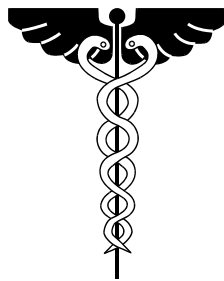


*Construction Documents*  
*Volume 2 of 2 -MEP*  
**Project Specifications**

**EDWARD HINES, JR. VA HOSPITAL  
CANOPY/AMBULANCE BAY /  
DECONTAMINATION AREA BLDG. 200  
PROJECT #578-315**

---



---

Submitted by the Team of:

**PFB ARCHITECTS, INC. / MELVIN COHEN AND  
ASSOCIATES, INC**

9461 Kenwood Road, Cincinnati, OH 45242

Original Drawing Issue Date 10.26.10  
Architectural Drawing Revision Date 02.11.11  
MEP Drawing Revision Date 01.14.11  
Date of Project Re-Issue 06.08.12

DEPARTMENT OF VETERANS AFFAIRS  
CANOPY/AMBULANCE BAY/DECONTAMINATION AREA BLDG. 200

TABLE OF CONTENTS  
Section 00003

**VOLUME 2**

	<b>DIVISION 13 - SPECIAL CONSTRUCTION</b>	
13930	Wet & Dry Sprinklers	08-01M
	<b>DIVISION 14 - CONVEYING SYSTEMS NOT USED</b>	
	<b>DIVISION 15 - MECHANICAL</b>	
15050	Basic Methods and Requirements (Mechanical)	04-04M
15200	Noise and Vibration Control	11-02M
15250	Insulation	11-02M
15400	Plumbing Systems	06-97M
15450	Plumbing Fixtures and Trim	11-02M
15705	HVAC Piping Systems	11-02M
15740	Terminal Units	09-02M
15750	Heating and Cooling Coils	06-99M
15822	Fans	06-99M
15840	Ductwork and Accessories	12-02M
15885	Air Filters	12-02M
15902	Controls and Instrumentation (DDC)	09-00M
15980	Testing, Adjusting and Balancing	12-02M
15991	Demonstrations and Tests - Boiler Plant	01-00M
	<b>DIVISION 16 - ELECTRICAL</b>	
16050	Basic Methods and Requirements (Electrical)	04-02M
16111	Conduit Systems	09-01M
16127	Cables, Low Voltage (600 Volts and Below)	09-01M
16140	Wiring Devices	03-03M
16150	Motors	05-03M
16155	Motor Starters	03-00M
16160	Panelboards	02-02M
16170	Disconnect Switches (Motor and Circuit)	03-00
16450	Grounding	08-02M
16460	Transformers (General Purpose)	02-02M
16510	Building Lighting, Interior	03-03M
16721	Modification to Existing Fire Alarm System	
	- - - E N D - - -	

**SECTION 15050**  
**BASIC METHODS AND REQUIREMENTS (MECHANICAL)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Basic methods and requirements for Division 15, MECHANICAL, applies to all sections of Division 15.
- 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.
- C. Contractor shall complete all required mechanical and electrical provisions for a fully functional HVAC system when hospital user groups have been given beneficial occupancy.

**1.2 RELATED WORK**

- A. Section 05500, METAL FABRICATIONS.
- B. Section 07270, FIRESTOPPING.
- C. Flashing for Wall and Roof Penetrations: Section 07600, FLASHING AND SHEET METAL.
- D. Section 07920, SEALANTS AND CAULKING.
- E. Section 09900, PAINTING.
- F. Section 15200, NOISE AND VIBRATION CONTROL.
- G. Section 15250, INSULATION.
- H. Section 15740, TERMINAL UNITS.
- I. Section 15980, TESTING, ADJUSTING, AND BALANCING.
- J. Section 16150, MOTORS.
- K. Section 16155, MOTOR STARTERS.
- L. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL)

**1.3 QUALITY ASSURANCE**

- A. Flow Rate Tolerance for HVAC Equipment: Section 15980, TESTING, ADJUSTING, AND BALANCING.
- B. Equipment Vibration Tolerance:

1. The allowable vibration tolerance is specified in Section 15200, NOISE AND VIBRATION CONTROL. Equipment specifications require factory balancing of equipment to this tolerance.
2. After air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.

C. Products Criteria:

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. 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.

D. 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.

E. 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.

F. Guaranty: Section 01001, GENERAL CONDITIONS.

G. Guarantee Period Services: Guarantee period for mechanical systems shall be for a period of (2) years or as otherwise noted in the individual specifications sections starting with the final day of acceptance. The detailed guarantee period service requirements for individual systems have been described in the individual specifications sections.

1. Qualifications: All service technicians assigned to perform work under this contract shall be qualified and factory trained by the Original Equipment Manufacturer (O.E.M.). Each technician shall have at least three years experience of working on comparable systems and shall be a full time employee of the contractor. The contractor shall furnish, for the Department of Veterans Affairs (VA) review and approval, resumes of all service technicians scheduled to service the equipment and systems. The resume shall include details of experience, training, and educational qualifications and performance evaluations.
2. Replacement Parts: The contractor shall be equipped with all replacement parts of all equipment and systems to be serviced and the manufacturer's standard service and repair procedures. All replacement parts shall be brand new and of current design. The replacement parts shall be O.E.M. items. Obsolete or refurbished parts are unacceptable. "Approved Equal" parts must have prior approval of the Contracting Officer. Contractor shall furnish evidence of guaranteed supply of parts for the life of the system.
3. Service Supplies: The services shall include, without any additional cost to the government, all replacement parts, special tools and equipment, and consumable materials, that is, lubrication oil, grease, and cleaning materials, as required. The requirement of UL listing, where applicable, shall not be voided by any replacement parts, components, software, or modifications provided by the contractor.
4. Scheduled and Emergency Call Service: The service shall include a scheduled same day two hour response time for equipment and/or systems on a 7 day, 24 hours call back service for emergency service. The emergency service is defined as a situation created by a breakdown or malfunction of any equipment or system warranting urgent attention. A qualified service representative shall respond to the VA request for emergency service within two hours and assess the problem either by telephone or remote diagnostic capability. If the emergency situation cannot be rectified by the VA personnel, on site emergency service shall be provided by sending a qualified service representative within 24 hours. For the rural locations of the VA medical centers, situated over 200 miles from the contractor's

established service depot, the maximum response time of 48 hours shall be acceptable. The emergency service shall be limited to adjustments and repairs specifically required to protect the safety of the equipment for which the emergency service was required to be performed.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. 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.
- C. Coordination Drawings: In accordance with Section 01001, GENERAL CONDITIONS, Article, SUBCONTRACTS AND WORK COORDINATION. Provide detailed layout drawings of all piping and duct systems. In addition provide details of the following.
  - 1. Mechanical equipment rooms.
  - 2. Interstitial space.
  - 3. Hangers, inserts, supports, and bracing.
  - 4. Pipe sleeves.
  - 5. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- D. Maintenance Data and Operating Instructions:
  - 1. Maintenance and operating manuals in accordance with Section 01010, 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.

