5 SPARE PARTS

Two weeks prior to the final inspection, provide one complete set of spare fuses (including heater elements) for each starter/controller installed on this project.

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DIVISION 26 00 00

SECTION 26 29 21 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, and connection of low voltage disconnect switches.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section of Division 26.
- B. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES 600 VOLTS AND BELOW: Cables and wiring.
- C. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and to provide a low impedance path for possible ground faults.
- D. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits for cables and wiring.
- E. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Motor rated toggle switches.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. Submit in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, and fuse types and classes.
 - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- C. Manuals:

1. Provide complete maintenance and operating manuals for disconnect switches, including technical data sheets, wiring diagrams, and information for ordering replacement parts. Deliver four copies to the Resident Engineer two weeks prior to final inspection.
2. Terminals on wiring diagrams shall be identified to facilitate maintenance and operation.
3. Wiring diagrams shall indicate internal wiring and any interlocking.
- D. Certifications: Two weeks prior to the final inspection, submit four copies of the following certifications to the Resident Engineer:
 1. Certification by the manufacturer that the materials conform to the requirements of the drawings and specifications.
 2. Certification by the contractor that the materials have been properly installed, connected, and tested.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
 - FU 1-07.....Low Voltage Cartridge Fuses
 - KS 1-06.....Enclosed and Miscellaneous Distribution
Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):
 - 70-08.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
 - 98-04.....Enclosed and Dead-Front Switches
 - 248-00.....Low Voltage Fuses
 - 977-94.....Fused Power-Circuit Devices

PART 2 - PRODUCTS

2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS

- A. In accordance with UL 98, NEMA KS1, and NEC.
- B. Shall have NEMA classification General Duty (GD) for 240 V switches and NEMA classification Heavy Duty (HD) for 480 V switches.
- C. Shall be HP rated.
- D. Shall have the following features:
 1. Switch mechanism shall be the quick-make, quick-break type.
 2. Copper blades, visible in the OFF position.

3. An arc chute for each pole.
4. External operating handle shall indicate ON and OFF position and have lock-open padlocking provisions.
5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable to permit inspection.
6. Fuse holders for the sizes and types of fuses specified.
7. Solid neutral for each switch being installed in a circuit which includes a neutral conductor.
8. Ground lugs for each ground conductor.
9. Enclosures:
 - a. Shall be the NEMA types shown on the drawings for the switches.
 - b. Where the types of switch enclosures are not shown, they shall be the NEMA types most suitable for the ambient environmental conditions. Unless otherwise indicated on the plans, all outdoor switches shall be NEMA 3R.
 - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).

2.2 LOW VOLTAGE UNFUSED SWITCHES RATED 600 AMPERES AND LESS

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, but without provisions for fuses.

2.3 LOW VOLTAGE FUSIBLE SWITCHES RATED OVER 600 AMPERES TO 1200 AMPERES

Shall be the same as Low Voltage Fusible Switches Rated 600 Amperes and Less, except for the minimum duty rating which shall be NEMA classification Heavy Duty (HD). These switches shall also be HP rated.

2.4 MOTOR RATED TOGGLE SWITCHES

Refer to Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

2.5 LOW VOLTAGE CARTRIDGE FUSES

- A. In accordance with NEMA FU1.
- B. Feeders: //Class L, fast acting// //Class L, time delay// //Class RK1, fast acting// //Class RK1, time delay// //Class RK5, fast acting// //Class RK5, time delay// //Class J, fast acting// //Class J, time delay//.
- C. Motor Branch Circuits: //Class RK1// //Class RK5//, time delay.
- D. Other Branch Circuits: //Class RK1, time delay// //Class RK5, time delay// //Class J, fast acting// //Class J, time delay//.
- E. Control Circuits: Class CC, //fast acting// //time delay//.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install disconnect switches in accordance with the NEC and as shown on the drawings.
- B. Fusible disconnect switches shall be furnished complete with fuses. Arrange fuses such that rating information is readable without removing the fuse.

3.2 SPARE PARTS

Two weeks prior to the final inspection, furnish one complete set of spare fuses for each fusible disconnect switch installed on the project. Deliver the spare fuses to the Resident Engineer.

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MEP

DIVISION 26 00 00

SECTION 26 32 13 - ENGINE-GENERATORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies the furnishing, installation, and testing of the low-voltage engine-generator system. This includes, but is not limited to: air filtration, starting system, generator controls, instrumentation, lubrication, fuel system, cooling system, and exhaust system.
- B. The engine-generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

1.2 RELATED WORK

- A. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Requirements for pipe and equipment support and noise control.
- B. Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION: Requirements for hot piping and equipment insulation.
- C. Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items common to more than one section of Division 26.
- E. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Low voltage conductors.
- 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 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for protective coordination of a standby and/or essential electrical system.
- H. Section 26 36 23, AUTOMATIC TRANSFER SWITCHES: Requirements for automatic transfer switches for use with engine-generators.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 QUALITY ASSURANCE

- A. The supplier of the engine-generator shall be responsible for satisfactory total operation of the system and its certification. This supplier shall have had experience with three or more installations of systems of comparable size and complexity. Each of these installations shall have been in successful operation for three or more years. Prior to review of submittals, the Government reserves the right to:
1. Have the manufacturer submit a list of locations with similar installations.
 2. Inspect any of these installations and question the user concerning the installations without the presence of the supplier.
- B. A factory-authorized representative shall be capable of providing emergency maintenance and repairs at the project site within 2 hours maximum of notification.
- C. Factory Test: The Government shall have the option of witnessing the following tests at the factory. The tests shall be performed on the specific engine-generator(s) being manufactured for this project. The Government will pay all expenses for the Government representative's trip to witness these tests. The contractor shall notify the Resident Engineer 15 days prior to date of testing. The manufacturer shall furnish load banks, testing instruments, and all other equipment necessary to perform these tests.
1. Load Test: Shall include six hours of continuous operation; four hours while the engine-generator is delivering 100% of the specified kW and two hours while delivering 110% of the specified kW. During this test record, the following data at 20-minute intervals:

Time	Engine RPM	Oil Temperature Out
kW	Water Temperature In	Fuel Pressure
Voltage	Water Temperature Out	Oil Pressure
Amperes	Oil Temperature In	Ambient Temperature

2. Quick Start Test: Record time required for the engine-generator to develop specified voltage, frequency, and kW load from a standstill condition.

1.5 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
Scaled drawings, showing plan views, side views, elevations, and cross-sections.
- C. Diagrams:
Control system diagrams, elementary diagrams, control sequence diagrams or tables, wiring diagrams, interconnections diagrams (between local control cubicles, remote annunciator panels, remote derangement panels, remote monitoring panels, remote exercising panel, automatic transfer switches, paralleling switchgear, and fuel storage tanks, as applicable), illustrative diagrams, flow diagrams, and other like items.
- D. Technical Data:
 1. Published ratings, catalog cuts, pictures, and manufacturers' specifications for engine-generator, governor, voltage regulator, radiator, muffler, dampers, day tank, pumps, fuel tank, batteries and charger, jacket heaters, torsional vibration, and control and supervisory equipment.
 2. Description of operation.
 3. Short-circuit current capacity and subtransient reactance.
 4. Sound power level data.
- E. Calculations:
Detailed engineering calculations with all equations, graphs, assumptions, and approximations shown and data sources referenced. Include any calculated performance derations appropriate to installed environment.
- F. Manuals:
 1. When submitting the shop drawings, submit complete maintenance and operating manuals of the engine-generator and auxiliaries, including technical data sheets, wiring diagrams, and information for ordering replacement parts.

2. Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the Resident Engineer:
 - a. Include complete "As Installed" diagrams, which indicate all items of equipment and their interconnecting wiring.
 - b. Include complete diagrams of the internal wiring for each of the pieces 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. Include complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.

G. Certifications:

1. Prior to fabrication of the engine-generator, submit the following to the Resident Engineer for approval:
 - a. A certification in writing that an engine-generator of the same model and configuration, with the same bore, stroke, number of cylinders, and equal or higher kW/kVA ratings as the proposed engine-generator, has been operating satisfactorily with connected loads of not less than 75% of the specified kW/kVA rating, for not fewer than 2,000 hours without any failure of a crankshaft, camshaft, piston, valve, injector, or governor system.
 - b. A certification in writing that devices and circuits will be incorporated to protect the voltage regulator and other components of the engine-generator during operation at speeds other than the rated RPM while performing maintenance. Submit thorough descriptions of any precautions necessary to protect the voltage regulator and other components of the system during operation of the engine-generator at speeds other than the rated RPM.
 - c. A certification from the engine manufacturer stating that the engine exhaust emissions meet the federal, state, and local regulations and restrictions specified. At a minimum, this certification shall include emission factors for criteria pollutants including nitrogen oxides, carbon monoxide,

particulate matter, sulfur dioxide, non-methane hydrocarbon, and hazardous air pollutants (HPAs).

2. Prior to installation of the engine-generator at the job site, submit four copies of certified factory test data to the Resident Engineer.
3. Two weeks prior to the final inspection, submit four copies of the following to the Resident Engineer:
 - a. Certification by the engine-generator manufacturer that the equipment conforms to the requirements of the drawings and specifications.
 - b. A certified report of field tests from the contractor that the engine-generator has been properly installed, adjusted, and tested.

1.6 STORAGE AND HANDLING

- A. Equipment shall withstand shipping and handling stresses in addition to the electrical and mechanical stresses which occur during operation of the system. Protect radiator core with wood sheet.
- B. Store the equipment in a location approved by the Resident Engineer.

1.7 JOB CONDITIONS

Shall conform to the arrangements and details shown on the drawings. The dimensions, enclosures, and arrangements of the engine-generator system shall permit the operating personnel to safely and conveniently operate and maintain the system in the space designated for installation.

1.8 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):
 - C37.50-00.....Low-Voltage AC Power Circuit Breakers Used In Enclosures-Test Procedures
 - C39.1-81 (R1992)Requirements for Electrical Analog Indicating Instruments
- C. American Society of Testing Materials (ASTM):

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- A53/A53M-07.....Standard Specification for Pipe, Steel, Black,
and Hot-Dipped, Zinc Coated Welded and
Seamless.
- B88-03.....Specification for Seamless Copper Water Tube
- B88M-03.....Specification for Seamless Copper water Tube
(Metric)
- D975-09b.....Diesel Fuel Oils
- D. Institute of Electrical and Electronic Engineers (IEEE):
- C37.13-08.....Low Voltage AC Power Circuit Breakers Used In
Enclosures
- C37.90.1-02.....Surge Withstand Capability (SWC) Tests for
Relays and Relay Systems Associated with
Electric Power Apparatus
- E. National Electrical Manufacturers Association (NEMA):
- ICS 6-06.....Enclosures
- ICS 4-05.....Terminal Blocks
- MG 1-07.....Motor and Generators
- MG 2-01.....Safety Standard and Guide for Selection,
Installation and Use of Electric Motors and
Generators
- PB 2-06.....Dead-Front Distribution Switchboards
- 250-08.....Enclosures for Electrical Equipment (1000 Volts
Maximum)
- F. National Fire Protection Association (NFPA):
- 30-08.....Flammable and Combustible Liquids Code
- 37-06.....Installations and Use of Stationary Combustion
Engine and Gas Turbines
- 70-08.....National Electrical Code (NEC)
- 99-05.....Health Care Facilities
- 110-10.....Standard for Emergency and Standby Power
Systems
- G. Underwriters Laboratories, Inc. (UL):
- 50-95.....Enclosures for Electrical Equipment
- 142-06.....Steel Aboveground Tanks for Flammable and
Combustible Liquids
- 2085-97.....Insulated Aboveground Tanks for Flammable and
Combustible Liquids

2200-98.....Stationery Engine Generator Assemblies
1236-06.....Battery Chargers for Charging Engine-Starter
 Batteries
467-07.....Grounding and Bonding Equipment
489-09.....Molded-Case Circuit Breakers, Molded-Case
 Switches and Circuit-Breaker Enclosures
508-99.....Industrial Control Equipment
891-05.....Switchboards

PART 2 - PRODUCTS

2.1 ENGINE-GENERATOR

- A. The engine-generator system shall be in accordance with NFPA, UL, NEMA and ANSI, and as specified herein. All information required by these specifications shall shown on the drawings.
- B. Provide a factory-assembled, wired (except for field connections), complete, fully automatic engine-generator system.
- C. Engine-Generator Parameter Schedule:
- Power Rating: Emergency Standby
- Voltage: 277/480V
- Service Load: as shown on drawings
- Motor Starting kVA (Max.): //____// kVA
- Power Factor: 0.8 lagging
- Engine-Generator Application: stand-alone
- Fuel: diesel
- Maximum Speed: 1800 RPM
- Frequency Bandwidth (steady state): 0.4%
- Voltage Regulation: + 2% (maximum) (No Load to Full Load) (standalone applications)
- Voltage Bandwidth: +2% (steady state)
- Frequency: 60 Hz
- Phases: 3 Phase, Wye
- Max Step Load Increase: 100 % of service load at 0.2 PF
- Maximum Frequency Deviation with 100% Step Load Increase: 5% of rated frequency
- Max Step Load Decrease (without shutdown): 100% of service load at 0.8 PF
- Max Time to Start and be Ready to Assume Load: 10 seconds

- D. Assemble, connect, and wire the equipment at the factory so that only the external connections need to be made at the construction site.
- E. Unit shall be factory-painted with manufacturer's primer and standard finishes.
- F. Connections between components of the system shall conform to the recommendations of the manufacturer.
- G. Couplings, shafts, and other moving parts shall be enclosed and guarded. Guards shall be metal, ruggedly constructed, rigidly fastened, and readily removable for convenient servicing of the equipment without disassembling any pipes and fittings.
- H. Engine-generator shall have the following features:
 - 1. Factory-mounted on a common, rigid, welded, structural steel base.
 - 2. Engine-generator shall be statically and dynamically balanced so that the maximum vibration in the horizontal, vertical, and axial directions shall be limited to 0.0059 in [0.15 mm], with an overall velocity limit of 0.866 in/sec [24 mm/sec] RMS, for all speeds.
 - 3. The isolators shall be constrained with restraints capable of withstanding static forces in any direction equal to twice the weight of the supported equipment.
 - 4. Shall be capable of operating satisfactorily as specified for not fewer than 10,000 hours between major overhauls.

2.2 ENGINE

- A. Coupled directly to a generator.
- B. Minimum four cylinders.
- C. The engine shall be able to start in a 40° F [4.5° C] () ambient temperature while using No. 2 diesel fuel oil without the use of starting aids such as glow plugs and ether injections.
- D. Fuel oil consumption of the engine rate shall not exceed the following values:

Size Range Net kW	% of Rated Output capacity	Fuel Usage kg/kWH (lbs/kWH)
100 -299	75 and 100	0.272 (0.600)
	50	0.292 (0.643)
300 -999	75 and 100	0.261 (0.575)
	50	0.272 (0.600)
1000 -2500	75 and 100	0.243 (0.536)

50

0.260 (0.573)

E. Equipped with electric heater for maintaining the coolant temperature between 90-100° F [32-38° C]), or as recommended by the manufacturer.

1. Install thermostatic controls, contactors, and circuit breaker-protected circuits for the heaters.
2. The heaters shall operate continuously except while the engine is operating or the water temperature is at the predetermined level.

2.3 GOVERNOR

- A. Isochronous, electronic type.
- B. Steady-state speed band at 60 Hz shall not exceed plus or minus one-third of 1%.
- C. While the engine is running, manual speed adjustments may be made.

2.4 LUBRICATION OIL SYSTEM

- A. Pressurized type.
- B. Positive-displacement pump driven by engine crankshaft.
- C. Full-flow strainer and full-flow or by-pass filters.
- D. Filters shall be cleanable or replaceable type and shall remove particles as small as 3 microns without removing the additives in the oil. For by-pass filters, flow shall be diverted without flow interruption.
- E. Extend lube oil sump drain line out through the skid base and terminate it with a drain valve and plug.
- F. Provide a 120-volt oil heater for exterior engine-generator.

2.5 FUEL SYSTEM

- A. Main fuel storage tank(s) shall comply with the requirements of Section 23 10 00, FACILITY FUEL SYSTEMS.
- B. Shall comply with NFPA 37 and NFPA 30, and have the following features:
 1. Injection pump(s) and nozzles.
 2. Plungers shall be carefully lapped for precision fit and shall not require any packing.
 3. Filters or screens that require periodic cleaning or replacement shall not be permitted in the injection system assemblies.
 4. Return surplus oil from the injectors to the main storage tank by gravity or a pump.

5. Filter System:

- a. Dual primary filters shall be located between the main fuel oil storage and day tank.
- b. Secondary filters (engine-mounted) shall be located such that the oil will be thoroughly filtered before it reaches the injection system assemblies.
- c. Filters shall be cleanable or replaceable type and shall entrap and remove water from oil as recommended by the engine manufacturer.

C. Day Tank:

1. Each engine-generator shall be provided with a welded steel integral day tank.
2. Each day tank shall have capacity to supply fuel to the engine for a 4-hour period at 100% rated load without being refilled, including fuel that is returned to the main fuel storage tank. The calculation of the capacity of each day tank shall incorporate the requirement to stop the supply of fuel into the day tank at 90% of the ultimate volume of the tank.
3. Secure, pipe, and connect the tank adequately for maximum protection from fire hazards, including oil leaks.
4. Incorporate a vent, drain cock, shutoff cocks, and gauge glass. Terminate the vent piping outdoors with mushroom vent cap.
5. Incorporate a float switch on the day tank to control the fuel oil transfer pump and to actuate an alarm in the engine-generator control cubicle when the oil level in the tank drops below the level at which the transfer pump should start to refill the tank.
 - a. The float switch contacts controlling the fuel oil transfer pump shall be set to energize the pump when the liquid level in the tank reaches one-third of the total volume of the tank.
 - b. The float switch contacts that actuate the low fuel oil day tank alarm device shall be set to alarm and energize the second fuel transfer pump when the liquid level in the tank reaches one-quarter of the total volume of the tank.
6. Day tank and engine supply line elevations shall be below the elevation of the injector return outlet on the engine.

D. Fuel Transfer Pump - Main Storage Tank to Day Tank(s):

1. Electric motor-driven, duplex arrangement, close-coupled, single-stage, positive-displacement type with built-in pressure relief valves. When the fuel is used for cooling components of the fuel injection system, the engine's fuel return line shall be returned to the main storage tank, rather than the day tank.
 2. Include a heavy-duty automatic alternator and H-O-A switch to alternate sequence of pumps. Pumps shall be controlled with the float switch on the day tank and H-O-A selector switch such that the day tank will be refilled automatically when the oil level lowers to the low limit for the float switch. The H-O-A selector switches shall enable the pumps to be operated manually at any time.
 3. For all engines, the related transfer pump and its electrical and plumbing connections shall be sized to provide a flow rate of at least four times the engine's fuel pumping rate.
 4. Provide a manually-operated, rotary-type transfer pump connected in parallel with the electric motor-driven transfer pumps so that oil can be pumped to the day tank while the electric motor-driven pumps are inoperative.
- E. Piping System: Black steel standard weight ASTM A-53 pipe and necessary valves and pressure gauges between:
1. The engine and the day tank as shown on the drawings.
 2. The day tank and the supply and return connections at the underground storage tank as shown on the drawings. Connections at the engine shall be made with flexible piping suitable for the fuel furnished.