- E. 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. Federal Specifications (Fed. Spec.):
  - FF-S-325 . . . . . Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)
- C. Air Conditioning and Refrigeration Institute (ARI):
  - 430-89 . . . . . Central Station Air-Handling Units
- D. American National Standard Institute (ANSI):
  - B31.1-98 . . . . . Power Piping
- E. Rubber Manufacturers Association (ANSI/RMA):
  - IP-20-88 . . . . . Drives Using Classical V-Belts and Sheaves - Cross Sections A, B, C, D, and E
  - IP-21-91 . . . . . Drives Using Double-V (Hexagonal) Belts (AA, BB, XX, DD Cross Sections)
  - IP-22-91 . . . . . Drives Using Narrow Multiple V-Belts (3V, 5V, and 8V Cross Sections)
- F. Air Movement and Control Association (AMCA):
  - 410-96 . . . . . Recommended Safety Practices for Air Moving Devices
- G. American Society of Mechanical Engineers (ASME):
  - Boiler and Pressure Vessel Code (BPVC):
    - SEC IX-98 . . . . . Qualifications Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators
- H. American Society for Testing and Materials (ASTM):
  - A36/A36M-97 . . . . . Carbon Structural Steel
  - A575-96 . . . . . Steel Bars, Carbon, Merchant Quality, M-Grades

- E84-98 . . . . . Surface Burning Characteristics of Building Materials
- E119-98 . . . . . Fire Tests of Building Construction and Materials
- I. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
  - SP-58-93 . . . . . Pipe Hangers and Supports-Materials, Design and Manufacture
  - SP-69-96 . . . . . Pipe Hangers and Supports-Selection and Application
- J. National Association of Plumbing - Heating - Cooling Contractors (NAPHCC):
  - 1996 . . . . . National Standard Plumbing Code
- K. National Fire Protection Association (NFPA):
  - 90A-96 . . . . . Installation of Air Conditioning and Ventilating Systems
  - 101-97 . . . . . Life Safety Code

## **PART 2 - PRODUCTS**

### **2.1 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: 5000 feet per minute.
- E. Adjustment Provisions: For alignment and ANSI/RMA standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ANSI/RMA specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.



H. Sheaves and Pulleys:

1. Material: Pressed steel, or close grained cast iron.
2. Bore: Fixed or bushing type for securing to shaft with keys.
3. Balanced: Statically and dynamically.
4. Groove spacing for driving and driven pulleys shall be the same.
5. Minimum Diameter of V-Belt Sheaves (ANSI/RMA recommendations) in inches:

Fractional Horsepower		Standard		High Capacity	
Cross Section	Min. od (in)	Cross Section	Min. od (in)	Cross Section	Min. od (in)
2L	0.8	A	3.25	3V	2.65
3L	1.5	B	5.75	4V	7.10
4L	2.5	C	9.40	5V	12.50
5L	3.5	D	13.60		
		E	21.80		

I. Drive Types, Based on ARI 435:

1. Provide adjustable-pitch or fixed-pitch drive as follows:
  - a. Fan speeds up to 1800 RPM: 10 horsepower and smaller.
  - b. Fan speeds over 1800 RPM: 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.

## 2.2 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. Drive guards may be excluded where motors and drives are inside factory fabricated air handling unit casings.
- B. 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.
- C. Access for Speed Measurement: One inch diameter hole at each shaft center.

### **2.3 ELECTRIC MOTORS**

- A. Section 16150, MOTORS, 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 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.

### **2.4 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09900, PAINTING.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 3/16-inch high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09900, 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 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. Plumbing: Provide for all valves (Fixture stops not included).
  - 2. HVAC: Provide for all valves other than for equipment in Section 15740, TERMINAL UNITS.

3. Valve tags: Engraved black filled numbers and letters not less than 1/2-inch high for number designation, and not less than 1/4-inch for service designation on 19 gage 1-1/2 inches round brass disc, attached with brass "S" hook or brass chain.
4. Valve lists: Typed or printed plastic coated card(s), sized 8-1/2 inches by 11 inches showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
5. 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 thumbtack in ceiling.

## **2.5 FIRESTOPPING**

Section 07270, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping and ductwork. Refer to Section 15250, INSULATION, for firestop pipe and duct insulation.

## **2.6 GALVANIZED REPAIR COMPOUND**

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

## **2.7 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. Vibration Isolators: Refer to Section 15200, NOISE AND VIBRATION CONTROL.
- B. In lieu of the paragraph which follow, suspended equipment support and restraints may be designed and installed in accordance with the National Uniform Seismic Installation Guidelines (NUSIG), most current edition. Submittals based on either the NUSIG guidelines 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. Support of suspended equipment over 500 pounds shall be submitted for approval of the Resident Engineer in all cases. See paragraph 2.8.L for lateral force design requirements.
- C. Supports For Roof Mounted Items:
  1. Equipment: Equipment rails shall be galvanized steel, minimum 18 gauge, with integral baseplate, continuous welded corner seams, factory installed 2 by 4 treated wood nailer, 18 gauge galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 11 inches. For surface insulated roof deck, provide raised cant strip to start at the upper surface of the insulation.
  2. Pipe/duct pedestals: Provide a galvanized unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

- D. Type Numbers Specified: MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05500, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- E. For Attachment to Concrete Construction:
  - 1. Concrete insert: Type 18, MSS SP-58.
  - 2. Self-drilling expansion shields and machine bolt expansion anchors: Fed. Spec. FF-S-325, permitted in concrete not less than four inches thick. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
  - 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than four inches thick when approved by the Resident Engineer for each job condition. Applied load shall not exceed one-fourth the proof test load listed in Fed. Spec. FF-S-325.
- F. 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 7/8-inch outside diameter.
- G. Attachment to Metal Pan or Deck: As required for materials specified in Section 05321, STEEL DECKING COMPOSITE.
- H. For Attachment to Wood Construction: Wood screws or lag bolts.
- I. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- J. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-5/8 inches by 1-5/8 inches, 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).
  - 5. Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 1/2-inch galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.
- K. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 15250, 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.

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. 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.

2. HVAC Piping (Other Than General Types):

- a. Medium and high pressure steam:
  - 1) Provide eye rod or Type 17 eye nut near the upper attachment.
  - 2) Piping 2 inches and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
- b. Spring Supports (Expansion and contraction of vertical piping):
  - 1) Movement up to 3/4-inch: Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
  - 2) Movement more than 3/4-inch: Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.

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

4. 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, 18 gage minimum.

L. Pre-insulated Calcium Silicate Shields:

- 1. Provide 360 degree water resistant high density 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 600 psi compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36) wear plates welded to the bottom sheet metal jacket.
- 5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

**2.8 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 one inch above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.

3. For drilled penetrations: Provide 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 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 07920, SEALANTS AND CAULKING.

## **2.9 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 one quart of oil, and 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.

## **2.10 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 3/32-inch for floor plates. For wall and ceiling plates, not less than 0.025-inch for up to 3-inch pipe, 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, ductwork and equipment. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. 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.
- C. Concrete and Grout: Use concrete and shrink compensating grout 25 MPa (3000 psi) minimum, specified in Section 03300, CAST-IN-PLACE CONCRETE.
- D. 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.



- E. Install steam piping expansion joints as per manufacturer's recommendations.
- F. Work in Existing Building:
  - 1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01010, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
  - 2. As specified in Section 01010, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
  - 3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills, will be permitted only with approval of the Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely necessary for the required installation.
- G. 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.
- H. 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 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 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 6-inch pipe, 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. Plumbing horizontal and vertical pipe supports, refer to the NAPHCC National Standard Plumbing Code.

### **3.3 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.

### **3.4 LUBRICATION**

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

### **3.5 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 01010, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### **3.6 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, perform required tests as specified in Section 01010, 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.

### **3.7 INSTRUCTIONS TO VA PERSONNEL**

Provide in accordance with Article, INSTRUCTIONS, of Section 01010, GENERAL REQUIREMENTS.

- - - E N D - - -

**SECTION 15200**  
**NOISE AND VIBRATION CONTROL**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Noise criteria, vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- A. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL): General mechanical requirements and items, which are common to more than one section of Division 15.
- B. Section 15705, HVAC PIPING SYSTEMS: Requirements for flexible pipe connectors to reciprocating and rotating mechanical equipment.
- C. Section 15200, DUCTWORK AND ACCESSORIES: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- D. Section 15980, TESTING, ADJUSTING AND BALANCING: requirements for sound and vibration tests.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE in specification Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Noise Criteria:
  - 1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

TYPE OF ROOM	NC LEVEL
Bathrooms and Toilet Rooms	40
Conference Rooms	35
Corridors (Nurse Stations)	40
Corridors (Public)	40
Examination Rooms	35
Lobbies, Waiting Areas	40
Offices, small private	35
Patient Rooms	35
Treatment Rooms	35

- 2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the fore-going noise criteria, local ordinance noise levels, and OSHA requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook 2001, Chapter 7, Sound and Vibration.

3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
  1. Vibration isolators:
    - a. Floor mountings
    - b. Hangers
    - c. Snubbers
    - d. Thrust restraints
  2. Bases.
  3. Acoustical enclosures.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):  
  
2001 . . . . . Fundamentals Handbook 2001, Sound and Vibration, Chapter 7
- C. American Society for Testing and Materials (ASTM):  
  
A123/A123M-00 . . Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products  
  
A307-00 . . . . . Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

- D2240-00 . . . . Standard Test Method for Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):
  - SP-58-93 . . . . Pipe Hangers and Supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):
  - 29 CFR 1910 . . . Guidelines for Noise Enforcement, Appendix A, 1983

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- C. Exposure to weather: Isolators, including springs, exposed to weather shall be hot dip galvanized after fabrication. Hot-dip zinc coating shall not be less than two ounces per square foot by weight complying with ASTM A123. In addition provide limit stops to resist wind velocity.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

### **2.2 VIBRATION ISOLATORS**

- A. Floor Mountings:
  - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
  - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
  - 3. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due

to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting.

4. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 50 pounds per square inch.
- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- C. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 1/4 inch when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

### **2.3 BASES**

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 4 inches. Where rails

are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.

- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid base. To assure adequate stiffness, height of members shall be a minimum of 1/12 of longest base dimension, but not less than four inches.
- C. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers 1/4 inch clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integral spring isolators shall comply with Spring Isolator (Type S) requirements.

## **2.4 SOUND ATTENUATING UNITS**

Refer to specification Section 15840, DUCTWORK AND ACCESSORIES.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Vibration Isolation:
  - 1. No metal-to-metal contact will be permitted between fixed and floating parts.
  - 2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
  - 3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
  - 4. Provide heat shields where elastomers are subject to temperatures over 100 degrees F.
  - 5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
  - 6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.