2.6 COOLING SYSTEM

- A. Liquid-cooled, closed loop, with fin-tube radiator mounted on the engine-generator.
- B. Cooling capacity shall not be less than the cooling requirements of the engine-generator and its lubricating oil while operating continuously at 110% of its specified rating.
- C. Water circulating pumps shall be the centrifugal type driven by engine. Incorporate pressure relief devices where required to prevent excessive pressure increase after the engine stops.
- D. Coolant shall be extended-life antifreeze solution, 50% ethylene glycol and 50% soft water, with corrosion inhibitor additive as recommended by the manufacturer.

E. Coolant hoses shall be flexible, per manufacturer's recommendation.

F. Self-contained thermostatic-control valve shall modulate coolant flow to maintain optimum constant coolant temperature, as recommended by the engine manufacturer.

2.7 AIR INTAKE AND EXHAUST SYSTEMS

A. Air Intake:

Provide an engine-mounted air cleaner with replaceable dry filter and dirty filter indicator.

B. Exhaust System:

1. Where turbo-charges are required, they shall be engine-mounted, driven by the engine gases, securely braced against vibration and adequately lubricated by the engine's filtered lubrication system.

2. Exhaust Muffler:

Shall be critical grade type and capable of the following noise attenuation:

Octave Band Hertz (Mid Frequency)	Minimum db Attenuation (.0002 Microbar Reference)
31	5
63	10
125	27
500	37
1000	31
2000	26
4000	25
8000	26

3. Pressure drop in the complete exhaust system shall be small enough for satisfactory operation of the engine-generator while it is delivering 110% of its specified rating.
4. Exhaust pipe size from the engine to the muffler shall be as recommended by the engine manufacturer. Pipe size from muffler to air discharge shall be two pipe sizes larger than engine exhaust pipe.

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- 5. Connections at the engine exhaust outlet shall be made with a flexible exhaust pipe. Provide bolted type pipe flanges welded to each end of the flexible section.
 - C. Condensate drain at muffler shall be made with schedule 40 black steel pipe through a petcock.
 - D. Exhaust Piping and Supports: Black steel pipe, ASTM A-53 standard weight with welded fittings. Spring type hangers, as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT, shall support the pipe.
 - E. Insulation for Exhaust Pipe and Muffler:
 - 1. Calcium silicate minimum 3 in [75 mm] thick.
 - 2. Insulation shall be as specified in Section 23 07 11, HVAC, PLUMBING, AND BOILER PLANT INSULATION.
 - 3. The installed insulation shall be covered with aluminum jacket 0.016 in [0.4 mm] thick. The jacket is to be held in place by bands of 0.015 in [0.38 mm] thick by 0.5 in [15 mm] wide aluminum.
 - 4. Insulation and jacket are not required on flexible exhaust sections.
 - F. Vertical exhaust piping shall be provided with a hinged, gravity-operated, self-closing rain cover.

2.8 ENGINE STARTING SYSTEM

- A. Shall start the engine at any position of the flywheel.
- B. Electric cranking motor:
 - 1. Shall be engine-mounted.
 - 2. Shall crank the engine via a gear drive.
 - 3. Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required RPM during five consecutive starting attempts of 10 seconds cranking each at 10-second intervals, for a total of 50 seconds of actual cranking without damage (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).
- C. Batteries shall be lead-acid high discharge rate type.
 - 1. Each battery cell shall have minimum and maximum electrolyte level indicators and a flip-top flame arrestor vent cap.
 - 2. Batteries shall have connector covers for protection against external short circuits.

3. With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85% of the nominal system voltage with the following demands:

Five consecutive starting attempts of 10 seconds cranking at 10second intervals for a total of 50 seconds of actual cranking (the fifth starting attempt will be manually initiated upon failure of a complete engine cranking cycle).

4. Battery racks shall be metal with an alkali-resistant finish and thermal insulation, and secured to the floor.

D. Battery Charger:

1. A current-limiting battery charger, conforming to UL 1236, shall be provided and shall automatically recharge the batteries. The charger shall be capable of an equalize-charging rate for recharging fully depleted batteries within 24 hours and a floating charge rate for maintaining the batteries at fully charged condition.
2. An ammeter shall be provided to indicate charging rate. A voltmeter shall be provided to indicate charging voltage.

2.9 LUBRICATING OIL HEATERS

Provide a thermostatically-controlled electric heater to automatically maintain the oil temperature within plus or minus 3° F [1.7° C] of the control temperature.

2.10 JACKET COOLANT HEATERS

Provide a thermostatically-controlled electric heater mounted in the engine coolant jacketing to automatically maintain the coolant within plus or minus 3° F [1.7° C] of the temperature recommended by the engine manufacturer to meet the starting time specified at the minimum winter outdoor temperature.

2.11 GENERATOR

- A. Synchronous, amortisseur windings, bracket-bearing, self-venting, rotating-field type connected directly to the engine.
- B. Lifting lugs designed for convenient connection to and removal from the engine.
- C. Integral poles and spider, or individual poles dove-tailed to the spider.
- D. Designed for sustained short-circuit currents in conformance with NEMA Standards.

- E. Designed for sustained operation at 125% of the RPM specified for the engine-generator without damage.
- F. Telephone influence factor shall conform to NEMA Standards.
- G. Furnished with brushless excitation system or static-exciter-regulator assembly.
- H. Nameplates attached to the generator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, kW/kVA output ratings, power factor rating, time rating, temperature rise ratings, RPM ratings, full load current rating, number of phases and frequency, and date of manufacture.
- I. The grounded (neutral) conductor shall be electrically isolated from equipment ground and terminated in the same junction box as the phase conductors.

2.12 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator circuit breaker shall be molded-case, electronic-trip type, and 100% rated, complying with UL 489. Tripping characteristics shall be adjustable long-time and short-time delay and instantaneous. Provide shunt trip-to-trip breaker when engine-generator is shut down by other protective devices.

2.13 CONTROLS

- A. Shall include Engine Generator Control Remote Annunciator Panel.
- B. General:
 - 1. Control Equipment shall be in accordance with UL 508, NEMA ICS-4, ICS-6, and ANSI C37.90.1.
 - 2. Panels shall be in accordance with UL 50.
 - 3. Coordinate controls with the automatic transfer switches shown on the drawings so that the systems will operate as specified.
 - 4. Wiring: Insulated, rated at 600 V.
 - a. Install the wiring in vertical and horizontal runs, neatly harnessed.
 - b. Terminate all external wiring at heavy duty, pressure-type, terminal blocks.
 - 5. The equipment, wiring terminals, and wires shall be clearly and permanently labelled.

6. The appropriate wiring diagrams shall be laminated or mounted under plexiglass within the frame on the inside of the cubicles and panels.
7. All indicating lamps and switches shall be accessible and mounted on the cubicle doors.
8. The manufacturer shall coordinate the interfacing of the control systems with all related equipment supplied in accordance with other sections of the project specification.

C. Engine-Generator Control:

1. Starting and Stopping Controls:

- a. A three-position, maintained-contact type selector switch with positions marked "AUTOMATIC," "OFF," and "MANUAL." Provide flashing amber light for OFF and MANUAL positions.
- b. A momentary contact push-button switch with positions marked "MANUAL START" and "MANUAL STOP."
- c. Selector switch in AUTOMATIC position shall cause the engine to start automatically when a single pole contact in a remote device closes. When the generator's output voltage increases to not less than 90% of its rated voltage, and its frequency increases to not less than 58 Hz, the remote devices shall transfer the load to the generator. An adjustable time delay relay, in the 0 to 15 minute range, shall cause the engine-generator to continue operating without any load after completion of the period of operation with load. Upon completion of the additional 0 to 15 minute (adjustable) period, the engine-generator shall stop.
- d. Selector switch in OFF position shall prevent the engine from starting either automatically or manually. Selector switch in MANUAL position shall also cause the engine to start when the manual start push-button is depressed momentarily.
- e. With selector switch is in MANUAL position, depressing the MANUAL STOP push-button momentarily shall stop the engine after a cool-down period.
- f. A maintained-contact, red mushroom-head push-button switch marked "EMERGENCY STOP" will cause the engine to stop without a cool down period, independent of the position of the selector switch.

2. Engine Cranking Controls:

- a. The cranking cycles shall be controlled by a timer that will be independent of the battery voltage fluctuations.
- b. The controls shall crank the engine through one complete cranking cycle, consisting of four starting attempts of 10 seconds each and 10 seconds between each attempt.
- c. Total actual cranking time for the complete cranking cycle shall be 40 seconds during a 70-second interval.
- d. Cranking shall terminate when the engine starts so that the starting system will not be damaged. Termination of the cranking shall be controlled by self-contained, speed-sensitive switch. The switch shall prevent re-cranking of the engine until after the engine stops.
- e. After the engine has stopped, the cranking control shall reset.

3. Supervisory Controls:

a. Overcrank:

- 1) When the cranking control system completes one cranking cycle (four starting attempts), without starting the engine, the OVERCRANK signal light and the audible alarm shall be energized.
- 2) The cranking control system shall lock-out, and shall require a manual reset.

b. Coolant Temperature:

- 1) When the temperature rises to the predetermined first stage level, the HIGH COOLANT TEMPERATURE - FIRST STAGE signal light and the audible alarm shall be energized.
- 2) When the temperature rises to the predetermined second stage level, which shall be low enough to prevent any damage to the engine and high enough to avoid unnecessary engine shutdowns, the HIGH COOLANT TEMPERATURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
- 3) The difference between the first and second stage temperature settings shall be approximately 10° F [-12° C].
- 4) Permanently indicate the temperature settings near the associated signal light.

- 5) When the coolant temperature drops to below 70° F [21° C], the "LOW COOLANT TEMPERATURE" signal light and the audible alarm shall be energized.
- c. Low Coolant Level: When the coolant level falls below the minimum level recommended by the manufacturer, the LOW COOLANT LEVEL signal light and audible alarm shall be energized.
- d. Lubricating Oil Pressure:
 - 1) When the pressure falls to the predetermined first stage level, the OIL PRESSURE - FIRST STAGE signal light and the audible alarm shall be energized.
 - 2) When the pressure falls to the predetermined second stage level, which shall be high enough to prevent damage to the engine and low enough to avoid unnecessary engine shutdowns, the OIL PRESSURE - SECOND STAGE signal light and the audible alarm shall be energized and the engine shall stop.
 - 3) The difference between the first and second stage pressure settings shall be approximately 15% of the oil pressure.
 - 4) The pressure settings near the associated signal light shall be permanently displayed so that the running oil pressure can be compared to the target (setpoint) value.
- e. Overspeed:
 - 1) When the engine RPM exceeds the maximum RPM recommended by the manufacturer of the engine, the engine shall stop.
 - 2) Simultaneously, the OVERSPEED signal light and the audible alarm shall be energized.
- f. Low Fuel - Day Tank:

When the fuel oil level in the day tank decreases to less than the level at which the fuel oil transfer pump should start to refill the tank, the LOW FUEL DAY TANK light and the audible alarm shall be energized.
- g. Reset Alarms and Signals:

Overcrank, Coolant Temperature, Coolant Level, Oil Pressure, Overspeed, and Low Fuel signal lights and the associated audible alarms shall require manual reset. A momentary-contact silencing switch and push-button shall silence the audible alarm by using relays of solid state devices to seal in the audible alarm in the de-energized condition. Elimination of the alarm condition shall

automatically release the sealed-in circuit for the audible so that it will be automatically energized again when the next alarm condition occurs. The signal lights shall require manual reset after elimination of the condition which caused them to be energized. Install the audible alarm just outside the generator room in a location as directed by the Resident Engineer. The audible alarm shall be rated for 85 dB at 10 ft [3 M].

i. Generator Breaker Signal Light:

- 1) A flashing green light shall be energized when the generator circuit breaker is in the OPEN or TRIPPED position.
- 2) Simultaneously, the audible alarm shall be energized.

4. Monitoring Devices:

- a. Electric type gauges for the cooling water temperatures and lubricating oil pressures. These gauges may be engine mounted with proper vibration isolation.
- b. A running time indicator, totalizing not fewer than 9,999 hours, and an electric type tachometer.
- c. A voltmeter, ammeter, frequency meter, kilowatt meter, manual adjusting knob for the output voltage, and the other items shown on the drawings shall be mounted on the front of the generator control panels.
- d. Install potential and current transformers as required.
- e. Individual signal lights:
 - 1) OVER-CRANK
 - 2) HIGH COOLANT TEMPERATURE - FIRST STAGE
 - 3) HIGH COOLANT TEMPERATURE - SECOND STAGE
 - 4) LOW COOLANT TEMPERATURE
 - 5) OIL PRESSURE - FIRST STAGE
 - 6) OIL PRESSURE - SECOND STAGE
 - 7) LOW COOLANT LEVEL
 - 8) GENERATOR BREAKER
 - 9) OVERSPEED
 - 10) LOW FUEL - DAY TANK
 - 11) LOW FUEL - MAIN STORAGE TANK
- f. Lamp Test: The LAMP TEST momentary contact switch shall momentarily actuate the alarm buzzer and all the indicating lamps.

5. Automatic Voltage Regulator:

- a. Shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.
- b. Shall include voltage level rheostat located inside the control cubicle.
- c. Provide a 3-phase automatic voltage regulator immune to waveform distortion.

2.14 REMOTE ANNUNCIATOR PANEL

- A. A remote annunciator panel shall be installed at the Engineering Control Center.
- B. The annunciator shall indicate alarm conditions of the engine-generator as follows:
 1. Individual visual signals shall indicate generator run.
 2. Individual visual signals plus a common audible alarm shall warn of the following:
 - a. LOW LUBRICATING OIL PRESSURE
 - b. LOW COOLANT
 - c. HIGH COOLANT TEMPERATURE
 - d. LOW FUEL - DAY TANK
 - e. LOW FUEL - MAIN TANK
 - f. FAILURE TO START
 - g. OVERSPEED
- C. The annunciator shall also have the following features:
 1. Lamp test momentary contact switch which will momentarily actuate the alarm buzzer and all indicating lamps.
 2. Audible Alarm: There shall be an audible alarm, rated for 85 dB at 10 feet, which shall become actuated whenever an alarm condition occurs. A momentary-contact acknowledge push-button shall silence the audible alarm, but not clear the alarm lamp. Elimination of the alarm condition shall automatically release the seal-in circuit for the audible alarm and extinguish the alarm lamp.
- D. Include control wiring between the remote annunciator panel and the engine-generator. Wiring shall be as required by the manufacturer.

2.15 Sound-Attenuated Enclosure

- A. The engine-generator and related equipment shall be housed in an outdoor weatherproof enclosure.

- B. The enclosure shall be provided with a factory-installed and factory-wired panelboard, 20A 120V receptacles, and compact fluorescent light fixtures with guards and switches.
- C. Airflow configuration shall be intake through rear of unit, and discharge air vertically up. Enclosure shall be suitable for winds up to 120 mph [193 kmh] roof load shall be equal to or greater than 40 lbs/sq ft [200 kg/sq m]. Non-distributed loading as required.
- D. The enclosure shall meet the following requirements:
 - 1. Radiator exhaust outlet shall be ducted through the end of the enclosure.
 - 2. All exterior surfaces shall be factory-painted with industrial enamel.
 - 3. Unit shall have sufficient guards to prevent entrance by small animals.
 - 4. Batteries shall fit inside enclosure and alongside the engine-generator. Batteries under the generator are not acceptable.
 - 5. The muffler shall be mounted and thermally-insulated inside the enclosure.

2.16 SPARE PARTS

- A. For each engine generator:
 - 1. Six lubricating oil filters.
 - 2. Six primary fuel oil filters.
 - 3. Six secondary fuel oil filters.
 - 4. Six intake air filters.
- B. For each battery charger:

Three complete sets of fuses.
- C. For each control panel:

Three complete sets of fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install concrete bases of dimensions shown on the drawings.
- B. Installation of the engine-generator shall comply with manufacturer's written instructions and with NFPA 110.
- C. Mounting:
 - 1. Support the base of engine-generator on vibration isolators, each isolator bolted to the floor (pad), and the generator base bolted to isolator.

2. Install sufficient isolators so that the floor (pad) bearing pressure under each isolator is within the floor (pad) loading specification.
3. Install equal number of isolators on each side of the engine-generator's base.
4. Locate isolators for approximately equal load distribution and deflection per isolator. The base of the engine-generator shall be drilled at the factory for the isolator bolts.
5. Isolators shall be shipped loose with the engine-generator.
6. All connections between the engine-generator and exterior systems, such as fuel lines, electrical connections, and engine exhaust system and air exhaust shroud, shall be flexible.

D. Balance:

The vibration velocity in the horizontal, vertical, and axial directions shall not exceed 0.65 in [16.25 mm] per second peak at any specific frequency. These limits apply to main structural components such as the engine block and the generator frame at the bearings.

E. Connect all components of the generator system so that they will continue to be energized during failure of the normal electrical power supply system.

F. Install piping between engine-generator and remote components of cooling, fuel, and exhaust systems.

G. Flexible connection between radiator and exhaust shroud at the wall damper:

1. Install noncombustible flexible connections made of 20-oz neoprene-coated fiberglass fabric approximately 6 in [150 mm] wide.
2. Crimp and fasten the fabric to the sheet metal with screws 2 in [50 mm] on center. The fabric shall not be stressed, except by the air pressure.

H. Exhaust System Insulation:

1. Adhesive and insulation materials shall be applied on clean, dry surfaces from which loose scale and construction debris has been removed by wire brushing.
2. Fill all cracks, voids, and joints of applied insulation material with high temperature 2000° F [1093° C] insulating cement before applying the outer covering.

3. The installation shall be clean and free of debris, thermally and structurally tight without sag, neatly finished at all hangers or other penetrations, and shall provide a smooth finish surface.
4. Insulation and jacket shall terminate hard and tight at all anchor points.
5. Insulate completely from engine exhaust flexible connection through roof or wall construction, including muffler.

3.2 ACCEPTANCE CHECKS AND TESTS

- A. Provide the services of a factory-authorized, factory-trained representative of the engine-generator manufacturer to inspect field-assembled components, and equipment installation and supervise the field tests.
- B. When the complete engine-generator system has been installed and prior to the final inspection, test all components of the system in the presence of the Resident Engineer for proper operation of the individual components and the complete system and to eliminate electrical and mechanical defects.
- C. Furnish fuel oil, lubricating oil, anti-freeze liquid, water treatment, and rust-inhibitor and load bank for testing of the engine-generator.
- D. Visual Inspection: Visually verify proper installation of engine-generator and all components per manufacturer's pre-start installation checklist.
- E. Set relays per this specification. Set engine-generator circuit breaker protective functions per Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY.
- F. Field Tests:
 1. Perform manufacturer's after-starting checks and inspections.
 2. Test the engine-generator for eight hours of continuous operation as follows:
 - a. First six hours while the engine-generator is delivering 100% of its specified kW rating.
 - b. Last two hours while the engine-generator is delivering 110% of its specified kW rating.
 - c. If during the 8-hour continuous test, a failure occurs, either the diesel engine shuts down or the full kW rating of the load bank is not achieved, the test is null and void. The test(s)

shall be repeated at no additional cost to the Government until satisfactory results are attained.