- B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

### **3.2 ADJUSTING**

- A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4inch movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

SELECTION GUIDE FOR VIBRATION ISOLATORS *1															
EQUIPMENT LOCATION *2															
EQUIPMENT	ON GRADE			6M (20FT) FLOOR SPAN			9M (30FT) FLOOR SPAN			12M (40FT) FLOOR SPAN			15M (50FT) FLOOR SPAN		
	BASE TYPE	ISOL TYPE	Q <sub>MIN</sub> DEFL	BASE TYPE	ISOL TYPE	Q <sub>MIN</sub> DEFL	BASE TYPE	ISOL TYPE	Q <sub>MIN</sub> DEFL	BASE TYPE	ISOL TYPE	Q <sub>MIN</sub> DEFL	BASE TYPE	ISOL TYPE	Q <sub>MIN</sub> DEFL
<u>AIR HANDLING UNITS, PACKAGED</u>															
SUSPENDED:															
UP THRU 5 HP				-	H	1.0	-	H	1.0	-	H	1.0	-	H	1.0
7-1/2 HP AND OVER:															
UP TO 500 RPM				-	H,TH R	1.7	-	H,TH R	1.7	-	H,TH R	1.7	-	H,TH R	1.7
501 RPM AND OVER				-	H,T HR	1.0	-	H,T HR	1.0	-	H,T HR	1.7	-	H,T HR	1.7
FLOOR MOUNTED:															
UP THRU 5 HP	-	D	-	-	S	1.0	-	S	1.0	-	S	1.0	-	S	1.0
7-1/2 HP AND OVER:															
UP TO 500 RPM	-	D	-	R	S,TH R	1.7	R	S,TH R	1.7	R	S,TH R	1.7	R	S,TH R	1.7
501 RPM AND OVER	-	D	-	-	S,TH R	1.0	-	S,TH R	1.0	R	S,TH R	1.7	R	S,TH R	1.7
<u>IN-LINE CENTRIFUGAL &amp; VANE AXIAL FANS</u>															
FLOOR MOUNTED (APR.9)															
UP THRU 50 HP:															
UP TO 300 RPM	-	D	-	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301-500 RPM	-	D	-	R	S	1.7	R	S	1.7	R	S	2.5	R	S	2.5
501 RPM AND OVER	-	D	-	-	S	1.0	-	S	1.0	R	S	1.7	R	S	2.5
60 HP AND OVER:															
301500 RPM	R	S	1.0	R	S	1.7	R	S	1.0	R	S	2.5	R	S	3.5
501 RPM AND OVER	R	S	1.0	R	S	1.7	R	S	1.0	R	S	1.7	R	S	2.5

FLOOR MOUNTED (APR.1): USE "B" TYPE IN LIEU OF "R" TYPE BASE

SUSPENDED: USE "H" ISOLATORS OF SAME DEFLECTION AS FLOOR MOUNTED

SELECTION GUIDE FOR ISOLATORS *1															
EQUIPMENT LOCATION *2															
EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	" MIN DEFL	BASE TYPE	ISOL TYPE	" MIN DEFL	BASE TYPE	ISOL TYPE	" MIN DEFL	BASE TYPE	ISOL TYPE	" MIN DEFL	BASE TYPE	ISOL TYPE	( " )MIN DEFL
<u>ROOF VENTILATORS</u>															
ABOVE OCUPIED AREAS:															
5 HP AND OVER	-	-	-	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
<u>CENTRIFUGAL BLOWERS</u>															
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201-300 RPM	B	N	0.3	B	S	1.7	B	S	2.5	B	S	2.5	B	S	3.5
301-500 RPM	B	N	0.3	B	S	1.7	B	S	1.7	B	S	2.5	B	S	3.5
501 RPM AND OVER	B	N	0.3	B	S	1.0	B	S	1.0	B	S	1.7	B	S	2.5
60 HP AND OVER:															
300 RPM	B	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301-500 RPM	B	S	1.7	I	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM AND OVER	B	S	1.0	I	S	1.7	I	S	1.7	I	S	2.5	I	S	2.5

- - - E N D - -

# SELECTION GUIDE FOR VIBRATION ISOLATORS

		ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
EQUIPMENT		BAS E TYP E	ISOL TYPE	MIN DEF L	BAS E TYP E	ISOL TYPE	MIN DEF L	BASE TYPE	ISOL TYPE	MIN DEF L	BAS E TYP E	ISOL TYPE	MIN DEF L	BAS E TYP E	ISOL TYPE	MIN DEF L
PUMPS																
CLOSE COUPLED	UP TO 1-1/2 HP	-- -	---	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---
	2 HP & OVER	-- -	---	---	I	S	1.0	I	S	1.0	I	S	1.7	I	S	1.7
BASE MOUNTED	UP TO 10 HP	-- -	---	---	I	S	1.0	I	S	1.0	I	S	1.7	I	S	1.7
ROOF VENTILATORS																
ABOVE OCCUPIED AREAS:																
5 HP & OVER		---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
CENTRIFUGAL BLOWERS																
UP TO 50 HP:																
UP TO 200 RPM		B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM		B	N	0.3	B	S	1.7	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM		B	N	0.3	B	S	1.7	B	S	1.7	B	S	2.5	B	S	3.5
501 RPM & OVER		B	N	0.3	B	S	1.0	B	S	1.0	B	S	1.7	B	S	2.5
60 HP & OVER:																
UP TO 300 RPM		B	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301 - 500 RPM		B	S	1.7	I	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM & OVER		B	S	1.0	I	S	1.7	I	S	1.7	I	S	2.5	I	S	2.5

AIR HANDLING UNIT PACKAGES															
SUSPENDED:															
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S,TH R	1.7	R	S,TH R	1.7	R	S,TH R	1.7	R	S,TH R	1.7
501 RPM & OVER	---	D	---	---	S,TH R	1.0	---	S,TH R	1.0	R	S,TH R	1.7	R	S,TH R	1.7
IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)															
UP THRU 50 HP:															
UP TO 300 RPM	---	D	---	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301 - 500 RPM	---	D	---	R	S	1.7	R	S	1.7	R	S	2.5	R	S	2.5
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	1.7	R	S	2.5
60 HP AND OVER:															
301 - 500 RPM	R	S	1.0	R	S	1.7	R	S	1.7	R	S	2.5	R	S	3.5
501 RPM & OVER	R	S	1.0	R	S	1.7	R	S	1.7	R	S	1.7	R	S	2.5

**SECTION 15250**  
**INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. HVAC piping, ductwork and equipment.
  - 2. Plumbing piping and equipment.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space directly supplied with heated or cooled air.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 60 degrees F or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases, and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, Boiler Plant and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases, 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 60 degrees F; HVAC and plumbing equipment or piping handling media above 105 degrees F and piping media and equipment 90 to 450 degrees F.
  - 8. Density: Pcf - pounds per cubic foot.
  - 9. Runouts: Branch pipe connections up to 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): BTU per inch thickness, per hour, per square foot, per degree F temperature difference.
  - 12. HPS: High pressure steam 60 psig and above.

- 13. HPR: High pressure steam condensate return.
- 14. MPS: Medium pressure steam 16 psig thru 59 psig.
- 15. MPR: Medium pressure steam condensate return.
- 16. LPS: Low pressure steam 15 psig and below.
- 17. LPR: Low pressure steam condensate gravity return.
- 18. PC: Pumped condensate.
- 19. HWH: Hot water heating supply.
- 20. HWHR: Hot water heating return.
- 21. GH: Hot glycol-water heating supply.
- 22. GHR: Hot glycol-water heating return.
- 23. R: Pump recirculation.
- 24. CW: Cold water.
- 25. SW: Soft water.
- 26. HW: Hot water.
- 27. CH: Chilled water supply.
- 28. CHR: Chilled water return.
- 29. GC: Chilled glycol-water supply.
- 30. GCR: Chilled glycol-water return.
- 31. RS: Refrigerant suction.
- 32. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 01569, TRADITIONAL ASBESTOS ABATEMENT: Insulation containing asbestos material.
- B. Section 07270, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- C. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL): General mechanical requirements and items, which are common to more than one section of Division 15.
- D. Section 15400, PLUMBING SYSTEMS: Hot and cold water piping.
- E. Section 15705, HVAC PIPING SYSTEMS: Piping and equipment.

- F. Section 15840, DUCTWORK AND ACCESSORIES: Ductwork, plenum and fittings.

### 1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

- B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 2-3.3.1 through 2-3.3.5; 2-3.10.2(a); and 3-4.6.4, parts of which are quoted as follows:
  - a. 2-3.3.1 Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesive, fasteners, tapes and supplementary materials added to air ducts, plenums, panels and duct silencers used in duct systems 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. Where these products are to be applied with adhesive, they shall be tested with such adhesive applied or the adhesive used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state.
  - b. 2-3.3.2 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 coverings; 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. In no case shall the test temperature be below 250 degrees F
  - c. 2-3.3.3 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.  
**Exception:** Where such coverings meet the requirements of 3-4.6.4.
  - d. 2-3.3.4 Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.
  - e. 2-3.3.5 Air duct coverings shall not be installed so as to conceal or prevent the use of any service openings.
  - f. "2-3.10.2(a) All materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50.
  - g. 3-4.6.4 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 1-inch 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.  
**Exception:** Where fire dampers are installed, proper clearance for expansion shall be maintained.
2. Test methods: ASTM E84, UL 723, or NFPA 255.
  3. Specified k factors are at 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.
  5. Listings or Certification from Underwriters Laboratories, Inc., or an equivalent third party testing laboratory will be required to show that surface burning characteristics for materials to continue to adhere to the specified ratings.
- 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 01340, SAMPLE AND SHOP DRAWINGS
- 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 4 inches square for board/block/ blanket; 6 inches long, full diameter for round types.
- 2. Each type of facing and jacket: Minimum size 4 inches square.
- 3. Each accessory material: Minimum 4 ounce liquid container or 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-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 -87 . . . Adhesive, Flexible Unicellular-Plastic

NOTICE 1 . . . . . Thermal Insulation

MIL-C-19565C (1)-88 . . Coating Compounds, Thermal Insulation, Fire-and Water-Resistant, Vapor-Barrier

MIL-C-20079H . . . . . Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass

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

A167-99 . . . . . Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip

B209-01 . . . . .	Aluminum and Aluminum-Alloy Sheet and Plate
C411-97 . . . . .	Standard test method for Hot-Surface Performance of High-Temperature Thermal Insulation
C449-00 . . . . .	Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
C533-95 . . . . .	Calcium Silicate Block and Pipe Thermal Insulation
C534-01 . . . . .	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
C547-00 . . . . .	Mineral Fiber pipe Insulation
C552-00 . . . . .	Cellular Glass Thermal Insulation
C553-00 . . . . .	Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
C585-90 . . . . .	Standard practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)
C612-00 . . . . .	Mineral Fiber Block and Board Thermal Insulation
C1126-98 . . . . .	Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
C1136-95 . . . . .	Flexible, Low Permeance vapor Retarders for Thermal Insulation
D1668-Rev.A-97 . . . . .	Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
E84-Rev.A-00 . . . . .	Surface Burning Characteristics of Building Materials
E119-Rev.A-00 . . . . .	Fire Tests of Building Construction and Materials
E136-99 . . . . .	Standard Test Methods for Behavior of Materials in a Vertical Tube Furnace at 1380 degrees F
E. National Fire Protection Association (NFPA):	
90A-99 . . . . .	Installation of Air Conditioning and Ventilating Systems

- 96-98 . . . . . Standards for Ventilation Control and Fire Protection of Commercial Cooking Operations
- 101-00 . . . . . Life Safety Code
- 251-99 . . . . . Standard methods of Tests of Fire Endurance of Building Construction Materials
- 255-00 . . . . . Standard Method of tests of Surface Burning Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
- 723-93 . . . . . UL Standard for Safety Test for Surface Burning Characteristics of Building Materials with Revision of 12/98
- G. Manufacturer's Standardization Society of the Value and fitting Industry (MSS):
- SP58-1993 . . . . . Pipe Hangers and Supports Materials and Design

## **PART 2 - PRODUCTS**

### **2.1 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. Manufacturer: Calsilite Group or equal.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

<b>Insulation Characteristics</b>		
<b>ITEMS</b>	<b>TYPE I</b>	<b>TYPE II</b>
Temperature, maximum degrees F	1200	1700
Density (dry), lb/ ft <sup>3</sup>	10	22
Thermal conductivity: (min.) Btu in/h ft <sup>2</sup> degrees F @ mean temperature of 200 degrees F	0.40	0.540
Surface burning characteristics:		
Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

## **2.2 MINERAL FIBER**

- A. ASTM C612 (Board, Block), Class 1 or 2,  $k = 0.26$  Btu/hr per foot, per degree F, external insulation for temperatures up to 400 degrees F.
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 2 pcf,  $k = 0.04$  for use at temperatures up to 400 degrees F
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.26$  for use at temperatures 450 degrees F.

## **2.3 MINERAL WOOL OR REFRACTORY FIBER**

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

## **2.4 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1,  $k = 0.15$ , for temperatures up to 250 degrees F with vapor barrier and all service jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1,  $k = 0.021$  (0.15), for temperatures up to 250 degrees F with rigid cellular phenolic insulation and covering, vapor barrier and all service jacket.