3. Record the following test data at 30-minute intervals:
 - a. Time of day, as well as reading of running time indicator.
 - b. kW.
 - c. Voltage on each phase.
 - d. Amperes on each phase.
 - e. Engine RPM.
 - f. Frequency.
 - g. Engine water temperature.
 - h. Fuel pressure.
 - i. Oil pressure.
 - j. Outdoor temperature.
 - k. Average ambient temperature in the vicinity of the engine-generator.
4. Demonstrate that the engine-generator will attain proper voltage, frequency, and will accept the specified block load within the specified time limit from a cold start after the closing of a single contact.
5. Furnish a resistance-type load for the testing of the engine-generator. Test loads shall always include adequate resistance to assure stability of the loads and equipment during all of the testing operations. The test load kW rating shall not be less than 110% of the specified kW rating of the engine-generator.

G. Starting System Test:

1. Demonstrate that the batteries and cranking motor are capable of five starting attempts of 10 seconds cranking each at 10-second intervals with the battery charger turned off.

H. Remote Annunciator Panel Tests:

Simulate conditions to verify proper operation of each indicating lamp, alarm device, meter, interconnecting hardware and software, and reset button.

I. Fuel systems shall be flushed and tested per Section 23 10 00, FACILITY FUEL SYSTEMS: Fuel supply and storage requirements.

J. Automatic Operation Tests:

Test the engine-generator to demonstrate automatic starting, loading and unloading. The load for this test shall utilize both load banks and

actual loads to be served. Initiate loss of normal source and verify the specified sequence of operation. Restore the normal power source and verify the specified sequence of operation. Verify resetting of controls to normal.

3.3 FOLLOW-UP VERIFICATION

Upon completion of acceptance checks, settings, and tests, the contractor shall demonstrate that the engine-generator(s) and control and annunciation components are in good operating condition and properly performing the intended function.

3.4 INSTRUCTIONS AND FINAL INSPECTIONS

- A. Laminate or mount under acrylic resin a set of operating instructions for the system and install instructions within a frame mounted on the wall near the engine-generator at a location per the Resident Engineer.
- B. Furnish the services of a competent, factory-trained technician for three 4-hour periods for instructions to VA personnel in operation and maintenance of the equipment, on the dates requested by the Resident Engineer.

- - - E N D - - -

MEP

DIVISION 26 00 00

SECTION 26 36 23 -AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing, installation, connection, and testing of open-transition automatic transfer switches with bypass isolation.

1.2 RELATED WORK

- A. Section 14 21 00, ELECTRIC TRACTION ELEVATORS: Requirements for elevator operation.
- B. Section 14 24 00, HYDRAULIC ELEVATORS: Requirements for elevator operation.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements and items that are common to more than one section in 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 personal safety and to provide a low impedance path for possible ground fault currents.
- F. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Raceways for power and control wiring.
- G. Section 26 05 71, ELECTRICAL SYSTEM PROTECTIVE DEVICE STUDY: Requirements for a coordinated electrical system.
- H. Section 26 32 13, ENGINE-GENERATORS: Requirements for normal and emergency power generation.
- I. Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS: General communications requirements that are common to more than one section in Division 27.
- J. Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATION SYSTEMS: Raceways for communications cabling.
- K. 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

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 an 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 Resident Engineer.
 - 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 Resident Engineer:
 - 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 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.

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. 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 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:

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:

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.
- B. 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:

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. 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.
 - c. Provide contacts for connection to elevator controllers, one closed when automatic transfer switch is connected to the normal

source, and one closed when automatic transfer switch is connected to the emergency source.

10. Elevator Pre-Transfer Signal Relay: Provide a pre-signal relay on all automatic transfer switches that will indicate to an elevator controller or controllers that a transfer or re-transfer is about to occur.
11. 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.
12. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to the automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit in-rush and seal currents are rated for actual currents to be encountered.
13. 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 bypass 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

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. 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.

E. Set field-adjustable intervals and delays, relays, and engine exerciser.

3.2 ACCEPTANCE CHECKS AND TESTS

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 Resident Engineer 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

At the final inspection in the presence of Resident Engineer, demonstrate that the complete auxiliary electrical power system operates properly in every respect. Coordinate this demonstration with the demonstration of the engine-generator(s).

3.4 TRAINING

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 Resident Engineer. Coordinate this training with that of the generator training.

- - - E N D - - -

MEP

DIVISION 26 00 00

SECTION 26 41 00 - FACILITY LIGHTNING PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

This section specifies the furnishing and installation of a complete master labeled lightning protection system, complying with NFPA 780, UL 96 and UL 96A.

1.2 RELATED WORK

- A. Section 07 60 00, FLASHING AND SHEET METAL: penetrations through the roof.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements 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 to ground for possible ground faults.

1.3 QUALITY ASSURANCE

Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1.4 SUBMITTALS

- A. In accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
 - 1. Isometric and plan views showing layout and connections to the required metal surfaces.
 - 2. Show the methods of mounting the system to the adjacent construction.
- C. Qualifications: Submit proof that the installer of the lightning protection system is a certified Lighting Protection Institute (LPI) installer, and has had suitable and adequate experience installing other lightning protection systems, and is capable of installing the system as recommended by the manufacturer of the equipment.
- D. Certification: Two weeks prior to final inspection, submit four copies of the following certifications to the Resident Engineer:

1. Certification that the lightning protection system has been properly installed and tested.
2. Certification that the lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Fire Protection Association (NFPA):
 - 70.....National Electrical Code (NEC)
 - 780.....Standard for the Installation of Lightning Protection Systems
- C. Underwriters Laboratories, Inc. (UL):
 - 96.....Lightning Protection Components
 - 96A.....Installation Requirements for Lightning Protection Systems
 - UL 467Standard for Grounding and Bonding Equipment

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Attach master labels to each item by its manufacturer as evidence that the materials have been manufactured in conformance with the UL Standards for master label lightning protection materials.
- B. In addition to conformance to UL 96, the component material requirements are as follows:
 1. Conductors: Electrical grade copper. Conductors shall be in accordance with NFPA 780 and UL 96 for Class I, Class II, or Class II modified materials as applicable.
 2. Air terminals: Solid copper, 18 inches long, not less than 3/8 inch [9mm] diameter, with sharp nickel-plated points.
 3. Ground rods: Copper clad steel, not less than 1/2 inch [13mm] diameter by 8 feet [2400mm] long. Rods made of copper-clad steel shall conform to UL 467 and galvanized ferrous rods shall conform to IEEE C135.30. Ground rods of copper-clad steel, steel, stainless steel, galvanized ferrous, and solid copper shall not be mixed on the project.

4. Ground plates: Solid copper, not less than 1/16 inch [2mm] thick.

5. Tubing: Stiff copper or brass.

- C. Anchors and fasteners: Bolt type which are most suitable for the specific anchor and fastener installations. Clamp-type connectors for splicing conductors shall conform to UL 96, class as applicable, and, Class 2, style and size as required for the installation. Clamp-type connectors shall only be used for the connection of the roof conductor to the air terminal and to the guttering. All other connections, bonds, and splices shall be done by exothermic welds or by high compression fittings. The exothermic welds and high compression fittings shall be listed for the purpose. The high compression fittings shall be the type which require a hydraulically operated mechanism to apply a minimum of 10,000 psi.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be coordinated with the roofing manufacturer and installer.
- B. Install the conductors as inconspicuously as practical and with the proper bends.
- C. Install the vertical conductors within the concealed cavity of exterior walls. Run the conductors to the exterior at elevations below the finished grade and make the ground connections to the earth outside of the building or stack perimeter.
- D. Make connections of dissimilar metal with bimetallic type fittings to prevent electrolytic action.
- E. Use the exothermic welding type connections that form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.
- F. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between one foot [300mm] below and seven feet [2100mm] above the finished grade. The conductor shall be bonded to the top and bottom of the tubing.
- G. Sheath copper conductors, which pass over cast stone, cut stone, architectural concrete and masonry surfaces, with not less than a 1/16 inch [2mm] thickness of lead to prevent staining of the exterior finish surfaces.

- H. For the earth connections, install ground rods and ground plates, and the conductor connections to them and the main water pipes in the presence of the Resident Engineer. For the conductors located outside of the building or stack, install the conductors not less than two feet [600mm] below the finished grade.
- I. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.
- J. Connect lightning protection cables to all metallic projections, equipment, and components above the roof as indicated on the drawings.
- K. Connect exterior metal surfaces, located within three feet [900mm] of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.
- L. Maintain horizontal or downward coursing of main conductor and insure that all bends have at least an 8-inch radius and do not exceed 90 degrees.
- M. Conductors shall be rigidly fastened every three feet [900mm] along the roof and down to the building to ground.
- N. Air terminals shall be secured against overturning either by attachment to the object to be protected or by means of a substantial tripod or other braces permanently and rigidly attached to the building or structure. Install air terminal bases, cable holders and other roof-system supporting means without piercing roof metal.
- O. Use through-roof connectors for down-conductor attachment to roof system. Provide flashing in accordance with Section 07 60 00, FLASHING AND SHEET METAL.
- P. Down-conductors coursed on or in reinforced concrete columns or on structural steel columns shall be connected to the reinforcing steel or the structural steel member at its upper and lower extremities. In the case of long vertical members an additional connection shall be made at intervals not exceeding 100 feet [30m].
- Q. A counterpoise, where shown, shall be of No. 1/0 copper cable or equivalent material having suitable resistance to corrosion and shall be laid around the perimeter of the structure in a trench not less than 2 feet [600mm] deep at a distance not less than 3 feet [900mm] nor more than 8 feet [2.5m] from the nearest point of the structure.

- R. On construction utilizing post tensioning systems to secure precast concrete sections, the post tension rods shall not be used as a path for lightning to ground. Down conductors shall be provided on structures using post tensioning systems. Down conductors shall have sufficient separation from post tension rods to prevent side-flashing. Post tension rods shall be bonded to the lightning protection and grounding systems only at the base of the structure; this bonding shall be performed in strict accordance with the recommendations of the post tension rod manufacturer, and shall be done by, or in the presence of, a representative of the manufacturer.
- S. Grounding: Test the ground resistance to earth by standard methods and conform to the ground resistance requirements specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- T. Where shown, use the structural steel framework or reinforcing steel as the main conductor:
1. Weld or bond the non-electrically-continuous sections together and make them electrically continuous.
 2. Verify the electrical continuity by measuring the ground resistances to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings.
 3. Connect the air terminals together with an exterior conductor connected to the structural steel framework at not more than 60 foot [18m] intervals.
 4. Install ground connections to earth at not more than 60 foot [18m] intervals around the perimeter of the building.
 5. Weld or braze bonding plates, not less than 8 inches [200mm] square, to cleaned sections of the steel and connect the conductors to the plates.
 6. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to UL Publication No. 96A.
- V. When the lightning protection systems have been installed, have the systems inspected by a UL representative. Obtain and install a UL numbered master label for each of the lightning protection systems at the location directed by the UL representative and the Resident Engineer.

Y. Metal fences that are electrically continuous with metal posts extending at least 2 feet [600mm] into the ground require no additional grounding. Other fences shall be grounded on each side of every gate. Fences shall be grounded by means of ground rods every 1000 to 1500 feet [300 to 450m] of length when fences are located in isolated places, and every 500 to 750 feet [150 to 225m] when in proximity (100 feet [30m] or less) to public roads, highways, and buildings.

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MEP

DIVISION 26 00 00

SECTION 26 43 13 -TRANSIENT-VOLTAGE SURGE SUPPRESSION

PART 1 - GENERAL

1.1 DESCRIPTION

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 23 00, LOW-VOLTAGE SWITCHGEAR: For factory-installed TVSS.
- C. Section 26 24 11, DISTRIBUTION SWITCHBOARDS: For factory-installed TVSS.
- D. Section 26 24 16, PANELBOARDS: For factory-installed TVSS.
- E. Section 26 26 00, POWER DISTRIBUTION UNITS FOR UNINTERRUPTIBLE POWER SYSTEMS: For factory-installed TVSS.

1.3 QUALITY ASSURANCE

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.
 - 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

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.

- A. 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
- B. National Electrical Manufacturers Association (NEMA):
 - NEMA LS 1.....Low Voltage Surge Protective Devices
- C. Underwriters Laboratories, Inc. (UL):
 - UL 1283.....Electromagnetic Interference Filters
 - UL 1449.....Surge Protective Devices
- D. National Fire Protection Association (NFPA):
 - NFPA 70.....National Electrical Code (NEC)

PART 2 - PRODUCTS

2.1 PANELBOARD SUPPRESSORS

- A. Surge Protection Devices:
 - 1. Non-modular.
 - 2. LED indicator lights for power and protection status.
 - 3. Audible alarm, with silencing switch, to indicate when protection has failed.
- 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: 70,000 A.
 - 2. Line to Ground: 70,000 A.
 - 3. Neutral to Ground: 50,000 A.
- 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: 1500 V for 480 V, 800 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.

B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide a circuit breaker, sized by manufacturer, as a dedicated disconnecting means for TVSS unless otherwise shown on drawings.

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

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 - - -

MEP

DIVISION 26 00 00

SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 DESCRIPTION:

This section specifies the furnishing, installation and connection of the interior lighting systems.

1.2 RELATED WORK

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General requirements 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 to ground for possible ground fault currents.
- D. Section 26 27 26, WIRING DEVICES: Wiring devices used for control of the lighting systems.

1.3 QUALITY ASSURANCE

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
C82.11-02.....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// //rapid-start// type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated; including the following features:

1. Lamp end-of-life detection and shutdown circuit (T5 lamps only).
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: 10 percent or less.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. Ballast Factor: 0.87 or higher unless otherwise indicated.
9. Power Factor: 0.98 or higher.
10. Interference: Comply with 47 CFT 18, Ch.1, Subpart C, for limitations on electromagnetic and radio-frequency interference for non-consumer equipment.
11. To facilitate multi-level lamp switching, lamps within fixture shall be wired with the outermost lamp at both sides of the fixture on the same ballast, the next inward pair on another ballast and so on to the innermost lamp (or pair of lamps). Within a given room, each switch shall uniformly control the same corresponding lamp (or lamp pairs) in all fixture units that are being controlled.

12. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common two-lamp ballast to operate the center lamp in pairs of adjacent units that are mounted in a continuous row. The ballast fixture and slave-lamp fixture shall be factory wired with leads or plug devices to facilitate this circuiting. Individually mounted fixtures and the odd fixture in a row shall utilize a single-lamp ballast for operation of the center lamp.
 13. Dimming ballasts shall be as per above, except dimmable from 100% to 5% of rated lamp lumens.
- B. 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.
- C. Ballasts for high intensity discharge fixtures: Multi-tap voltage (120-480v) electromagnetic ballast for high intensity discharge lamps. Comply with ANSI C82.4 and UL 1029. Include the following features unless otherwise indicated:
1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single-lamp ballasts.
3. Rated Ambient Operating Temperature: 104 deg F (40 deg C).
4. Open-circuit operation that will not reduce average life.
5. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.3 LAMPS

A. Linear 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. Over the beds in Intensive Care, Coronary Care, Recovery, Life Support, and Observation and Treatment areas; Electromyographic, Autopsy (Necropsy), Surgery, and certain dental rooms (Examination, Oral Hygiene, Oral Surgery, Recovery, Labs, Treatment, and X-Ray) use color corrected lamps having a CRI of 85 or above and a correlated color temperature between 5000 and 6000°K.
 - b. Other areas as indicated on the drawings.

B. Compact Fluorescent Lamps:

1. T4, CRI 80 (minimum), color temperature 3500 K, and suitable for use with dimming ballasts, unless otherwise indicated.

C. Long Twin-Tube Fluorescent Lamps:

1. T5, CRI 80 (minimum), color temperature between 3500° and 4100°K, 20,000 hours average rated life.

2.4 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 fluorescent fixtures:

- a. Where the suspended ceiling system is supported at the four corners of the fixture opening, hardware devices shall clamp the fixture to the ceiling system structural members, or plaster frame at not less than four points in such a manner as to resist spreading of the support members and safely lock the fixture into the ceiling system.
- b. Where the suspended ceiling system is not supported at the four corners of the fixture opening, hardware devices shall independently support the fixture from the building structure at four points.

5. Hardware for surface mounting fluorescent fixtures to suspended ceilings:

- a. In addition to being secured to any required outlet box, fixtures shall be bolted to a grid ceiling system at four points spaced near the corners of each fixture. The bolts shall be not less than 1/4 inch [6mm] secured to channel members attached to and spanning the tops of the ceiling structural grid members. Non-turning studs may be attached to the ceiling structural grid members or spanning channels by special clips designed for the purpose, provided they lock into place and require simple tools for removal.
- b. In addition to being secured to any required outlet box, fixtures shall be bolted to ceiling structural members at four points spaced near the corners of each fixture. Pre-positioned 1/4 inch [6mm] studs or threaded plaster inserts secured to ceiling structural members shall be used to bolt the fixtures to the ceiling. In lieu of the above, 1/4 inch [6mm] toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.//

- 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.

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- 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. Exercise electronic dimming ballasts over full range of dimming capability by operating the control devices(s) in the presence of the Resident Engineer. Observe for visually detectable flicker over full dimming range.
 - H. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Government. Burn-in period to be 40 hours minimum, unless a lesser period is specifically recommended by lamp manufacturer. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage. Replace any lamps and ballasts which fail during burn-in.
 - I. At completion of project, relamp/reballast fixtures which have failed lamps/ballasts. Clean fixtures, lenses, diffusers and louvers that have accumulated dust/dirt/fingerprints during construction. Replace damaged lenses, diffusers and louvers with new.
 - J. Dispose of lamps per requirements of Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

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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

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.

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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. 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

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- 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

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.

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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.
- C. Section 26 41 00, FACILITY LIGHTNING PROTECTION: Requirements for a lightning protection system.

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

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.

- A. 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
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
 - 70-2005.....National Electrical Code (NEC)
- D. Telecommunications Industry Association, (TIA)
 - J-STO-607-A-2002.....Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- E. Underwriters Laboratories, Inc. (UL):
 - 44-2005Thermoset-Insulated Wires and Cables
 - 83-2003Thermoplastic-Insulated Wires and Cables
 - 467-2004Grounding and Bonding Equipment
 - 486A-486B-2003Wire 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

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

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 3/4 inch).

2.7 GROUND TERMINAL BLOCKS

At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.8 SPLICE CASE GROUND ACCESSORIES

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

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. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 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

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. 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 splice 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 COMMUNICATIONS 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.

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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. 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 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- H. 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

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

- A. 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.

- B. 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 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 Resident Engineer 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 Resident Engineer 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 Resident Engineer.

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 Resident Engineer 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 Section 09 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.

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".

3.11 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. Where 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).