## **2.5 FLEXIBLE ELASTOMERIC CELLULAR THERMAL (Armaflex)**

ASTM C534,  $k = 0.27$  Btu per hour, per foot, per degree F, flame spread not over 25, smoke developed not over 100, for temperatures from minus 40 degrees F to 200 degrees F. No jacket required.

## **2.6 CELLULAR GLASS CLOSED-CELL**

Comply with Standard ASTM C552, density 8.5 pcf nominal,  $k = 0.38$ .

## **2.7 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 1 mil thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 5 units, Suitable for painting without sizing. Jackets shall have minimum 1-1/2 inch lap on longitudinal joints and minimum 4-inch butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units:

Foil-Scrim-Kraft (FSK) or PVDC vapor retarder jacketing type for concealed ductwork and equipment.

- D. Glass Cloth Jackets: Presized, minimum 7.8 ounces per square yard, 300 psig bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- E. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- F. Pipe fitting insulation covering (jackets) (Zeston): 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 0.03 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, 0.023 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 0.024-inch minimum thickness material to match material and construction of straight run jackets. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 0.75-inch wide on 18-inch centers. System shall be weatherproof if utilized for outside service.
- H. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.020 inches thick with 1-1/4 inch corrugations or 0.032 inches thick with no corrugations. System shall be weatherproof if used for outside service.

## 2.8 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees F (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 3.0 pcf.

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size (inches)	Insert Blocks (inches)
Up through 5	6 long
6	6 long
8, 10, 12	9 long
14, 16	12 long
18 through 24	14 long

- B. Warm or hot pipe supports: Premolded pipe insulation 180 degrees F (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or calcium silicate. Insulation at supports shall have same thickness as adjacent insulation.

## **2.9 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.

## **2.10 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or stainless steel.
- C. Wire: 18 gage soft annealed galvanized or 14 gage copper clad steel or nickel copper alloy.
- D. Bands: 3/4 inch nominal width, brass, galvanized steel, aluminum or stainless steel.

## **2.11 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.
- D. Hexagonal wire netting: one inch mesh, 22 gage galvanized steel.
- E. Corner beads: 2 inch by 2 inch, 26 gage galvanized steel; or, 1 inch by 1 inch, 28 gage aluminum angle adhered to 2 inch by 2 inch Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 40 degrees F to 250 degrees F. Below 40 degrees F and

above 250 degrees F. Provide double layer insert. Provide color matching, vapor barrier, pressure sensitive tape.

## **2.12 FIRESTOPPING MATERIAL**

Other than pipe and duct insulation, refer to Section 07270 FIRESTOPPING.

## **2.13 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".

## **2.14 APPLICATIONS**

See Section 3.2 - "Insulation Installation", for type and size of insulation.

# **PART 3 - EXECUTION**

## **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Where removal of insulation of piping, ductwork and equipment is required to comply with Sections 01569 and 01570, Asbestos Abatement, such areas shall be reinsulated to comply with this specification.
- D. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 60 degrees F and below. Lap and seal vapor barrier over ends and exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 6 inches.
- E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- F. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that



must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.

- G. Insulation on hot piping and equipment shall be terminated square at insulation ends and items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- H. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- I. HVAC work not to be insulated:
  - 1. Internally insulated ductwork and air handling units. Omit insulation on relief air ducts (Economizer cycle exhaust air).
  - 2. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
  - 3. Equipment: Expansion tanks, flash tanks, hot water pumps.
  - 4. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 3/4 inch and smaller, exposed piping through floor for convectors and radiators. Insulate piping to within approximately 3 inches of uninsulated items.
- J. Plumbing work not to be insulated:
  - 1. Piping and valves of fire protection system.
  - 2. Chromium plated brass piping.
  - 3. Water piping in contact with earth.
  - 4. Piping in pipe basement serving wall hydrants.
  - 5. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).
  - 6. Distilled water piping.
  - 7. Equipment:
    - a. Pumps-inlet to outlet
    - b. Safety valves
    - c. Chemical feeders
    - d. All nameplates

8. Specialties:
- a. Control valves - water
  - b. Strainers under 2-1/2 inch pipe size
  - c. Expansion bellows
  - d. Flexible connectors
  - e. Ball joints except piping between joints
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Firestop Pipe and Duct insulation:
- 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07270, FIRESTOPPING.
  - 2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through mechanical room floors
    - b. Pipe or duct chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
- N. Provide metal jackets over insulation as follows:
- 1. All piping and ducts exposed to outdoor weather.
  - 2. Piping exposed in building, within 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 2 inch overlap is required at longitudinal and circumferential joints.

### **3.2 INSULATION INSTALLATION**

- A. Mineral Fiber Board:
- 1. Faced board: Apply board on pins spaced not more than 12 inches on center each way, and not less than 3 inches from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
  - 2. Plain board:

- a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 9 inches on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
  - b. For hot equipment: Stretch 1 inch mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 1/4 inch thick, trowel led to a smooth finish.
  - c. For cold equipment: Apply meshed glass fabric in a tack coat 60 to 70 square feet per gallon of vapor mastic and finish with mastic at 12 to 15 square feet per gallon over the entire fabric surface.
  - d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.
3. Cold equipment: 1-1/2 inch thick insulation faced with ASJ.
- a. Chilled water pumps, water filter, chemical feeder pot or tank.
  - b. Pneumatic, cold storage water and surge tanks.
4. Hot equipment: 1-1/2 inch thick insulation faced with ASJ.
- a. Convertors, air separators, steam condensate pump receivers.
  - b. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.
  - c. Domestic water heaters and hot water storage tank.
  - d. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
  - e. Laundry: Hot exhaust ducts from dryers and from ironers, where duct is exposed in the laundry.

B. Flexible Mineral Fiber Blanket:

- 1. Adhere insulation to metal with 4-inch wide strips of insulation bonding adhesive at 8 inches on center all around duct. Additionally secure insulation to bottom of ducts exceeding 24 inches in width with pins welded or adhered on 18-inch centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.
- 2. Supply air ductwork to be insulated includes main and branch ducts from fan discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and

angle iron hangers for flat oval ducts that are in direct contact with metal duct.