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SECTION 27 08 00

COMMISSIONING OF COMMUNICATIONS SYSTEMS

PAET 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. Nurse Call / Code Blue systems (Local stations, system hardware and software, reset functions, response time per activation, and notification signals).
 2. Public Address and Mass Notification Systems (Amplifiers and head-end hardware, speaker volume, and background noise - i.e. hiss or similar interference).
 3. 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 -----

SECTION 27 10 00
STRUCTURED CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 RELATED WORK

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 27: Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- C. Conduits for cables and wiring: Section 27 05 33, RACEWAYS AND BOXES FOR COMMUNICATIONS SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.

1.3 SUBMITTALS

- A. 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. Install all wiring in raceway systems.
- B. 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 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.

3.3 CONTROL, COMMUNICATION AND SIGNAL SYSTEM IDENTIFICATION

- A. Install a permanent wire marker on each wire at each termination.
- B. Identifying numbers and letters on the wire markers shall correspond to those on the wiring diagrams used for installing the systems.
- C. Wire markers shall retain their markings after cleaning.
- D. In each manhole and handhole, install embossed brass tags to identify the system served and function.

3.4 EXISTING WIRING

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

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SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "*the System*"), and associated equipment and hardware to be installed in the VA Medical Center here-in-after referred to as "*the Facility*". The System shall include, but not be limited to: 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 Analog 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 support the following operating parameters:

a. Analog RF Service:

- 1) Broadcast or "off air" RF (or television) analog service is considered to be at RF (below 900 MHz in frequency bandwidth). Usually a RF television circuits require a single coaxial cable plant from the headend to each TC location.
- 2) Closed Circuit Analog Video Service: Analog video service is considered to be at baseband (below 100 MHz in frequency bandwidth). An analog video circuit requires a separate analog video from the audio connector. The following minimum operating parameters shall be capable over each installed analog video circuit:

Impedance	75 Ohm, unbalanced
Output Level	1.0 V peak to peak (P-P), for 87.5% depth of Modulation (Mod)
Diff Gain	±1 dB at 87.5% Mod
Diff Phase	±1.5 at 87.5% Mod
Signal to Noise (S/N) ratio	44 dB, minimum
Hum Modulation	-55 dB
Return Loss	-14 dB (or 1.5 Voltage Standing Wave Ratio [VSWR]), maximum
Isolation (outlet-outlet)	24 DB, MINIMUM
Bandwidth	6.0 MHz per channel, fully loaded, 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 27 51 16, PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS.
- H. 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
467	Grounding and Bonding Equipment
884	Underfloor Raceways and Fittings

- D. ANSI/EIA/TIA Publications:

568B	Commercial Building Telecommunications Wiring
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	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. International Telecommunication Union - Telecommunication Standardization Sector (ITU-T).
- F. Federal Information Processing Standards (FIPS) Publications.
- G. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.
- H. United States Air Force: Technical Order 33K-1-100 Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.
- I. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.
- J. 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. List of the equipment to be furnished.

QUANTITY	UNIT
As required	Cabinet Assembly(s)
As required	Environmental Cabinet
As required	Distribution/Interface Cabinet
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	System Connectors
As require/	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, and coaxial cable 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. Signal Level Meter.
 - b. Volt-Ohm Meter.

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. RF (F) 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. 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.
 5. 610 mm (2 ft.) section of each analog RF, video coaxial and audio cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
 6. Analog video CCS patch panel or breakout box with cable management equipment and "BNC" 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	Identifies the number of cable pair

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

c. Analog RF Cabling Requirements/Column Explanation:

Column	Explanation
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
TO FLOOR TC	Identifies building, by number or location, to which cabling is installed
NUMBER OF STRANDS	Identifies the number of strands in each run of RF 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, and analog RF 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.
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 and analog RF 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 and analog RF coaxial 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 is responsible for informing the Contractor regarding the minimum climate control requirements. In identified hostile TC locations where it has been determined (by the 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, one designated for data, in each TC location identified on the drawings, in lieu of providing additional required TC air handling capability.

B. System Performance:

1. Analog RF Service: Broadcast or "off air" RF (or television) analog service is considered to be at RF (below 900 mHz in frequency

bandwidth). Usually a RF television circuits require a single coaxial cable plant from the headend to each TC location.

- a. Isolation (outlet-outlet): 14 dB.
- b. Impedance: 75 Ohms, Unbalanced (UNBAL).
- c. Signal Level: 10 dBmV + 5.0 dBmV.
- d. Bandwidth: 6.0 MHz per channel, fully loaded.

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 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, or coaxial 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, or coaxial cable unterminated, unconnected, loose or unsecured.
 9. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING 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.

D. Equipment Functional Characteristics:

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

E. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Care performing Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials or equipment. See paragraph minimum requirements Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, 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 capacity 20 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 \pm 15%
Power capacity	20 AMP, 120 VAC
Voltage output regulation	\pm 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 1.0 mS at sub branch panels, 100 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 1.0 mS (or 12 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 standalone 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° \pm 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

a. 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

3. 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.
4. 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.

5. 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.

E. 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

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:

- A. Floor loading for batteries and cabinets.
- B. Minimum floor space and ceiling heights.
- C. Minimum size of doors for equipment passage.

- D. Power requirements: The bidders shall provide the specific voltage, amperage, phases, and quantities of circuits required.
- E. Air conditioning, heating, and humidity requirements. The bidder shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.
- F. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).
- G. Proposed floor plan based on the expanded system configuration of the bidder's proposed EPBX for this Facility.
- H. Conduit size requirement (between equipment room and console room).

2.4 INSTALLATION KIT

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:

- A. 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.

- B. 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.
- C. 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.
- D. 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.
- E. 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.
- F. 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.
- 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 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 analog 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 coaxial cables shall be terminated so any future changes only requires modifications of the existing 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 coaxial cables carrying analog signals in analog video systems.
 9. 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 Nurse Call, and PA 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 Clinic 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 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 cabling connections are in compliance with ANSI/EIA/TIA standards. Visually confirm marking of outlets, faceplates, outlet/connectors and patch cords.
2. 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.
3. 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.
4. 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) 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 UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has an overall shield. Test the operation of shorting bars in connection blocks. Test cables after termination and prior to cross-connection.
- E. Performance Testing:
1. Perform Category 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:

- F. Total System Acceptance Test: The Contractor shall perform verification tests for UTP copper cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.

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 possession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.
3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
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.

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SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the furnishing, installing, certification, testing, and guaranty of a complete and operating Voice and Digital Cable Distribution System (here-in-after referred to as "*the System*"), and associated equipment and hardware to be installed in the VA Medical Center here-in-after referred to as "*the Facility*". The System shall include, but not be limited to: 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, and analog radio frequency (RF) systems coaxial 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. Digital and Analog 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 support the following operating parameters:
 - a. EPBX connection:
 - 1) System speed: 1.0 gBps per second, minimum.
 - 2) Impedance: 600 Ohms.
 - 3) Cross Modulation: -60 deci-Bel (dB).
 - 4) Hum Modulation: -55 dB.
 - 5) System data error: 10 to the -10 Bps, minimum.
 - 6) Loss: Measured at the frame output with reference Zero (0) deciBel measured (dBm) at 1,000 Hertz (Hz) applied to the frame input.
 - a) Trunk to station: 1.5 dB, maximum.
 - b) Station to station: 3.0 dB, maximum.
 - c) Internal switch crosstalk: -60 dB when a signal of ± 10 deciBel measured (dBm), 500-2,500 Hz range is applied to the primary path.
 - d) Idle channel noise: 25 dBm "C" or 3.0 dBm "O" above reference (terminated) ground noise, whichever is greater.
 - e) Traffic Grade of Service for Voice and Data:
 - (1) A minimum grade of service of P-01 with an average traffic load of 7.0 CCS per station per hour and a traffic overload in the data circuits will not interfere with, or degrade, the voice service.
 - (2) Average CCS per voice station: The average CCS capacity per voice station shall be maintained at 7.0 CCS when the

EPBX is expanded up to the projected maximum growth as stated herein.

b. Telecommunications Outlet (TCO):

1) Voice:

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

2) Data:

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

3) Fiber optic:

- a) Isolation (outlet-outlet): 36 dB.
- b) Signal Level: 0 dBmV \pm 0.1 dBmV.
- c) System speed: 540 mBps, minimum.
- d) System data error: 10 to the -6 bps, minimum.

4) Analog RF Service:

- a) Broadcast or "off air" RF (or television) analog service is considered to be at RF (below 900 mHz in frequency bandwidth). Usually a RF television circuits require a single coaxial cable plant from the headend to each TC location.
- b) Isolation (outlet-outlet): 14 dB.
- c) Impedance: 75 Ohms, Unbalanced (UNBAL).
- d) Signal Level: 10 dBmV \pm 5.0 dBmV.
- e) Bandwidth: 6.0 mHz per channel, fully loaded.

5) Closed Circuit Analog Video Service: Analog video service is considered to be at baseband (below 100 mHz in frequency bandwidth). An analog video circuit requires a separate analog video from the audio connector. The following minimum operating parameters shall be capable over each installed analog video circuit:

Impedance	75 Ohm, unbalanced
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Output Level	1.0 V peak to peak (P-P), for 87.5% depth of Modulation (Mod)
Diff Gain	± 1 dB at 87.5% Mod
Diff Phase	± 1.5 at 87.5% Mod
Signal to Noise (S/N) ratio	44 dB, minimum
Hum Modulation	-55 dB
Return Loss	-14 dB (or 1.5 Voltage Standing Wave Ratio [VSWR]), maximum
Isolation (outlet-outlet)	24 DB, MINIMUM
Bandwidth	6.0 mHz per channel, fully loaded, minimum

- 6) Closed Circuit Analog Audio Service: Analog audio service is considered to be at baseband (below 10 mHz in frequency bandwidth). Usually an analog audio circuit requires separate audio connectors and video connectors even though both are considered baseband signals. However, since each TCO has multiple 600 (or 120) Ohm BAL line pairs, the analog audio circuit may be designated to one of the provided pairs of UTP or STP for each TCO and as shown on the drawings, in lieu of providing a separate baseband audio run to the TCO. The following minimum operating parameters shall be capable over each installed analog audio circuit:

Impedance	600 Ohm, BAL
Input Level	59 mV Root Mean Squared (RMS), minimum
Output Level	0 dBm
S/N ratio	55 dB, minimum
Hum Modulation	-50 dB, minimum
Return Loss	-14 dB (or 1.5 VSWR), maximum
Isolation (outlet-outlet)	24 DB, MINIMUM
Frequency Bandwidth	100 Hz - 10K Hz, 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 51 16, PUBLIC ADDRESS AND MASS NOTIFICATION SYSTEMS.
- I. Specification Section 27 41 31, MASTER ANTENNA TV EQUIPMENT AND 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. International Telecommunication Union - Telecommunication Standardization Sector (ITU-T).
- F. Federal Information Processing Standards (FIPS) Publications.
- G. Federal Communications Commission (FCC) Publications: Standards for telephone equipment and systems.
- H. United States Air Force: Technical Order 33K-1-100 Test Measurement and Diagnostic Equipment (TMDE) Interval Reference Guide.
- I. Joint Commission on Accreditation of Health Care Organization (JCAHO): Comprehensive Accreditation Manual for Hospitals.
- J. 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.

QUANTITY	UNIT
As required	Cabinet Assembly(s)
As required	Distribution/Interface Cabinet
As required	Cross Connection (CCS) Systems
As Required	Distribution Cables
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, and coaxial cable 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 Waveform Monitor.
 - h. Video Vector Scope.
 - i. Color Video Monitor with audio capability.
 - j. 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. Cover Plate installed.

- b. RF (F)/video installed.
 - 2. 610 mm (2 ft.) section of each analog RF, video coaxial and audio cable to be used with cable sweep tags as specified in paragraph 2.4.H and connectors installed.
 - 3. Analog video CCS patch panel or breakout box with cable management equipment and "BNC" connectors installed.
 - 4. Analog audio CCS patch panel or breakout box with cable management equipment and "XL" connectors installed.
 - 5. Analog RF patch panel or breakout box with cable management equipment and "F" 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. Connections (each CSU shall be compatible with) shall be compatible with the following:
 - a. Initially connect:

<u>EQUIPPED ITEM</u>	<u>CAPACITY</u>	<u>WIRED CAPACITY</u>
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		

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:

- c. Analog RF Cabling Requirements/Column Explanation:

Column	Explanation
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
TO FLOOR TC	Identifies building, by number or location, to which cabling is installed
NUMBER OF STRANDS	Identifies the number of strands in each run of RF 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

- d. Analog Video Cabling Requirements/Column Explanation:

Column	Explanation
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FROM BUILDING	Identifies building, by number or location, from which cabling is installed
TC ROOM NUMBER	Identifies the room, by number, from which cabling shall be installed
TO BUILDING IMC	Identifies building, by number or location, to which cabling is installed
TC ROOM NUMBER	Identifies the room, by number, to 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 analog RF service. The System shall:
 2. Cable Systems - and Analog RF Coaxial:
 - a. General:
 - 1) The Contractor shall be responsible for providing a new system conforming to current and accepted, analog RF 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 analog RF 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 Facility Chief of Medical Media Production Service (MMPS) to install baseband analog RF, video, and audio interface cables and circuits from each TC to designated TCO locations and as shown on the drawings. The Contractor shall work with the Facility Chief of

MMPS to establish circuits throughout the Facility and shall provide proper test equipment to guarantee that analog RF, video, and audio cables meet each OEM's standard transmission requirements, and guarantee the cables will carry analog video and audio 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.
3. Specific Subsystem Requirements: The System shall consist, as a minimum, of the following independent sub-systems to comprise a complete and functional analog RF 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.
 - 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. 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 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 analog RF coaxial 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 is responsible for informing the Contractor regarding the minimum climate control requirements. In identified hostile TC locations where it has been determined (by the 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 analog RF 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) 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 to earth ground at each cable's entry point in and out of the MTC and each IMTC.

c. 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 RF coaxial used in the intra-building backbone cabling system shall be designed according to the system requirements, OEM standards and guidelines, and as described herein. Analog RF coaxial trunk system shall be provided as a part of the System.

1) An analog RF coaxial cable trunk system shall be provided. A minimum of two coaxial cables shall be provided between the IMCCS and each Riser VCCS to comprise an individual circuit as designated and as shown on the drawings. Additional analog RF coaxial cables shall be provided as system design dictates and as shown on the drawings.

2) The analog RF coaxial trunk-line systems shall be connected between each IMCCS "bottom" row of "F" connectors and shall

terminate on the VCCS "top" row of "F" connectors on an appropriate patch panel. A minimum of six coaxial cables shall be provided in the riser trunk-line system.

- d. 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 analog RF coaxial used in the CCS system shall be designed according to the System requirements, OEM standards and guidelines, and as described herein. RF coaxial shall be provided as a part of the System.
- 1) The RF coaxial trunk-line cabling systems are that connected between the trunk-lines.
 - 2) The analog RF coaxial 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 "F" connectors for each analog RF coaxial cable.
 - d) The technical requirements of the VCCS and HCCS "patch", "terminating", or "breakout" panels and cable management assemblies for RF coaxial cables shall be as described in the above MCCS, IMCCS, and TC technical paragraphs.
 - 3) The analog RF coaxial cabling systems shall be connected between each IMCS and RTC shall terminate on the VCCS on the "top" row of "F" connectors on an appropriate patch panel. Additionally, each horizontal distribution analog RF coaxial cable shall terminate on the HCCS on the "bottom" row of "F" connectors of the same panel.
 - 4) The analog RF terminating panel(s) shall be the "patch" type. Each panel shall be the 19" EIA rack dimensions and provided with a minimum of 12 double female "F" connector rows. Each patch panel shall be provided with the expansion capability of a maximum of 24 double row "F" slots that can be field activated.

- 5) Each analog RF "patch" panel shall be provided inside a lockable cabinet or enclosure. Stacking of the "patch" panels is permitted as long as installation guidelines are met.
 - e. 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) The analog RF coaxial cables dedicated from the "bottom" row of "F" connectors of the appropriate VCCS patch panel where the "input" connections were made, to each floor TCO shall provided in the "home run" configuration and be sufficient to accommodate all the TCO's served by the HC distribution cable system minimum of one analog RF coaxial cable shall be provided for each TCO circuit and as shown on the drawings).
 - f. System Telecommunication Outlets (TCO): The System shall be capable of receiving the specified analog RF cable 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 one analog RF coaxial "F" connector. 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 analog RF cable to a female "F" connector provided on each TCO and as shown on the drawings and to each bottom row of "F" connectors on the HCCS patch panel(s) serving the area. The Contractor is not to "interconnect" VCCS and HCCS analog RF distribution cables OR provides active analog RF distribution equipment as a part of the System.
- B. System Performance:
- 1. At a minimum, the System shall be able to support the following analog RF operations Telecommunication Service:
 - a. Provide the following interchange (or interface) capabilities:

- 1) Wide (or Broad) Band:
 - a) All channels: 140 mega(m)-Bps, minimum, capable to 565 mBps at "T" reference.
 - b. System Sensitivity: Satisfactory service shall be provided for at least 3,000 feet for all analog RF locations.
2. At a minimum the System shall support the following operating parameters:
 - a. Telecommunications Outlet (TCO):
 - 1) Data:
 - a) Isolation (outlet-outlet): 24 dB.
 - b) Impedance: 600 Ohms, BAL.
 - c) Signal Level: 0 dBmV \pm 0.1 dBmV.
 - 2) Analog RF Service: Broadcast or "off air" RF (or television) analog service is considered to be at RF (below 900 mHz in frequency bandwidth). Usually a RF television circuits require a single coaxial cable plant from the headend to each TC location.
 - a) Isolation (outlet-outlet): 14 dB.
 - b) Impedance: 75 Ohms, Unbalanced (UNBAL).
 - c) Signal Level: 10 dBmV \pm 5.0 dBmV.
 - d) Bandwidth: 6.0 mHz per channel, fully loaded.

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. 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.
 5. All passive distribution equipment shall meet or exceed -80 dB radiation shielding specifications.
 6. All interconnecting coaxial 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 coaxial cable unterminated, unconnected, loose or unsecured.
 7. Color code all distribution wiring to conform to the Telephone Industry standard, EIA/TIA, and this document, whichever is the more stringent. At a minimum, all equipment, cable duct and/or conduit, enclosures, wiring, terminals, and cables shall be clearly and permanently labeled according to and using the provided record drawings, to facilitate installation and maintenance. Reference Specification Section 27 10 00, STRUCTURED CABLING.
 8. 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.
 9. 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.

10. All equipment faceplates utilized in the System shall be stainless steel, anodized aluminum, or UL approved cycolac plastic for the areas where provided.
11. 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.

D. Equipment Functional Characteristics:

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

E. Equipment Standards and Testing:

1. The System has been defined herein as connected to systems identified as Critical Care performing Life Support Functions. Therefore, at a minimum, the system shall conform to all aforementioned National and/or Local Life Safety Codes (which ever are the more stringent), NFPA, NEC, this specification, JCAHCO Life Safety Accreditation requirements, and the OEM recommendations, instructions, and guidelines.
2. All supplies and materials shall be listed, labeled or certified by UL or a nationally recognized testing laboratory where such standards have been established for the supplies, materials or equipment. See paragraph minimum requirements Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS, 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 baseband analog RF, video, or jack 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 analog RF, video, and audio connections shall be "F", "BNC", or "XL" female types respectively.
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 analog jack(s) and the outlet box provided (100mm (4in.) x 100mm (4in.) for single and 100mm (4in.) x 200mm (8in.) for dual outlet box applications). For PBPV installations, the cover plate shall be stainless steel.
6. Interface of the analog RF "F", video "BNC", and audio "XL" jacks to appropriate patch panels in the associated RTC, is the responsibility of the Contractor. The Contractor shall not cross-connect analog cables in the RTCs to analog equipment or install active analog equipment.

- ### **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
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2. 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.

3. General Purpose Analog RF:

- a. The coaxial cable shall be an RG-6/U type (or equal), minimum and shall be increased in size (i.e. RG-11/U, .500", .750", etc.) as required to meet system design. It may also be used for baseband signals as approved by the OEM.
- b. Technical Characteristics:

Impedance	75 OHM, UNBAL
Center conductor	20 AWG, solid or stranded copper, or copper plated steel or aluminum
Dielectric	Cellular polyethylene
Shield coverage	95%, copper braid
Connector type	BNC or UHF
Attenuation	
Frequency (k or mHz)	Maximum dB/30.5M (100ft.)
10 kHz	0.20
100 kHz	0.22
1.0 kHz	0.25
4.5 mHz	0.85
10.0 mHz	1.40
100 mHz	5.00 //

4. Public Address and/or General Purpose Audio:

- a. The audio cable shall be two-conductor, STP cable with stranded conductors. The cable shall be able to handle the power used for the load impedance over the distance required, with not more than 5% power loss. This cable is to be provided in local PA areas only and is not to be used as a part of the telephone system.
- b. Technical Characteristics:

Impedance	70.7VRMS audio signal
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Wire size	20 AWG, minimum
Working shield	350 V
Color coding	Required, EIA audio industry standard
Connectors	As required
Bend radius	10X the cable outside diameter
Impedance	100 Ohms \pm 15%, BAL
Bandwidth	20 MHz, minimum
DC resistance	10.0 Ohms/100M (330 ft.), 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

C. Outlet Connection Cables:

1. Analog RF:

- a. The Contractor shall provide a connection cable for each TCO analog RF connector in the System with 10% spares. The analog RF connection cable shall connect a analog RF instrument to the TCO analog RF jack. The Contractor shall not provide analog RF equipment.

b. Technical Characteristics:

Length	1.8M (6 ft.), minimum
Cable	Flexible RG-6/U, minimum
Connector	"F" male on each end

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. "BNC" Type:

- a. The BNC connector shall have a bayonet locking coupling for quick connect/disconnect of coaxial cable/termination's. It shall be a crimp-on (twist on are acceptable) connector designed to fit the coaxial cable furnished.
- b. Technical Characteristics:

Impedance	50 or 75 Ohms, UNBAL
Working Voltage	500 V

4. "F" Type:

- a. The "F" connector shall have a screw type coupling for quick connect/disconnect of coaxial cable/termination's. It shall be a crimp-on connector designed to fit the coaxial cable furnished with integral 12.7 mm ($\frac{1}{2}$ in.) ferrule.
- b. Technical Characteristics:

Impedance	75 Ohms, UNBAL
Working Voltage	500 V

5. "XL" Type:

- a. The XL connector shall have three solder pins (screw types are acceptable) with a metal cover to firmly attach to the connector and cable protecting the internal connections. It shall be a coupling for quick connect/disconnect of audio cable/termination's. It shall be a connector designed to fit the coaxial cable furnished.
- b. Technical Characteristics:

Impedance	120 or 600 Ohms, BAL
Working Voltage	500 V

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

2.3 TELECOMMUNICATIONS CLOSET REQUIREMENTS

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

2.4 ENVIRONMENTAL REQUIREMENTS

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:

- A. Floor loading for batteries and cabinets.
- B. Minimum floor space and ceiling heights.
- C. Minimum size of doors for equipment passage.
- D. Power requirements: The bidders shall provide the specific voltage, amperage, phases, and quantities of circuits required.
- E. Air conditioning, heating, and humidity requirements. The bidder shall identify the ambient temperature and relative humidity operating ranges required preventing equipment damage.
- F. Air conditioning requirements (expressed in BTU per hour, based on adequate dissipation of generated heat to maintain required room and equipment standards).
- G. Proposed floor plan based on the expanded system configuration of the bidder's proposed EPBX for this Facility.
- H. Conduit size requirement (between equipment room and console room).

2.5 INSTALLATION KIT

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, cable reels, conduit, cable tray, and/or cable duct bundles, wire rolls, physical installation hardware. The following are the minimum required installation sub-kits:

A. 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. Equipment Racks.
 - d. Equipment Cabinets.
 - e. Conduits.
 - f. Duct.
 - g. Cable Trays.
 - h. Power Panels.
 - i. Connector Panels.
 - j. Grounding Blocks.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

- 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 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 analog 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 coaxial cables shall be terminated so any future changes only requires modifications of the existing 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 coaxial cables carrying analog signals in telephone analog video 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.

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- 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, Nurse Call, PA, and Radio Paging 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 that are installed in appropriate bulkhead connector panels.
- b. 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.
- c. 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 its 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 grommets.
- 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.

1. Wires or cables installed outside of conduit, cable trays, wireways, cable duct, etc.

- 1) Only when specifically authorized as described herein, will wires or cables be identified and approved to be installed outside of conduit. The wire or cable runs shall be UL rated plenum and OEM certified for use in air plenums.
- 2) Wires and cables shall be hidden, protected, fastened and tied at 600 mm (24 in.) intervals, maximum, as described herein to building structure.
- 3) Closer wire or cable fastening intervals may be required to prevent sagging, maintain clearance above suspended ceilings, remove unsightly wiring and cabling from view and discourage tampering and vandalism. Wire or cable runs, not provided in conduit, that penetrate outside building walls, supporting walls, and two hour fire barriers shall be sleeved and sealed with an approved fire retardant sealant.
- 4) Wire or cable runs to system components installed in walls (i.e.: volume attenuators, circuit controllers, signal, or data outlets, etc.) may, when specifically authorized by the RE, be fished through hollow spaces in walls and shall be certified for use in air plenum areas.

E. Outlet Boxes, Back Boxes, and Faceplates:

1. Outlet Boxes: Signal, power, interface, connection, distribution, and junction boxes shall be provided as required by the system design, on-site inspection, and review of the contract drawings.
2. Back Boxes: Back boxes shall be provided as directed by the OEM as required by the approved system design, on-site inspection, and review of the contract drawings.
3. Face Plates (or Cover Plates): Faceplates shall be of a standard type, stainless steel, anodized aluminum or UL approved cycloac 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. 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.
 - b. 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 pin assignments and cabling connections are in compliance with ANSI/EIA/TIA standards. Visually confirm marking of outlets, faceplates, outlet/connectors and patch cords.

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 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.

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 backbone coax cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield.

E. Total System Acceptance Test: The Contractor shall perform verification tests for coax cabling system(s) after the complete telecommunication distribution system and workstation outlet are installed.

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 possession of the building(s)), that certifies each item of equipment installed conforms to OEM published specifications.
2. The Contractor's maintenance personnel shall have the ability to contact the Contractor and OEM for emergency maintenance and logistic assistance, remote diagnostic testing, and assistance in resolving

technical problems at any time. The Contractor and OEM shall provide this contact capability at no additional cost to the VA.

3. All Contractor installation, maintenance, and supervisor personnel shall be fully qualified by the OEM and must provide two (2) copies of current and qualified OEM training certificates and OEM certification upon request.
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.

C. 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.

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MEP

DIVISION 28 00 00

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 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

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 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 the GENERAL CONDITIONS.

1.8 EQUIPMENT INSTALLATION AND REQUIREMENTS

- A. Equipment location shall be as close as practical to locations shown on the drawings.
- B. Inaccessible Equipment:
 - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, the equipment shall be removed and reinstalled as directed at no additional cost to the Government.

2. "Conveniently accessible" is defined as being capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as, but not limited to, motors, pumps, belt guards, transformers, piping, ductwork, conduit and raceways.

1.9 EQUIPMENT IDENTIFICATION

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

1.10 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. The Government's approval shall be obtained for all equipment and material before delivery to the job site. Delivery, storage or installation of equipment or material which has not had prior approval will not be permitted at the job site.
- C. All submittals shall include adequate descriptive literature, catalog cuts, shop drawings and other data necessary for the Government to ascertain that the proposed equipment and materials comply with specification requirements. Catalog cuts submitted for approval shall be legible and clearly identify equipment being submitted.
- D. Submittals for individual systems and equipment assemblies which consist of more than one item or component shall be made for the system or assembly as a whole. Partial submittals will not be considered for approval.
 1. Mark the submittals, "SUBMITTED UNDER SECTION_____".
 2. Submittals shall be marked to show specification reference including the section and paragraph numbers.
 3. Submit each section separately.
- E. The submittals shall include the following:
 1. Information that confirms compliance with contract requirements. Include the manufacturer's name, model or catalog numbers, catalog information, technical data sheets, shop drawings, pictures, nameplate data and test reports as required.

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

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.
- 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

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.

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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. Sealing around penetrations to maintain the integrity of time rated construction: Section 07 84 00, FIRESTOPPING.
- B. General electrical requirements that are common to more than one section in Division 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- C. Conduits for cables and wiring: Section 28 05 33, RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY.
- D. 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 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.

3.3 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 EXISTING WIRING

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

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SECTION 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.
- E. 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

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.

- A. 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
- B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
81-1983.....IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- C. National Fire Protection Association (NFPA):
70-2005.....National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
44-2005Thermoset-Insulated Wires and Cables
83-2003Thermoplastic-Insulated Wires and Cables
467-2004Grounding and Bonding Equipment
486A-486B-2003Wire 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

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

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

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

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

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

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

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. 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.

3.9 GROUNDING FOR RF/EMI CONTROL

- A. Install bonding jumpers to bond all conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers shall consist of 100 mm (4 inches) wide copper strip or two 6 mm² (10 AWG) copper conductors spaced minimum 100 mm (4 inches) apart. Use 16 mm² (6 AWG) copper where exposed and subject to damage.
- B. Comply with the following when shielded cable is used for data circuits.
 - 1. Shields shall be continuous throughout each circuit.
 - 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
 - 3. Do not connect shields from different circuits together.
 - 4. Shield shall be connected at one end only. Connect shield to signal reference at the origin of the circuit. Consult with equipment manufacturer to determine signal reference.

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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. Mounting board for communication closets: Section 06 10 00, ROUGH CARPENTRY.
- 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 28: Section 28 05 11, REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATIONS.
- G. 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

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

- A. 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.

- B. 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.
 - a. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are also acceptable.
 - b. Locknuts: Bonding type with sharp edges for digging into the metal wall of an enclosure.
 - c. 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.
 - d. 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.
 - e. 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

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- 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. Surface metal raceway fittings: As recommended by the raceway manufacturer.
7. 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.

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- 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.

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 Resident Engineer 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 Resident Engineer 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 Resident Engineer.

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 Resident Engineer 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 Section 09 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.

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. 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. Where 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
$\frac{3}{4}$	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 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).

- - - E N D - - -

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. 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, heat 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 -----

SECTION 28 13 11
PHYSICAL ACCESS CONTROL SYSTEM (PACS)

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an extension to an existing 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 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 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 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 control and operation of all security systems, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.
- L. For security camera systems, 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 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):
- AC-01.....Access Control: Wiegand Card Reader Interface
Standard
 - AC-03.....Access Control: Badging Techniques
- C. American National Standards Institute (ANSI)/ International Code Council (ICC):
- A117.1.....Standard on Accessible and Usable Buildings and
Facilities
- D. Department of Justice American Disability Act (ADA)
- 28 CFR Part 36-90.....ADA Standards for Accessible Design
- E. Government Accountability Office (GAO):
- GAO-03-8-02.....Security Responsibilities for Federally Owned
and Leased Facilities
- F. National Electrical Contractors Association
- 303-2005.....Installing Closed Circuit Television (CCTV)
Systems

- G. National Electrical Manufacturers 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
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

O. Uniform Federal Accessibility Standards (UFAS) 1984

P. ADA Standards for Accessible Design 1994

1.6 WARRANTY OF CONSTRUCTION.

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, combustibile 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. 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
- D. 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.

E. 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	17" SVGA

Adapter board	(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

F. 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	EMPI 26 or 34-bit
Output Format	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.
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.

G. 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

H. 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 than 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.

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- 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 than 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.

- a. 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.

I. 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.

J. 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).
11. 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

K. 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.

L. 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

M. 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

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.

- E. Integration with these security subsystems shall be achieved by computer programming or the direct hardwiring of the systems.
- F. 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.
- 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 system. The Contractor shall not take any corrective action without written permission from the Government.
- H. 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.
- I. 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.
- J. 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.
- K. 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.
- L. 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.
- M. 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.
- N. 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.

O. Biometrics:

1. Connect all signal input and output cables along with all power cables.
2. Program and ensure the device is in operating order.

P. 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.

Q. 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).

R. 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.

S. 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.
- T. 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

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

SECTION 28 13 16
ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an addition to an existing 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 Manufacturers 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
ADA Standards for Accessible Design 1994

1.6 WARRANTY OF CONSTRUCTION.

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. 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.

C. 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 clearly 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.
 14. 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	6 sq. ft.	6 sq. ft.	6 sq. ft.
Clearance	from	from	from center
	center of	center of	of Console
	Console	Console	Slope front
	Slope	Slope	
	front	front	
Distance	96 in.	96 in.	96 in. (240
Between	(240 cm)	(240 cm)	cm)
Console Rows			
Distance	36 in. (90	36 in.	36 in. (90
Between	cm) from	(90 cm)	cm) from the
Console and	the rear	from the	rear and/or
Wall	and/or	rear	side of
	side of	and/or	console or
	console or	side of	rack
	rack	console	
		or rack	

D. 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 of 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. There 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.
- E. 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.

F. 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

G. 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.

H. 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

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

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

SECTION 28 13 53
SECURITY ACCESS DETECTION

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an addition to an existing Detection and Screening System, hereinafter 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.
- D. 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
- E. 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.
- F. 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.
- G. 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.
- H. 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.
- I. 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 Manufacturers 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 500-101Care 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.

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.

H. 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

9. 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 10 seconds after access of touchpad
Tamper alarm	
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	Monitor up to
Capabilities	4 scanners
Capabilities	Change settings LED bar-graph display Functionality Program in operation Errors Traffic Count Alarm activations Alarm Percentages Technician trouble-shoot
Access	Dual-level
Control	access codes Operators Supervisory

I. 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.

J. 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 conveyor 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
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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

K. 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.
- c. Detector shall be a simple push-button automatic operation that displays go/no go results on a LCD display.

- d. 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	Nanogram levels of:
Capabilities	1) Explosives: PETN, RDX,TNT, NG, Dynamite, Semtex, C4 2) Narcotics: Cocaine, Opiates (heroin & 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

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

SECTION 28 16 11
INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an addition to an existing 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-01-00Control 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 Manufacturers 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.

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.
- 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 $\frac{1}{4}$ - $\frac{1}{2}$ 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	Single and
ability	multi-pane
	glass, wired
	glass,
	tempered and
	laminated
	glass to $\frac{1}{4}$
	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.
- The detector shall provide multiple detection zones distributed at a variety of angles and distance.
 - 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	Eight (8)
heights	ft. (2.4 m) - 18 ft (5.4 m)
Sensitivity	Three (3)
adjustments	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 resistor 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.
- The mat shall be easily interfaced directly to a micro-sensor controller.
 - Shall be sealed on all edges and pre-wired and made of durable material that is waterproof for indoor/outdoor use.
 - 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.
 - Shall have a slip resistant surface with four (4) lead fail-safe wiring.
 - Mat detectors shall be resistant to water and dust and the wiring circuitry shall be capable of direct supervision.
 - Pressure Mat Detector Technical Characteristics:

Operating Voltage	15 VDC AC with max current 20
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	mA
Activation	80 lbs.
Weight	(36.28kg. per 3 in. (76.2mm) square
Activation	500,000
Lifespan	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	110 VAC 60 HZ 2
Power	amp
Output	12 VDC Nominal
Voltage	(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	4 amp max. @
Current	13.8 VDC
	3 amp max. @
	27.6 VDC
Battery	3.5 A @ 250 VAC
Fuse	
Size	
Charging	Built-in
Circuit	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 Manufacturers 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. Lightning 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%.
- 6. 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. 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.
 - e. Signal processing equipment shall be separately mounted such that no desensitized zones are created within the zone of detection.
7. Microwave: Do not install microwave sensors where fluorescent lights may pose a problem due to radiated ionization from lights.

3.2 TESTS AND TRAINING

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

SECTION 28 23 00
VIDEO SURVEILLANCE

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install an addition to an existing Video Surveillance System, which is identified as the Closed Circuit Television System hereinafter referred to as the CCTV System 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, 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 providing, 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.

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 of 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)
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16. P/T/Z Cameras Technical Characteristics:

Effective Pixels	768 (H) x 494 (V)
Scanning Area	1/4-type CCD
Synchronization	Internal/Line-lock/Multiplexed Vertical Drive (VD2)
Video Output	1.0 v[p-p] NTSC composite/75 ohm
H. Resolution	570-line at B/W, or 480-line at color imaging
Signal-to-noise Ratio	50dB (AGC off, weight on)
Super Dynamic II	64 times (36dB) (selectable on/off)
Minimum Illumination	0.06 lx (0.006 fc) at B/W, 1 lx(0.1 fc)
Zoom Speed	Approx. 2.1s (TELE/WIDE) in sequence mode
Focus Speed	Approx. 2s (FAR/NEAR) in sequence mode
Iris	Automatic (Open/Close is possible)/manual
Maximum Aperture Ratio	1:1.6 (Wide) ~ 3.0 (Tele)
Focal Length	3.79 ~ 83.4 mm
Angular Field of View	H 2.6° ~ 51.7° V 2.0° ~ 39.9°
Electronic Shutter	1/60 (off), 1/100, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 s
Zoom Ratio	Optical 22x w/10x electronic zoom
Iris Range	F1.6 ~ 64, Close
Panning Range	360° endless
Panning Speed	Manual: Approx. 0.1°/s ~ 120°/s 16 steps
Tilting Range	0 ~ 90° (Digital Flip off), 0 ~180° (Digital Flip on)
Tilting Speed	Manual: Approx. 0.1°/s ~ 120°/s. 16 steps
Pan/Tilt	Manual/Sequential position/Auto

	Pan
Controls	Pan/Tilt, Lens, 64 Preset Positions, Home Position
Video Connector	BNC
Controller I/F	Multiplex-coaxial

17. 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 (ICMP), 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 compliant
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18. Wireless Cameras

- a. Prior to installation of any wireless camera, ensure operating frequency is given full approval by the VA controlling authority. Wireless cameras shall be utilized as either part of a CCTV network or a standard analog system.
- b. Power for a wireless camera will be 110 VAC tied into a dedicated circuit breaker on a power panel that is dedicated to the security system and is fed from a power source with back-up in the event primary power to the CCTV System is lost. Power will be run to the camera and connected at both ends in accordance with Division 26 of the VA Master Specification and the VA Electrical Manual. In addition, wireless systems are line of sight dependant and all considerations for environmental layout must be taken into consideration prior to design, engineering, and installation of this type of camera system. Proximity to transmitting and receiving devices, cell phone towers, and any and all electrical devices can also cause interference with the camera signal and must be considered in advance.
- c. Shall be located within a minimum of one quarter of a mile from the receiving unit. Repeaters shall be used as required to ensure the strongest possible signal between transmitters and receivers.
- d. Shall be Federal Communication Commission (FCC) approved and compliant.
- e. If using wireless cameras, the following equipment shall be utilized to ensure operation of the system:
 - 1) Receiver
 - 2) Receiver antenna as required
 - 3) Repeater as required
 - 4) Mounting Hardware
- f. Receivers shall only handle up to four (4) cameras per unit.
- g. Technical Characteristics
 - 1) Wireless Cameras:

Imaging Device	1/3-inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)
Sensing Area	6 mm diagonal
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
Frequency range	2.41-2.47GHz
Modulation	FM
Video signal/noise ratio	48dB
Audio signal/noise ratio	45db
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
Lens Mount	C/CS mount (adjustable)

2) Receivers

Frequency range	2.4-2.49GHz
Video output	1V P/P
Signal/noise ratio	38dB

- 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. Video Display Equipment

1. Will consist of color monitors and shall be EIA 375A compliant.
2. Shall be able to display analog, digital, and other images in either NTSC or MPEG format associated with the operation of the Security Management System (SMS).
3. Shall:
 - a. Have front panel controls that provide for power on/off, horizontal and vertical hold, brightness, and contrast.
 - b. Accept multiple inputs, either directly or indirectly.
 - c. Have the capabilities to observe and program the CCTV System.
 - d. Be installed in a manner that they cannot be witnessed by the general public.