3. Concealed supply air ductwork.
  - a. Above ceilings at a roof level: 2-inch thick insulation faced with FSK.
  - b. Above ceilings for other than roof level: 1½-inch thick insulation faced with FSK.
4. Concealed return air duct above ceilings at a roof level and in chases with external wall or containing steam piping; 1-1/2 inch thick, insulation faced with FSK. Concealed return air ductwork in other locations need not be insulated.
5. Return air duct in interstitial spaces: 1-1/2 inch thick insulation faced with FSK.
6. Concealed outside air duct: 1-1/2 inch thick insulation faced with FSK.

C. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
2. Contractor's options for fitting, flange and valve insulation:
  - a. Insulating and finishing cement for sizes less than 4 inches operating at surface temperature of 61 degrees F or more.
  - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 40 degrees F, or above 250 degrees F. Secure first layer of insulation with twine. Seal seam edges with vapor retarder mastic and secure with fitting tape.
  - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 60 degrees F or less, vapor seal with a layer of glass fitting tape imbedded between two 1/16-inch coats of vapor retarder mastic.
  - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 2 inches.
3. Nominal thickness in inches specified in table below, for piping above ground:

Nominal Thickness of Insulation				
Nominal Pipe Size, inches:	(1) & below	1-1/4 - 3	4-6	8 and above
a. 251-350 F) (HPS, MPS,)	2.0	2.5	3.5	3.5
b. 212-250 degrees F (LPS, Vents for PRV safety valves, receivers and flash tanks)	1.0	2.0	2.0	2.0
c. 100-211 degrees F (LPR, PC, HWH, HWHR, GH, GHR)	1.0	1.5	2.0	2.0
1. Runouts to fan coil units	0.5	-	-	-
2. Runouts to // reheat coils // air terminal unit reheat coils //	0.5	-	-	-
d. Domestic hot water supply and return	0.5	0.75	1.0	1.5

D. Rigid Closed-cell Phenolic Foam:

1. Rigid closed cell phenolic insulation maybe provided for piping, ductwork and equipment for temperatures up to 250 degrees F.
  - a. Note the NFPA 90 A burning characteristics requirements of 25/50 in paragraph 1.3.B
  - b. Provide secure attachment facilities such as welding pins.
  - c. Apply insulation with joints tightly drawn together
  - d. Apply adhesives, coverings, neatly finished at fittings, and valves.
  - e. Final installation shall be smooth, tight, neatly finished at all edges.
2. Minimum thickness in inches specified in table below, for piping above ground:

Nominal Thickness of Insulation					
Nominal Pipe Size (inches):	1 & below	1-1/4 - 3	4 - 6	8 - 12	14 & above
1. 212-250 degrees F, LPS, Vents, receivers, flash tanks.	0.5	1	1	--	--
2. 100-211 degrees F, LPR, PC, HWH, HWHR, GH and GHR.	0.5	0.75	1	--	--
a. Reheat coils.	0.5	--	--	--	--
3. 40-60 degrees F, CH, CHR, GC, and GCR.	0.75	0.75	1	1.5	2.0
4. 50 degrees F and less, RS for DX refrigerants.	0.5	0.75	--	--	--
5. Domestic hot water supply and return.	0.5	0.5	0.75	0.75	--

3. Condensation control insulation: Minimum 0.75 inch thick for all pipe sizes.
  - a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.
  - b. Plumbing piping as follows:
    - 1) Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
    - 2) Waste piping from electric water coolers and icemakers to drainage system.
    - 3) Waste piping located above basement floor from ice making and film developing equipment and air handling units, from fixture (including trap) to main vertical waste pipe.
    - 4) MRI quench vent piping.
    - 5) Bedpan sanitizer atmospheric vent
    - 6) Reagent grade water piping.
    - 7) Cold water piping.

E. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in inches as tabulated below for chilled water and refrigerant piping.

Nominal Thickness of Insulation				
Inches	11/2	2-6	8-12	14
1. 40-60 degrees F (CH and CHR within chiller room and pipe chase and underground)	2.0	3.0	3.0	4.0
2. 40-60 degrees F (CH and CHR outside chiller room)	1.5	2.0	2.0	2.5

2. Cold equipment: 2 inchthick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.
- F. 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 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
    - 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 inches as specified in table below for piping above ground:

Nominal Thickness of Insulation				
Nominal Pipe Size in inches	1 & below	1-1/4 - 3	4 - 6	8
1. 100-200 degrees F (HWH, HWHR, GH, GHR)	1.0	1.5	-	-
a. Runouts to air terminal unit reheat coils	0.75	1.5	-	-
2. 40-60 degrees F (CH, CHR, GC, GCR)	1.0	1.5	-	-
3. Domestic hot water supply and return	0.50	0.75	1.0	1.50

5. Minimum 0.75 inch thick insulation for pneumatic control lines for a minimum distance of 20 feet from discharge side of the refrigerated dryer.

G. Weatherproof Outdoor Insulation:

1. Piping, round and oval ducts: Protective metal jacket
2. Plenums, casing, fans, rectangular or square ducts and equipment: Apply two coats of weatherproof coating, Mil. Spec. MIL-C-19565, each trowelled or sprayed in place to a wet thickness of 1/4 inch, reinforced with open weave glass fabric. After the second layer of mastic has dried, coat and seal with a layer of asphalt aluminum sealer brushed in place.
3. Flexible elastomeric cellular insulation: Finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
4. Insulation installed outside shall be protected (minimum daily) from the adverse effects of the weather, with metal jackets installed the same day as insulation is installed. Otherwise, provide temporary insulation protection until metal jackets are installed. Damaged insulation shall be removed and replaced at no charge.