4. Color Video Monitors Technical Characteristics:

Sync Format	PAL/NTSC
Display Tube	90° deflection angle
Horizontal Resolution	250 TVL minimum, 300 TVL typical
Video Input	1.0 Vp-p, 75 Ohm
Front Panel Controls	Volume, Contrast, Brightness, Color
Connectors	BNC

5. Liquid Crystal Display (LCD) Flat Panel Display Monitor

a. Technical Characteristics:

Sync Format	PAL/NTSC
LCD Panel	TFT LCD
Resolution	1280 x 1024 pixels; 500 TV
Contrast Ratio (CR)	500:1
Viewing Angle	140° horizontal, 130°

	vertical
Video Input	(CVBS) 1.0 Vp-p (0.5-1.5 Vp-p), 75 Ohm Y/C (S-video) 0.7 Vp-p, 0.3 Vp-p, 75 Ohm
Video 1	Composite video two (2) BNC (1 in, 1 out)
Video 2	Composite video two (2) BNC (1 in, 1 out)
Y/C (S-video)	two (2) mini-dins, 4-pin (1 in, 1 out)

H. Camera Housings and Mounts:

1. This section pertains to all interior and exterior housings, domes, and applicable wall, ceiling, corner, 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.

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- 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 than 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 not 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.

I. 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) Po	6-conductor modular jack x 12 (2- wire or 4-wire communication, With termination

rt	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.
- 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
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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

1. 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 Certification s	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

J. 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.
4. Digital Video Recorder (DVR):
 - a. Shall record video to a hard drive-based digital storage medium in either NTSC or MPEG format.
 - b. Shall meet the following minimum requirements:
 - 1) Record at minimum rate of 30 images per second (IPS).
 - 2) Have a minimum of eight (8) to 16 looping inputs.

- 3) Have a minimum of eight (8) to 16 alarm inputs and two (2) relay outputs.
- 4) Shall provide instantaneous playback of all recorded images.
- 5) Be IP addressable, if part of a CCTV network.
- 6) Have built-in digital motion detection with masking and sensitivity adjustments.
- 7) Provide easy playback and forward/reverse search capabilities.
- 8) Complete audit trail database, with minimum of a six-month history that tracks all events related to the alarm; specifically who, what, where and when.
- 9) DVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
- 10) Accessible locally and remotely via the Internet, Intranet, or a personal digital assistant (PDA).
- 11) Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.
- 12) Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
- 13) Allow for independently adjustable frame rate settings.
- 14) Be compatible with the matrix switcher utilized to operate the cameras. The DVR could be utilized as a matrix switcher only if it meets all of the requirements listed in the matrix switcher section.

c. Technical Characteristics:

Processor	Intel Pentium III 750 MHz
Memory	256 MB RAM
Operating System	Windows 98, NT, ME, 2000, and XP
Video Card	4 MB of RAM capable of 24-bit true color display
Free Hard Disk Space	160 MB for software installation
Network Card	10Base-T network for LAN operation
Archiving	80 GB, 160 GB, 320 GB and 640 GB Hard Drive; CD-RW
Video Input	1.0 Vpp (signal 714mV, sync 286mV) 75 ohms (BNC unbalanced)
Video Output	1.0 Vpp +/-10%, 75 ohms (BNC)

Level	unbalanced)
Impedance	75 ohms/Hi- impedance x 16 switchable
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

5. Network Video Recorder (NVR)

- a. Shall record video to a hard drive-based digital storage medium in MPEG format.
- b. Shall meet the following minimum requirements:
 - 1) Record at minimum rate of 30 IPS.
 - 2) Have a minimum of eight (8) to 16 looping inputs.
 - 3) Have a minimum of eight (8) to 16 alarm inputs and two (2) relay outputs.
 - 4) Shall provide instantaneous playback of all recorded images.
 - 5) Be IP addressable, if part of a CCTV network.
 - 6) Have built-in digital motion detection with masking and sensitivity adjustments.
 - 7) Easy playback and forward/reverse search capabilities.
 - 8) Complete audit trail database, with minimum of a six-month history that tracks all events related to the alarm; specifically who, what, where and when.
 - 9) NVR management capability providing automatic video routing to a back-up spare recorder in case of failure.
 - 10) Accessible locally and remotely via the internet, intranet, or a personal digital assistant (PDA).
 - 11) Records all alarm events in real time, ensuring 60 seconds before and after the event are included in the recording.

- 12) Utilize RS-232 or fiber optic connections for integration with the SMS computer station via a remote port on a network hub.
- 13) Allow for independently adjustable frame rate settings.
- 14) Be compatible with the matrix switcher utilized to operate the cameras.

c. Technical Characteristics:

Hardware/CPU	Pentium III Xeon or IV, 1.8 GHz
HDD Interface	IDE or better; optional: SCSI II, SCSI Ultra, or Fiber Channel
RAM	1024 MB
Operating System	Windows 2000/XP Professional/Server 2003 Standard
Graphic	Card VGA
Ethernet Card	100/1000 MB
Memory	20 MB
Software Setup	Centralized setup from each authorized PC; access via VIDOS or integrated web server
Storage Media	All storage media possible (e.g., HD, RAID), depending on operating system
Storage Mode	Linear mode, ring mode (capacity-based)
Recording Configuration	Camera name assignment, bandwidth limit, frame rate, video quality
Recording Content	Video and/or audio data
Search Parameters	Time, date, event
Playback	Playback via VIDOS over any IP network (LAN/WAN) simultaneous recording, playback, and backup
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

6. Time Lapse Video Recorder (VCR)

- a. Shall be specifically designed as a time lapse recorder within the CCTV System and shall meet the following minimum requirements:
- 1) Allow for repeat recording.
 - 2) Allow for series recording with multiple recorders.
 - 3) Be able to record Daily/Weekly/Holiday schedules.
 - 4) Jog/Shuttle for easy forward or reverse field playback.
 - 5) Search using alarm index, time and date, skip, counter memory stop.
 - 6) Have a built in time and date generator that can be turned on and off, and shall impose the time and date on the video during recording.
 - 7) Have a built in alarm that shall annunciate the end of tape, excessive condensation, transport malfunction, or tape jam.
 - 8) Have on-screen programming.
 - 9) Interface with the matrix switcher.
 - 10) Have automatic head cleaning.
 - 11) Have battery backup for internal settings.
 - 12) Have a tape use counter.
 - 13) Have a daylight saving time setting.
- b. Video tape used in the recorder shall:
- 1) Be contained in a cassette mechanism.
 - 2) Be self loading and not require the operator the thread the tape.
 - 3) Load through the front of the recorder.
 - 4) Be labeled with the date and times of coverage.
 - 5) Stored for a period not less then that specified in the VA CCTV standards.
- c. Shall be locally installed at the monitoring station.
- d. Technical Characteristics:

Tape Format	Standard 1/2 inch VHS
Video Recording Standard	6/8 Hour in NTSC
Time Lapse Recording	18/30/54/78/102/126/174 or 24/40/72/104/136/160/232 hour
Video Recording System	Rotary 2-head azimuth
Video Head Configuration	4-head double azimuth Tape Transport
Rewind/FF Speed	Within 120 seconds (with T-

	120 VHS tape)
Head Cleaning	Automatic
Record/Playback	Time Mode (EP) 6H, L18H, L30H, 48H, 72H, 96H, 0H
Horizontal Resolution	(SR Mode) 400 lines (VHS Mode) 240 lines
Video Input/Output	(BNC) 1.0 Vp-p, 75 Ohm
Audio System Record/Playback	6H, L18H, L30H
Timer Recording	8 event programmability
Display	Month/Day/Year and Time

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

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- station, shall not be less than 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 volts 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 μ H/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

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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 μ H/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
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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 with standard RJ-45 connector at each end. The cable must 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
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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

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- 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

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.

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- 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. 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 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. 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. 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, and Mounts:

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 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.
3. Connect signal lines and AC power to the housing interfaces.

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.

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- 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

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

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SECTION 28 26 00
ELECTRONIC PERSONAL PROTECTION SYSTEM (EPPS)

PART 1 - GENERAL

1.1 DESCRIPTION

Provide and install complete Duress-Panic Alarms, Emergency Phones, 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 connections, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).
- D. For infrastructure, Section 26 05 36, CABLE TRAYS FOR ELECTRICAL SYSTEMS.
- E. For other communication systems, Section 27 05 11, REQUIREMENTS FOR COMMUNICATIONS INSTALLATIONS.
- F. For grounding of equipment, Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- G. For infrastructure, Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- H. For cabling requirements, Section 27 15 00, COMMUNICATIONS HORIZONTAL CABLING.
- I. For routing requirements, Section 27 31 00, VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT.
- J. For integration with PACS, Section 28 13 11, PHYSICAL ACCESS CONTROL SYSTEM (PACS).
- K. For integration with IDS, Section 28 16 11, INTRUSION DETECTION SYSTEM (IDS).
- L. For security cameras, Section 28 23 00, VIDEO SURVEILLANCE.
- M. For monitoring of equipment, Section 28 13 16, ACCESS CONTROL SYSTEM AND DATABASE MANAGEMENT.
- 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 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 Manufacturers 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.

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 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 AND 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.

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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	0° to 110°F
Range	(-17.8°C to 43.3°C)
Nominal	12 V DC @ 6
Voltage	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

O. Security Intercoms:

1. Shall be utilized to assist in controlling entry to 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	-4°F to +149°F (-20°C to +65°C)
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 intercom 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 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

All testing and training shall be compliant with the VA General Requirements, Section 01 00 00, GENERAL REQUIREMENTS.

-----END-----

MEP

DIVISION 28 00 00

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 s identify which buildings shall have an automatic digitized voice fire alarm signal with emergency manual voice override to notify occupants to evacuate. The digitized voice message shall identify the area of the building (smoke zone) from which the alarm was initiated.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the existing main fire alarm system control unit.
- 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.
- 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 08 71 00, DOOR HARDWARE: Combination Closer-Holders.
- E. Section 09 91 00, PAINTING: Painting for equipment and existing surfaces.
- F. Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS: Sprinkler systems.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.
- H. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.
- I. 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 AutoCAD Release 14 software 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),

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- 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 blue-line 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

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. 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.

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.

2.6 VOICE COMMUNICATION SYSTEM (VCS)

A. General:

1. An emergency voice communication system shall be installed throughout the project area.
2. Upon receipt of an alarm signal from the building fire alarm system, the VCS shall automatically transmit a pre-recorded fire alarm message throughout the floor in alarm, the floor above, and the floor below.
3. A digitized voice module shall be used to store each prerecorded message.
4. The VCS shall be arranged as a single channel system.
5. The VCS shall supervise all speaker circuits, control equipment, remote audio control equipment, and amplifiers.

B. Speaker Circuit Arrangement:

1. Speaker circuits shall be arranged such that there is one speaker circuit per smoke zone.
2. Audio amplifiers and control equipment shall be electrically supervised for normal and abnormal conditions.
3. Speaker circuits shall be either 25 VRMS or 70.7 VRMS with a minimum of 50% spare power available.
4. Speaker circuits and control equipment shall be arranged such that loss of any one speaker circuit will not cause the loss of any other speaker circuit in the system.

C. Digitized Voice Module (DVM):

1. The Digitized Voice Module shall provide prerecorded digitized evacuation and instructional messages. The messages shall be professionally recorded and approved by the COTR prior to programming.
2. The DVM shall be configured to automatically output to the desired circuits following a 10-second slow whoop alert tone.

3. Prerecorded magnetic taped messages and tape players are not permitted.
4. The digitized message capacity shall be no less than 15 second in length.
5. The digitized message shall be transmitted three times.
6. The DVM shall be supervised for operational status.
7. Failure of the DVM shall result in the transmission of a constant alarm tone.
8. The DVM memory shall have a minimum 50% spare capacity after those messages identified in this section are recorded. Multiple DVM's may be used to obtain the required capacity.

E. Audio Amplifiers:

1. Audio Amplifiers shall provide a minimum of 50 Watts at either 25 or 70.7 VRMS output voltage levels.
2. Amplifiers shall be continuously supervised for operational status.
3. Amplifiers shall be configured for either single or dual channel application.
4. Each audio output circuit connection shall be configurable for Style X.
5. A minimum of 50% spare output capacity shall be available for each amplifier.

F. Tone Generator(s):

1. Tone Generator(s) shall be capable of providing a distinctive three-pulse temporal pattern fire alarm signal as well as a slow whoop.
2. Tone Generator(s) shall be continuously supervised for operational status.

2.7 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.

2.8 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.
5. Unless otherwise specified, all exposed parts shall be red in color and have a smooth, hard, durable finish.

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.

2.9 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. See Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS for new switches to be added. Connect tamper switches for all control valves shown on the approved shop drawings.
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.

2.10 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.

2.11 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.
- E. Where combination holder-closer units are required to match existing, these devices are furnished and installed as per Section 08 71 00, DOOR HARDWARE. Connection and wiring shall be as herein specified.

2.12 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.

2.13 SPARE AND REPLACEMENT PARTS

A. Provide spare and replacement parts as follows:

1. Manual pull stations - 5
2. Heat detectors - 2 of each type
3. Fire alarm strobes - 5
4. Fire alarm bells - 5
5. Fire alarm speakers - 5
6. Smoke detectors - 20
7. Duct smoke detectors with all appurtenances - 1
8. Sprinkler system water flow switch - 1 of each size
9. Sprinkler system water pressure switch - 1 of each type
10. Sprinkler valve tamper switch - 1 of each type
11. Control equipment utility locksets - 5
12. Control equipment keys - 25
13. 2.5 oz containers aerosol smoke - 12
14. Printer paper - 3 boxes
15. Printer replacement ribbons - 3
16. Monitor modules - 3
17. Control modules - 3
18. Fire alarm SLC cable (same as installed) - 152 m (500 feet)

B. Spare and replacement parts shall be in original packaging and submitted to the COTR.

C. 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.

D. 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.

2.14 INSTRUCTION CHART:

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 flow and tamper switches installed under Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS.
- L. 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 // indicate 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 Buildings.
 - 3. Release only the magnetic door holders on the floor from which alarm was initiated.
 - 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 indicate the buildings where there is Phase I elevator recall 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.

PART 4 - SCHEDULES

4.1 SMOKE ZONE DESCRIPTIONS:

4.2 DIGITIZED VOICE MESSAGES:

- A. Digitized voice messages shall be provided for each smoke zone of Building. The messages shall be arranged with a 3 second alert tone, a "Code Red" message and a description of the fire alarm area (building number, floor, level and smoke zone). A sample of such a message is as follows:

Alert Tone

Code Red

Building One, Second Floor, East Wing

Code Red

Building One, Second Floor, East Wing

Code Red

Building One, Second Floor, East Wing

4.3 LOCATION OF VOICE MESSAGES:

Upon receipt of an alarm signal from the building fire alarm system, the voice communication system shall automatically transmit a 3 second tone alert and a pre-recorded fire alarm message throughout the floor in alarm, the floor above and the floor below.

- - - END - - -

**SECTION 31 23 00
EXCAVATION AND FILL**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to Work of this section.

1.2 STANDARDS

- A. The following Standards are listed in this specification:

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM D448	Standard Classification for Sizes of Aggregates for Road and Bridge Construction
ASTM D698	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³)
ASTM D1557	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³))
ASTM D1621	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4716	Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile
ASTM D4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products

1.3 DESCRIPTION OF WORK

- A. Earthwork: The extent of earthwork is indicated on the drawings. The work, in general, includes the following items:
1. Excavation and backfill for building structure and foundation.
 2. Preparation of subgrade for building slabs.

3. Excavation and backfill in conjunction with underground mechanical and electrical utilities under slabs on grade, and mechanical and electrical appurtenances that are buried under the building slab.

4. Rough and finish grading adjacent to the building.

5. Furnishing Unit Prices for additional earthwork.

- B. Excavation Definition: "Excavation" consists of removal of all material encountered to required subgrade elevations indicated and subsequent disposal of all materials removed.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with all applicable requirements of governing authorities having jurisdiction.

- B. Testing and Inspection Services:

1. Testing Laboratory: The Contractor will engage a soil testing and inspection service for quality control testing of all proposed soil materials during earthwork operations which also includes .
Reference Section entitled "Testing Laboratory Services".

- C. Depth of Bearing Strata: It is to be understood that site soil conditions are variable across the site. Footing design dimensions and bearing elevations shown are minimums. The design of the footings is based on the assumed strata bearing capacity at the elevation shown on the drawings and as indicated in the General Notes. If the indicated depth of footing excavation is reached without developing the required strata bearing capacity, the Owner's Geotechnical Engineer on site will immediately advise the Contractor on the required bearing elevation for each individual footing or mat. Revisions will be paid for in accordance with the Contract condition relative to changes in the Work.

- D. Survey Work, Grades, and Elevations:

1. Grades and Elevations: Finished grades indicated by spot elevation and normal contour line elevations denote finished top surface elevations. Report conflicts, errors and inconsistencies in grades and elevations to Architect/Engineer for resolution. Do not proceed with the work in questionable areas until conflicts are resolved by the Architect/Engineer.
2. Survey Work: Lay out work to the lines and levels required before excavation. Record actual measurements of each footing plan centerline location, bottom elevation, deviation from specified tolerances, and all other pertinent data as required.

1.5 SUBMITTALS

- A. Laboratory Test Reports: Submit the following reports directly to the Architect/Engineer from the testing services, with copy to Contractor:
1. Test reports on borrow and fill material including optimum moisture-maximum density curve for each type of soil.
 2. Verification reports of each footing subgrade.
 3. Field density test reports.
 4. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 5. All other test reports as required by "Testing Laboratory Services", and other specification sections.
 6. Product Data.

1.6 JOB CONDITIONS

- A. Site Information: Data on indicated subsurface conditions are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by the Contractor at no cost to the Owner.
- B. Removal of Items Remaining from Demolition: Include as part of earthwork the breaking up and removal of all concrete slabs, pavements, footings, foundations, cisterns, septic tanks, abandoned underground utility lines and all other obstructions remaining from previous demolition operations that may have occurred.
- C. Existing Utilities:
1. Locate all existing underground utilities in areas of work before proceeding. Provide adequate support and protection during earthwork operations of utilities that are to remain in place. Demolish and completely remove from the site existing utilities indicated to be removed. Coordinate with utility companies for proper shut-off of services for active lines.
 2. If any active utility not indicated in drawings is encountered, notify Architect/Engineer and protect from damage until instructions for proper disposition of the utility are given by the Architect/Engineer. Perform the requested work in compliance with rules and regulations of authority having jurisdiction.
 3. Repair active utilities scheduled to remain that are damaged by earthwork operations to the satisfaction of the utility owner.

4. If any inactive utility not indicated on the drawings is encountered, remove, plug, or cap as directed by the Architect/Engineer. Obtain any necessary data relative to proposed abandonment of existing utility service from authority having jurisdiction.

D. Use of Explosives:

1. The use of explosives is not permitted.

E. Protection of Persons and Property:

1. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.
3. Perform excavation within drip-line of large trees to remain by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with emulsified asphalt tree paint.
4. Accidental or Careless Damage to Work Intended to Remain in Place: Restore to a condition as good or better than existed before work was commenced as approved by the Architect/Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 DEFINITION OF SOIL MATERIALS

- A. Satisfactory Soil Materials: Satisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GW, GP, GM, SM, SW, and SP. Some CL materials subject to the requirements for "Select Fill" may be acceptable.
- B. Unsatisfactory Soil Materials: Unsatisfactory soil materials are defined as those complying with ASTM D 2487 soil classification groups GC, ML, MH, CH, OL, OH, and PT. Groups SC and CL are also unsatisfactory unless conforming to requirements specified below.
- C. Fill and Backfill:
 1. Definition: "Fill" is soil material that is used to raise existing grades such as under foundation slabs or above footings, or to replace unsuitable material. Backfill" is soil material that is used to fill an excavation, to fill against the structure, or to fill behind foundation walls.

2. Select Fill (Structural Clay Fill): "Select fill" material shall be used as noted on the drawings as fill and/or backfill and shall conform to one of the following:
 - a. Sandy clay or clayey sand having a plasticity index between 8 and 20, a liquid limit not exceeding 40, and at least 60 percent of the material finer than the No. 200 sieve. Material shall be free of debris, roots, vegetation, organic matter and all other deleterious substances and free of rock or gravel greater than 2" in any dimension. It is not recommended to mix sand with high plasticity clay to develop structural clay fill.
 - b. Satisfactory Soil Material as defined above free of clay, rock, or gravel larger than 2" in any dimension and free of debris, roots, vegetation, waste and all other deleterious materials.
3. Drainage Fill: "Drainage fill" shall be used as noted on the drawings as fill material that is used around a drainage pipe in a wall drainage system or under a foundation slab as part of an underfloor drainage system and shall conform to the following:
 - a. Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, conforming to the coarse aggregate requirements of ASTM C 33, size 67 with 100% passing a 1" sieve and 0% to 5% passing a No. 8 sieve.
 - b. Washed evenly graded mixture of crushed stone or crushed or uncrushed gravel, ASTM C33; coarse-aggregate grading Size 56; with 100% passing a 1 1/2" sieve and not more than 5% passing a No. 4 sieve.
4. Drainage Backfill: "Drainage backfill" shall be used as noted on the drawings as backfill material that is used behind a foundation wall as part of a wall drainage system. Drainage backfill must be compatible with any drainage fill material to which it comes in contact as part of the complete wall drainage system. Drainage backfill shall conform to the following:
 - a. A washed free draining river sand graded so that 100% will pass a 3/8" sieve and less than 3% shall pass a No. 200 sieve.
 - b. Washed evenly graded mixture of crushed stone or crushed or uncrushed gravel, ASTM D448; coarse-aggregate grading Size 57; with 100% passing a 1 1/2" sieve and not more than 5% passing a No. 8 sieve.
5. Impervious Fill: "Impervious Fill" shall be used as noted on the drawings as backfill material that is used as a cap to seal off

- surface water from penetrating into backfill below. The material shall be lean clay with a Liquid Limit of between 35 and 50, with a Plasticity Index of between 20 and 30, and capable of compacting to a dense composite.
6. Leveling Sub-base under Moisture Retarder: "Leveling Sub-Base" shall be used as noted on the drawings as a thin smoothing layer over the sub-grade and directly below the moisture retarder. The material shall be a clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D448, size 10, with 100 percent passing a No. 4 sieve and 10 to 30 percent passing a No. 100 sieve; meeting deleterious substance limits of ASTM C33 for fine aggregates.
7. Flowable Fill: Flowable Fill (soil-cement slurry) shall be used as noted on the drawings and in these specifications as backfill to replace over-excavated areas during foundation excavation. Flowable fill to be used for backfill should meet the following recommendations:
- a. Sandy soils used for flowable fill contain no more than 30 percent fines
 - b. The soil and cement for the flowable fill should be thoroughly mixed
 - c. Proportioning of the sandy soil and cement is sufficient to produce a minimum unconfined compressive strength of 50 psi at 7 days while remaining workable for placement
 - d. Placement of the flowable fill should not be performed when the ambient air temperature is below 40 degrees F.
 - e. Placement of the flowable fill should completely fill the space to be backfilled
 - f. Flowable fill is properly compacted using standard ASTM procedures for soil-cement materials; if a fluid consistency is used for the flowable fill, an "elephant trunk" vibrator may be used to consolidate and remove air voids from the mixture
 - g. The consistency of the mix shall be tested by filling an open-ended 3-inch diameter cylinder 6 inches high, to the top with flowable fill; the cylinder shall be immediately pulled straight up and the correct consistency should produce a minimum 8-inch diameter circular spread with no segregation and maintain the consistency when placed
 - h. Construction over the flowable fill will not be performed until after initial set (4 to 6 hours) has been achieved for the flowable fill.

8. Cement Stabilized Sand Backfill: "Cement Stabilized Sand" shall be used as noted on the drawings and in these specifications as backfill material and shall be a well mixed composite of the following materials:
- a. Granular soil material conforming to one of the following:
 - (1) Uniformly graded mixture of natural or crushed gravel, crushed stone, and natural sand, conforming to the fine aggregate (concrete sand) requirements of ASTM C 33, with 100% passing a 3/8" sieve and 2% to 10% passing a No. 100 sieve.
 - (2) Concrete sand, 3/8" to No. 100, conforming to ASTM C 33.
 - (3) A washed free draining river sand graded so that 100% will pass a 3/8" sieve and less than 3% shall pass a No. 200 sieve.
 - b. Potable Water added in such proportion to make the mixture workable and fully hydrate the cement.
 - c. Cement, Type I, ASTM C 150 added in such proportion that the cement to dry sand ratio by weight shall be a minimum of 7%.
The cement stabilized sand shall produce a minimum unconfined compressive strength of 100 PSI in 48 hours and 400 PSI in 7 days where compacted to 95% density according to ASTM D 698 without additional moisture control, cured in accordance with ASTM C 31 Item 9, and tested in accordance with ASTM C 31.
9. Use of On-site Materials: On-site materials may be used for fill and backfill only when physical characteristics are confirmed by the Geotechnical Engineer-of-Record prior to their usage as well as approved by the Testing Laboratory.
- D. Approval: All soil materials used for the project shall be approved by the Testing Laboratory prior to hauling or placement. Soil materials used for fill and backfill shall be retested and reapproved each time the source or character of the material changes.
- E. Filter Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile: made from polyolefins, polyesters, or polyamides: and with the following minimum properties determined according to ASTM D4759 and referenced standard test methods:
- Grab Tensile Strength: 100 lbf: ASTM D4632
 - Tear Strength: 40 lbf: ASTM D4533
 - Puncture Resistance: 50 lbf; ASTM D4833
 - Water Flow Rate; 90 gpm per sq. ft.; ASTM D4491
 - Apparent Opening Size; No. 50; ASTM D4751

F. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; and with the following minimum properties determined according to ASTM D 4759 and referenced standard test methods:

Grab Tensile Strength: 200 lbf: ASTM D4632

Tear Strength: 75 lbf: ASTM D4533

Puncture Resistance: 90 lbf; ASTM D4833

Water Flow Rate; 4 gpm per sq. ft.; ASTM D4491

Apparent Opening Size; No. 30; ASTM D4751

G. Slotted Collector Pipe: Provide Schedule 80 PVC pipe with 0.10 inch slots comprising a minimum of 8% of the total surface area of the pipe but no more than 10%.

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING:

A. Remove all existing slabs, pavements, trash, rubbish, debris, trees, roots, stumps, underbrush, grass, shrubs, plants and other vegetation from within the mass excavation limits.

3.2 PREPARATION:

A. Survey Work:

1. Set required lines and levels as required to accurately perform the excavation work.
2. Maintain all bench marks and other reference points.

B. Protection of Existing Work:

1. Protect bench marks and existing structures, utilities, roads, sidewalks, paving, curbs and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations. In areas where excavations must be carried to such depths that surcharge from streets, sidewalks, or earth pressure create hazardous conditions, provide sheet piling, shoring and bracing, or combinations thereof, as required to protect excavations. Remove shoring and bracing before backfilling is completed, but not before permanent supporting structure is in place.
2. Protect excavations by laying back sides on a maximum 1:1 slope or by other methods as required to prevent cave-ins and loose dirt from falling into excavations.
3. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

4. Notify Architect/Engineer of any unexpected subsurface conditions. Discontinue work in area until Architect/Engineer provides notification to resume work.

3.3 EXCAVATION:

- A. Unclassified Excavation: The excavation for this project is unclassified. The Contractor is required to excavate to subgrade elevations specified, regardless of the character of materials or obstructions encountered. No additional costs will be paid by the Owner for any underground obstructions encountered.
- B. Unauthorized Excavation:
 1. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Architect/Engineer. Unauthorized excavation, as well as remedial work directed by Architect/Engineer, shall be at Contractor's expense.
 2. Under footings, foundation bases, or foundation walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill or flowable fill (soil-cement slurry) may be used to bring elevation to proper position, when acceptable to Architect/Engineer and approved by the Geotechnical Engineer.
 3. Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Architect/Engineer.
- C. Approval of Subgrade:
 1. When excavation has reached required subgrade elevations, notify Owner's Geotechnical Engineer who will make an inspection of conditions.
 2. Proofroll exposed subgrade below building with appropriate compaction equipment. Conduct proofrolling operations only in the presence of the Owner's Geotechnical Engineer. Undercut areas which "pump" or "rut" during operations to firm natural soil, and backfill and compact as specified.
 3. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material with flowable fill or lean concrete as directed by Owner's Geotechnical Engineer.

4. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in the work.

5. Reconstruct subgrades damaged by freezing temperature, frost, rain, accumulated water, or construction activities as directed by the Owner's Geotechnical Engineer.

D. Stability of Excavations:

1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction and in accordance with the requirements noted in the Geotechnical Report. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

2. Maintain sides and slopes of excavations in safe condition until completion of backfilling. Protect slopes from erosion by covering the slope with material such as polyethylene sheet.

E. Shoring and Bracing:

1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

2. Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

3. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

4. Provide permanent steel sheet piling or pressure creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops as required and leave permanently in place.

F. Dewatering:

1. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

2. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

3. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. Do not discharge

drainage water lines into municipal sewers without municipal approval. Prevent water running onto adjacent properties and public thoroughfares. Direct surface drainage away from excavated areas.

G. Material Storage:

1. Where required by schedule or site limitations, stockpile satisfactory soil materials and/or select fill where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage.
2. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
3. Dispose of excess soil material and waste materials as herein specified.

H. Excavation for Structures:

1. Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10'. Excavations for footings may be neat excavated where possible with sides and top edges free of loose or wet materials. Where neat excavation is not possible, excavate by open cut and allow sufficient distance from the edge of footings and foundations to permit placing and removing concrete formwork, installing services, other construction, and for inspection.
2. In excavating for footings and foundation, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Where unsatisfactory bearing surfaces are encountered, the area shall be undercut as required and backfilled with flowable fill or lean concrete as directed by the Geotechnical Engineer. Trim bottoms to required lines and grades to leave solid, clean, level and flat base to receive other work.
3. Protect soils exposed at the base of completed foundation excavations against disturbance from construction activities and changes in moisture content. Excavations shall not be left overnight unless it is protected with a minimum 2" thick seal slab of lean concrete. Where the bottom of the excavation will be exposed to movement of crawler type heavy equipment, the contractor may leave about one foot of undisturbed soil above indicated bottom of footing elevations until just prior to final excavation.

I. Excavation and Backfilling for Trenches:

1. Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room. Provide 6" to 9" clearance on both sides of pipe or conduit.

2. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to keep the top of pipe or conduit below the frost line.
 3. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
 4. For pipes or conduit 5" or less in nominal size and for flat-bottomed multiple-duct conduit units, do not excavate beyond indicated depths. Hand excavate bottom cut to accurate elevations and support pipe or conduit on undisturbed soil.
 5. For pipes or conduit 6" or larger in nominal size, tanks and other mechanical/electrical work indicated to receive subbase, excavate to subbase depth indicated, or, if not otherwise indicated, to 6" below bottom of work to be supported.
 6. Except as otherwise indicated, excavate for exterior waterbearing piping (water, steam, condensate, drainage) so top of piping is not less than 3'-6" below finished grade.
 7. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.
 8. Backfill trenches with concrete where trench excavations are close to column or wall footings such that the bottom of the excavation is below the zone of influence of such footings, or which pass under wall footings. The zone of influence of a footing is defined by 45 degree planes extending downward from the bottom edges of the footing. Place concrete to level of bottom of adjacent footing. In other locations, backfill trenches with flowable fill.
 9. Do not backfill trenches until tests and inspections have been made and backfilling authorized by Geotechnical Engineer or other authorized Owner's representative. Use care in backfilling to avoid damage or displacement of pipe systems.
 10. For piping or conduit less than 2'-6" below surface of roadways, provide 4" thick concrete base slab support. After installation and testing of piping or conduit, provide minimum 4" thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.
- J. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

3.4 PLACING FILL AND BACKFILL:

- A. Location: Place satisfactory and approved soil material in layers to required subgrade elevations for each area classification listed below:
 - 1. Excavations: In excavations use select fill or approved excavated material. Place in layers to required subgrade elevations.
 - 2. Building Slabs: Under building slabs use 1 to 2-foot thick pad of select fill (structural clay fill) or flowable fill. Place fill between the top of footings and the building slab.
 - 3. Around Footings: Backfill around the formed edges of with lean concrete or flowable fill.
 - 4. Behind Foundation Walls: Behind foundation walls, use drainage fill around the wall drain and drainage backfill over the drainage fill and wall drain up to within two feet of grade. Use impervious fill material at the top 24" of the wall backfill.
 - 5. Backfill Adjacent to Structures: Backfill against the structure with select fill up to within two feet of grade. Use impervious fill material at the top 24" of backfill adjacent to structures.
 - 6. Under Steps: Use minimum 6" course of subbase or base material.
 - 7. Under Piping and Conduit: Under piping and conduit use subbase or base material, shaped to fit bottom of trench.
- B. Prior to Backfill Placement: Backfill excavations as promptly as work permits but not until completion of each of the following:
 - 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - 2. Inspection, testing, approval, and recording locations of underground utilities.
 - 3. Removal of concrete formwork.
 - 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 - 5. For basement walls, until floor construction at top of wall is complete.
 - 6. Removal of trash and debris.
 - 7. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
- C. Ground Surface Preparation:
 - 1. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to

placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

2. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

D. Grading:

1. General: Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between points where elevations are indicated, or between such points and existing grades.
2. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes to the following tolerances:
 - a. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - b. Walks: Plus or minus 1 inch.
3. Grading Surface of Fill Under Building Slabs: Provide final grades within a tolerance of 1/2" when tested with a 10' straightedge.
4. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.
5. Allowance for Compaction and Settlement: Allow for natural compaction and settlement during grading operations. Where excessive settlement occurs, scarify settled areas, fill and compact to required subgrade levels.

3.5 COMPACTION:

- A. General: Control all soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below. Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture density relationship (cohesive soils)

determined in accordance with ASTM D 698. Cohesive soils are defined as those that have more than 50% of the soil material by weight passing the #200 sieve.

1. Building Slabs and Steps: Remove a minimum of 6 feet of existing subgrade material and replace with fill material up to the planned subgrade level. Compact each lift at the optimum moisture content (-1% to +3%) to 95% maximum density. Place and compact the ½" layer of the leveling sub-base at the optimum moisture content (± 2%) to 85% relative density before placing the moisture retarder.
2. Behind Foundation Wall: Compaction requirements within five feet of the wall shall be 90% maximum density for cohesive soils. Compaction requirements outside the five-foot band shall be 95% maximum density. The moisture content shall be at optimum moisture (1% to +3%). The top two feet of impervious fill shall be compacted at optimum moisture content to 90% or 95% of maximum density depending on the proximity to the wall.

C. Moisture Control:

1. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.6 FIELD QUALITY CONTROL:

- A. Refer to Section entitled "Testing Laboratory Services" for required quality control testing during construction.

3.7 MAINTENANCE:

- A. Protection of Graded Areas:
 1. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
 2. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.
- B. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather,

scarify surface, re-shape, and compact to required density prior to further construction.

- C. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.8 DISPOSAL OF EXCESS WASTE MATERIALS:

- A. Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property.

3.9 UNIT PRICES:

- A. Basis of Bids: Include excavation work and other earthwork necessary to produce the work required.
- B. Changes in the Work: Payment for changes in earthwork will be made on the actual net volume change of foundation in place and accepted based on design dimensions shown. No additional compensation will be made for excavation, concrete fill, reinforcing, or other costs due to unauthorized over-excavating in any dimension.
- C. Unit Prices: Quote Unit Prices which include full compensation for labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casing as required, dewatering, and other necessary items for complete installation. Provide Unit Prices for the following items, as set forth in the Contract conditions, which will apply in the event additions to or deductions from the Work are required and authorized by a written order from the Architect and approved by the Owner to the Contractor. Refer to Section 03 30 00 for concrete, reinforcing steel, and dowel Unit Price requirements.
1. Soil excavation, per cu. yd.
 2. Rock excavation, per cu. yd.
 3. Select fill material, placement, and compaction, per cu. yd.
 4. Flowable fill and/lean concrete material and placement, per cu. yd.

- - - END - - -

SECTION 31 20 11
EARTH MOVING (SHORT FORM)

PART 1 - GENERAL

1.1:DESCRIPTION:

This section specifies the requirements for furnishing all equipment, materials, labor and techniques for earthwork including excavation, fill, backfill and site restoration utilizing fertilizer, seed and/or sod.

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 materials, including silts, which are unstable; and inorganic materials, including silts, too wet to be stable.
2. Existing Subgrade (except footings): Same materials as above paragraph, that are not capable of direct support of slabs, pavement, and similar items, with the possible exception of improvement by compaction, proofrolling, or similar methods of improvement.

B. Earthwork: Earthwork operations required within the new construction area. It also includes earthwork required for auxiliary structures and buildings and sewer and other trenchwork throughout the job site.

C. Degree of Compaction: Degree of compaction is expressed as a percentage of maximum density obtained by the test procedure presented in ASTM D698.

D. The term fill means fill or backfill as appropriate.

1.3 RELATED WORK:

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

B. Safety Requirements: Section 00 72 00, GENERAL CONDITIONS, Article, ACCIDENT PREVENTION.

C. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01 00 00, GENERAL REQUIREMENTS.

D. Subsurface Investigation: Section 01 00 00, GENERAL REQUIREMENTS, Article, PHYSICAL DATA.

1.4 CLASSIFICATION OF EXCAVATION:

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on the 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.

1.6 SUBMITTALS:

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Furnish to Resident Engineer, soil samples, suitable for laboratory tests, of proposed off site or on site fill material.

1.7 APPLICABLE PUBLICATIONS:

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Nursery and Landscape Association (ANLA):
2004.....American Standard for Nursery Stock
- C. American Association of State Highway and Transportation Officials (AASHTO):
T99-01 (R2004).....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
- D. American Society for Testing and Materials (ASTM):
D698-07.....Laboratory Compaction Characteristics of Soil Using Standard Effort
D1557-02.....Laboratory Compaction Characteristics of Soil Using Modified Effort
- E. Standard Specifications of Texas Department of Transportation (TxDOT), latest revision.
- F. Fugro Consultants, Inc. Geotechnical Report No. 04.12100060, dated February 11, 2011.
- G. City of Houston Standard Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage, Street Paving, And Traffic. (2011)

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Fills: Materials approved from on site and off site sources meeting the requirements described in the Fugro Consultants, Inc. Report No. 04.12100060 February 11, 2011.
- B. Granular Fill:
 - 1. Under concrete slab, crushed stone or gravel graded from 25 mm (1 inch) to 4.75 mm (No. 4).
 - 2. Bedding for sanitary, water and storm sewer pipe, cement stabilized sand meeting the requirements of City of Houston Standard Specification, Section 02321.
- C. Fertilizer: (5-10-5) delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.
- D. Seed: Grass mixture comparable to existing turf delivered to site in unopened containers that clearly display the manufacturer's label, indicating the analysis of the contents.
- E. Sod: Comparable species with existing turf. Use State Certified or State Approved sod when available. Deliver sod to site immediately after cutting and in a moist condition. Thickness of cut must be 19 mm to 32 mm (3/4 inch to 1 1/4 inches) excluding top growth. There shall be no broken pads and torn or uneven ends.

PART 3 - EXECUTION

3.1 SITE PREPARATION:

- A. Clearing: Clearing within the limits of earthwork operations as described or designated by the Resident Engineer. Work includes removal of trees, shrubs, fences, foundations, incidental structures, paving, debris, trash and any other obstructions. Remove materials from the Medical Center Property.
- B. Grubbing: Remove stumps and roots 75 mm (3 inches) and larger diameter. Undisturbed sound stumps, roots up to 75 mm (3 inches) diameter, and nonperishable solid objects which will be 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 the areas within 4500 mm (15 feet) of new construction and 2250 mm (7'-6") of utility lines if such removal is approved in advance

by the Resident Engineer. Remove materials from the Medical Property. Trees and shrubs, shown to be transplanted, shall be dug with a ball of earth and burlapped in accordance with the latest issue of the, "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 semi-annually 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 the conclusion of the contract. Box, and otherwise protect from damage, existing trees and shrubs which are not shown to be removed in the construction area. Repair immediately damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including the roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Building materials shall not be stored closer to trees and shrubs, that are to remain, than the farthest extension of their limbs.

- D. Stripping Topsoil: Unless otherwise indicated on the drawings, the limits of earthwork operations shall extend anywhere the existing grade is filled or cut or where construction operations have compacted or otherwise disturbed the existing grade or turf. Strip topsoil as defined herein, or as indicated in the geotechnical report, from within the limits of earthwork operations as specified above unless specifically indicated or specified elsewhere in the specifications or shown on the drawings. Topsoil shall be fertile, friable, natural topsoil of loamy character and characteristic of the locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by the Resident Engineer. Eliminate foreign material, 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 the 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 the soil is wet so that the tilth of the soil will be destroyed.

1. 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 Medical Center Property.

- E. Disposal: All materials removed from the property shall be disposed of at a legally approved site, for the specific materials, and all removals shall be in accordance with all applicable Federal, State and local regulations.

3.2 EXCAVATION:

- A. Shoring, Sheet piling and Bracing: Shore, brace, or slope to its angle of repose banks of excavations to protect workmen, banks, adjacent paving, structures, and utilities, in compliance with OSHA requirements.
1. Extend shoring and bracing to the bottom of the excavation. Shore excavations that are carried below the elevations of adjacent existing foundations.
- B. Excavation Drainage: Operate pumping equipment, and/or provide other materials, means and equipment as required, to keep excavations free of water and subgrades 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. When subgrade for foundations has been disturbed by water, remove the disturbed material to firm undisturbed material after the water is brought under control. Replace disturbed subgrade in trenches by mechanically tamped sand or gravel. When removed disturbed material is located where it is not possible to install and properly compact disturbed subgrade material with mechanically compacted sand or gravel, the Resident Engineer should be contacted to consider the use of flowable fill.
- C. Trench Earthwork:
1. Utility trenches (except sanitary, water and storm sewer):
 - a. Excavate to a width as necessary for sheet piling 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. The length of open trench in advance of pipe laying shall not be greater than is authorized by the Resident Engineer.

2. Sanitary, water and storm sewer trenches:

- a. Trench width below a point 150 mm (6 inches) above top of the pipe shall be 600 mm (24 inches) for 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. The bottom quadrant of the pipe shall be bedded on cement stabilized sand fill.
 -) Cement Stabilized Sand Fill: Depth of fill shall be a minimum of 75 mm (3 inches) plus one-sixth of pipe diameter below the pipe and 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.
 - c. Place and compact as specified the 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.
- D. Site Earthwork: Excavation shall be accomplished as required by drawings and specifications. Remove subgrade materials, that are determined by the 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. When unsuitable material is encountered and removed, the 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 meters (yardage) in cut section only.
- E. Finished elevation of subgrade shall be as follows:
1. Pavement Areas - bottom of the pavement or base course as applicable.
 2. Planting and Lawn Areas - 100 mm (4 inches) below the finished grade, unless otherwise specified or indicated on the drawings.

3.3 FILLING AND BACKFILLING:

- A. General: Do not fill or backfill until all debris, unsatisfactory soil materials, obstructions, and deleterious materials have been removed from the excavation. Proof-roll exposed subgrades with a fully loaded

dump truck. Use excavated materials or borrow for fill and backfill, as applicable. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, and pipes coming in contact with backfill have been installed, and inspected and approved by Resident Engineer.

- B. Proof-rolling Existing Subgrade: Proof-roll with a fully loaded dump truck. Make a minimum of one pass in each direction. Remove unstable uncompactable material and replace with granular fill material completed to mix requirements specified.
- C. Placing: Place material in horizontal layers not exceeding 200 mm (8 inches) in loose depth and then compacted. Do not place material on surfaces that are muddy, frozen, or contain frost.
- D. Compaction: Use approved equipment (hand or mechanical) well suited to the type of material being compacted. Do not operate mechanized vibratory compaction equipment within 3000 mm (10 feet) of new or existing building walls without the prior approval of the Resident Engineer. Moisten or aerate material as necessary to provide the moisture content that will readily facilitate obtaining the specified compaction with the equipment used. Compact each layer to not less than 95 percent of the maximum density determined in accordance with the following test method ASTM D698.

3.4 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 unfinished areas fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside the building away from the building walls for a minimum distance of 3048 mm (10 feet) at a minimum five percent (5%) slope.
- D. The finished grade shall be 150 mm (6 inches) below bottom line of windows or other building wall openings unless greater depth is shown.

- E. Place crushed stone or gravel fill under concrete slabs on grade tamped and leveled. The thickness of the fill shall be 150 mm (6 inches), unless otherwise indicated.
- F. Finish subgrade in a condition acceptable to the Resident Engineer at least one day in advance of the paving operations. Maintain finished subgrade in a smooth and compacted condition until the succeeding operation has been accomplished. Scarify, compact, and grade the subgrade prior to further construction when approved compacted subgrade is disturbed by contractor's subsequent operations or adverse weather.
- G. Grading for Paved Areas: Provide final grades for both subgrade and base course to +/- 6 mm (0.25 inches) of indicated grades.

3.5 LAWN AREAS:

- A. General: Harrow and till to a depth of 100 mm (4 inches), new or existing lawn areas to remain, which are disturbed during construction. Establish existing or design grades by dragging or similar operations. Do not carry out lawn areas earthwork out when the soil is wet so that the tilth of the soil will be destroyed. Plant bed must be approved by Resident Engineer before seeding or sodding operation begins.
- B. Finished Grading: Begin finish grading after rough grading has had sufficient time for settlement. Scarify subgrade surface in lawn areas to a depth of 100 mm (4 inches). Apply topsoil so that after normal compaction, dragging and raking operations (to bring surface to indicated finish grades) there will be a minimum of 100 mm (4 inches) of topsoil over all lawn areas; make smooth, even surface and true grades, which will not allow water to stand at any point. Shape top and bottom of banks to form reverse curves in section; make junctions with undisturbed areas to conform to existing topography. Solid lines within grading limits indicate finished contours. Existing contours, indicated by broken lines are believed approximately correct but are not guaranteed.
- C. Fertilizing: Incorporate fertilizer into the soil to a depth of 100 mm (4 inches) at a rate of 12 kg/100 m² (25 pounds per 1000 square feet).
- D. Seeding: Seed at a rate of 2 kg/100 m² (4 pounds per 1000 square feet) and accomplished only during periods when uniform distribution may be assured. Lightly rake seed into bed immediately after seeding. Roll seeded area immediately with a roller not to exceed 225 kg/m (150 pounds per foot) of roller width.
- E. Sodding: Topsoil shall be firmed by rolling and during periods of high temperature the topsoil shall be watered lightly immediately prior to

laying sod. Sod strips shall be tightly butted at the ends and staggered in a running bond fashion. Placement on slopes shall be from the bottom to top of slope with sod strips running across slope. Secure sodded slopes by pegging or other approved methods. Roll sodded area with a roller not to exceed 225 kg/m (150 pounds per foot) of the roller width to improve contact of sod with the soil.

- F. Watering: The Resident Engineer is responsible for having adequate water available at the site. As sodding is completed in any one section, the entire sodded area shall be thoroughly irrigated by the contractor, to a sufficient depth, that the underside of the new sod pad and soil, immediately below sod, is thoroughly wet. Resident Engineer will be responsible for sod after installation and acceptance.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL:

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Medical Center property.
- B. Place excess excavated materials suitable for fill and/or backfill on site where directed.
- C. Remove from site and dispose of any excess excavated materials after all fill and backfill operations have been completed.
- D. 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.

3.6 CLEAN-UP:

Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Provide site clear, clean, free of debris, and suitable for subsequent construction operations. Remove debris, rubbish, and excess material from the Medical Center Property.

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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. The materials and mix design for the flowable fill should be designed to produce a comparable compressive strength to the surrounding soil after hardening, making excavation at a later time possible.

1.2 DESCRIPTION:

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, verbally or in writing. This section specifies flowable fill for use as structural fill to remain 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 11, EARTH MOVING (SHORT FORM).

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 320 - 1300 kg/m³ (20 - 80 lb/feet³) 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:

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:

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 MATERIALS:

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.

- A. Portland Cement: ASTM C150, Type 1 or Type 2. Meeting TxDOT standards.
- B. Mixing Water: Fresh, clean, and potable. Meeting Meeting TxDOT standards for use as mix-water for cast-in-place concrete.
- C. Air-Entraining Admixture: ASTM C260.
- D. Chemical Admixtures: ASTM C494.
- E. 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 320 - 1300 kg/m³ (20 - 80 lbs/feet³) measured at the point of placement after a 60 minute ready-mix truck ride. In the absence of strength data the cementitious content shall be a maximum of 90 kg/m³ (150 lbs/cy).
- E. Flowable fill shall have an in-place yield of 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:

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 APPLICATION OF FLOWABLE FILL:

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:

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.

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**SECTION 32 05 23
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, gutter, and combination curb and gutter wheel stop.
- C. Pedestrian Pavement: Walks, grade slabs, lawn mower strips, wheelchair curb ramps, terraces and steps.
- D. Vehicular Pavement: driveways.
- E. Equipment Pads:

1.2 RELATED WORK

- A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Section 31 20 11, EARTH MOVING (SHORT FORM).
- 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

Design all elements with the latest published version of applicable codes.

1.4 WEATHER LIMITATIONS

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.

1.6 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

SPEC WRITER NOTE: Update materials to
agree with requirements (type, grades,
class, test method, tables, etc.)

specified in the referenced APPLICABLE
PUBLICATIONS.

PART 2 - PRODUCTS

2.1 GENERAL

Concrete shall be Type C, air-entrained as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, with the following exceptions:

<u>TYPE</u>	<u>MAXIMUM SLUMP*</u>
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 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.

2.4 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 2 and shall be free of paraffin or petroleum.

2.5 EXPANSION JOINT FILLERS

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 11, EARTH MOVING (SHORT FORM).
- 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.

3.3 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 Registered Professional Land Surveyor, specified in Section 00 72 00, GENERAL CONDITIONS, 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 AND GUTTER

- 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, gutter, 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, Lawn Mower Crossings, Wheelchair Curb Ramps, and 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 and gutters by inserting 3 mm (1/8 inch) steel plates conforming to the cross sections of the curb and gutter.
- 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 and transverse 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 and gutter 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 and gutter 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.

3.20 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 least 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 m²/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.

3.21 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.

3.22 PROTECTION

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.

3.23 FINAL CLEAN-UP

Remove all debris, rubbish and excess material from the Station.

- - - E N D - - -

SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION:

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 11, EARTH MOVING (SHORT FORM).
- 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 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):
(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.
- C. 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

- ## PART 2 - PRODUCTS

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: potable water-blue.

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:

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:

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:

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 [two] "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 present local fire department and/or water department standards.
- 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:

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 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).

2.12 CAST IRON FRAME AND COVER, STEPS, ETC.:

Cast iron frame and cover, steps, etc. shall comply with State Department of Transportation standard details. Identify cover as "WATER".

2.13 FLEXIBLE EXPANSION JOINTS: (PROVIDE FOR DOMESTIC AND FIRE SERVICE)

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.

2.14 POTABLE WATER:

Water used for filling, flushing, and disinfection of water mains and appurtenances shall conform to Safe Drinking Water Act.

2.15 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.

2.16 WARNING TAPE

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:

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:

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:

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 water 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:

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)			
In	(mm)	gpm	(L/sec)	1(25)	1 1/2(38)	2(51)	2 1/2-in (64 mm)
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

The backflow preventers shall not be in place during the flushing.

- C. 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.
- D. 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.
- E. The bacteriological test specified in AWWA C651 shall be performed by a laboratory approved by the Texas Commission on Environmental Quality (TCEQ). The cost of sampling, transportation, and testing shall be the responsibility of the Contractor.
- F. Re-disinfection and bacteriological testing of failed sections of the system shall be the sole responsibility of the Contractor.
- G. 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.

- - - E N D - - -

SECTION 33 30 00
SANITARY SEWERAGE UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION:

Outside, underground sanitary sewer system, complete, ready for operation, including all gravity flow 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 11, EARTH MOVING (SHORT FORM).
- 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, 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.

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/ft³ (600
kN-m/m³))
 - 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
- C900-97Polyvinyl 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 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.

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.

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, 1/4 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 (5-1/2 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:

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:

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.6 CLEANOUT FRAMES AND COVERS:

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.

2.7 WARNING TAPE:

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 the entire structure and the.
- C. Piping under and within 1500 mm (5 feet) of building areas shall be completely removed.
- D. Piping outside of building areas shall have all ends of the piping at the limit of the abandonment and within structures and manholes, plugged with concrete, and abandoned in-place.
- 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 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).

3.6 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 gaskets with fused 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.

3.7 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:
 - 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 (1-inch per foot) nor more than 1:6 (2 inches per foot). Bottom slab and benches shall be concrete.
- 6. The wall that support 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.

3.8 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 1/8 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.

3.9 INSPECTION OF SEWERS:

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.

3.10 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.

- - - E N D - - -

**SECTION 33 40 00
STORM DRAINAGE UTILITIES**

PART 1 - GENERAL

1.1 DESCRIPTION:

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 11, EARTH MOVING (SHORT FORM).
- 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/ft³ (600
kN-m/m³))

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, Reinforced arch culvert and storm drainpipe shall comply with ASTM C506, Class A-III. Reinforced elliptical culvert and storm drainpipe shall comply with ASTM C507, Class VE III. Joints shall be watertight flexible joints made with rubber-type gaskets conforming to ASTM C443.

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 26 pipe and fittings shall gaskets conforming to ASTM F 477, and shall be able to withstand a hydrostatic pressure of 345 kPa (50 psi).

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.

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 Texas Department of Transportation (TxDOT) 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, 1/4 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 (5-1/2 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 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 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. Frame and Cover for Gratings: Frame and cover for gratings shall be cast gray iron conforming to ASTM A48; cast ductile iron conforming to ASTM A536 in accordance with Texas 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:

Concrete shall be in accordance with Texas Department of Transportation standard specification (2004) Item 421. 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:

Reinforcing steel shall be deformed bars, ASTM A615, Grade 40 unless otherwise noted.

2.7 FLARED END SECTIONS:

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.

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:

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:

Excavation of trenches and for appurtenances and backfilling for storm drains, shall be in accordance with the applicable portions of Section 31 20 11, EARTH MOVING (SHORT FORM).

3.2 Pipe bedding:

The bottom quadrant of the pipe shall be bedded on cement stabilized sand fill. Cement stabilized sand fill: depth of fill shall be a minimum of 75 mm (3 inches) plus one-sixth of pipe diameter below the pipe and 300 mm (12 inches) above top of pipe. Place and tamp fill material by hand.

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 gasketed 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:

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.

3.7 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.

3.8 CURB INLETS, CATCH BASINS, AND AREA DRAINS:

Reinforced concrete as shown or precast concrete.

3.9 INSPECTION OF SEWERS:

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.

3.10 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.

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