- - - E N D - - -



**SECTION 15400  
PLUMBING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Penetrations in rated enclosures: Section 07270, FIRESTOPPING.
- B. Preparation and finish painting and identification of piping systems: Section 09900, PAINTING.
- C. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- D. Pipe Insulation: Section 15250, INSULATION.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
  - 1. Piping.
  - 2. Valves.
  - 3. Floor Drains.
  - 4. Backflow Preventers.
  - 5. Strainers.
  - 6. Pressure Gages.
  - 7. Cleanouts.
  - 8. Pressure Reducing Valves
  - 9. 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. Federal Specifications (Fed. Spec.):

L-C-530C . . . . .	Coating, Pipe, Thermoplastic Resin
L-T-1512A . . . . .	Tape, Pressure Sensitive Adhesive, Pipe Wrapping
0-C-114B(2) . . . . .	Calcium Hypochlorite, Technical
0-S-602E . . . . .	Sodium Hypochlorite Solution
BB-C-120C . . . . .	Chlorine, Technical, Liquid
WW-U-516B . . . . .	Unions, Brass or Bronze Threaded, Pipe Connections and Solder-Joint Tube Connections
WW-V-35C . . . . .	Valve Ball Brass or Bronze
WW-V-1967 INT AMD 1 . . .	Valve, Butterfly (Threaded Ends And Solder Ends)

C. American National Standards Institute (ANSI):

American Society of Mechanical Engineers (ASME): (Copyrighted Society)

A11.21.1M-91 . . . . .	Floor Drains ANSI/ASME
A13.1-81 . . . . .	Scheme for Identification of Piping Systems
B16.3-92 . . . . .	Malleable Iron Threaded Fittings ANSI/ASME
B16.4-92 . . . . .	Cast Iron Threaded Fittings Classes 125 and 250 ANSI/ASME
B16.9-93 . . . . .	Factory-Made Wrought Steel Buttwelding Fittings ANSI/ASME
B16.11-91 . . . . .	Forged Steel Fittings, Socket-Welding and Threaded ANSI/ASME
B16.12-83 . . . . .	Cast Iron Threaded Drainage Fittings ANSI/ASME
B16.15-85 . . . . .	Cast Bronze Threaded Fittings ANSI/ASME
B16.18-84 . . . . .	Cast Copper Alloy Solder-Joint Pressure Fittings ANSI/ASME
B16.22-89 . . . . .	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings ANSI/ASME
B40.1-91 . . . . .	Gauges-Pressure Indicating Dial Type Elastic Element ANSI/ASME

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

A47-90 . . . . .	Ferritic Malleable Iron Castings Revision 1989
A53-95 . . . . .	Pipe, Steel, Black And Hot-Dipped, Zinc coated Welded and Seamless
A74-94 . . . . .	Cast Iron Soil Pipe and Fittings
A183-83 (R1990 . . . . .	Carbon Steel Track Bolts and Nuts
A312-94 . . . . .	Seamless and Welded Austenitic Stainless Steel Pipe
A536-84 (R1993 . . . . .	Ductile Iron Castings
A733-93 . . . . .	Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
B32-95 . . . . .	Solder Metal
B61-93 . . . . .	Steam or Bronze Castings
B62-93 . . . . .	Composition Bronze or Ounce Metal Castings
B75-93 (Rev A) . . . . .	Seamless Copper Tube
B88-95 . . . . .	Seamless Copper Water Tube
B306-95 . . . . .	Copper Drainage Tube (DWV)
B584-93 . . . . .	Copper Alloy Sand Castings for General Applications Revision A
B687-88 . . . . .	Brass, Copper, and Chromium-Plated Pipe Nipples
C564-95 . . . . .	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
D2000-90 . . . . .	Rubber Products in Automotive Applications
D2146-82 . . . . .	Propylene Plastic Molding 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

- D4101-91 . . . . . Propylene Plastic Injection and Extrusion Materials
- E. American Water Works Association (AWWA):
- C110-93 . . . . . Ductile Iron and Gray Iron Fittings - 75 mm thru 1200 mm (3 inch thru 48 inches) for Water and other liquids
- C151-91 . . . . . Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
- C203-91 . . . . . Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied
- C651-92 . . . . . Disinfecting Water Mains
- C701-88 . . . . . Cold Water Meters-Turbine Type, for Customer Service
- F. National Fire Protection Association (NFPA):
- 54-92 . . . . . National Fuel Gas Code
- G. American Welding Society (AWS):
- A5.8-92 . . . . . Filler Metals for Brazing
- H. National Association of Plumbing - Heating - Cooling Contractors (PHCC):
- National Standard Plumbing Code - 1996
- I. Cast Iron Soil Pipe Institute (CISPI):
- 301-90 . . . . . Hubless Cast Iron Soil and Fittings
- J. International Association of Plumbing and Mechanical Officials (IAPMO):
- Uniform Plumbing Code - 1991
- IS6-93 . . . . . Installation Standard
- K. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
- SP-67-95 . . . . . Butterfly Valve of the Single flange Type (Lug Wafer)
- SP-70-90 . . . . . Cast Iron Gate Valves, Flanged and Threaded Ends.
- SP-72-92 . . . . . General Purpose Ball Valves

- SP-80-87 . . . . . Gate Valve-Bronze
- L. American Society of Sanitary Engineers (ASSE):
- 1001-70 . . . . . Pipe Applied Atmospheric Type Vacuum Breakers
- 1013-93 . . . . . Reduced Pressure Principle Backflow Preventers
- 1015-93 . . . . . Double Check Backflow Prevention Assembly
- 1018-86 . . . . . Performance for trap seal primer valve-water supply fed
- 1020-81 . . . . . Vacuum Breakers, Anti-Siphon, Pressure Type
- M. Factory Mutual (FM):
- 1680-89 . . . . . Coupling Used in Hubless Cast Iron Systems for Drains, Waste and Vent Systems.

## **PART 2 - PRODUCTS**

### **2.1 SANITARY, WASTE, STORM WATER DRAIN AND VENT PIPING**

- A. Cast Iron Soil Pipe and Fittings: Used for interior waste and vent piping above grade. Pipe shall be bell and spigot, modified hub, or plain end (no-hub) as required by selected jointing method.
1. Material, (Pipe and Fittings): ASTM A74, C1SP1-301, Service Class.
  2. Joints: Provide any one of the following types to suit pipe furnished.
    - a. Lead and oakum and caulked by hand (all storm piping).
    - b. Double seal, compression-type molded neoprene gasket. Gaskets shall suit class of pipe being jointed (sanitary only).
    - c. Mechanical: Meet the requirements and criteria for pressure, leak, deflection and shear tests as outlined in Factory Mutual No. 1680 for Class 1 couplings.
      - 1) Stainless steel clamp type coupling of elastomeric sealing sleeve, ASTM C564 and a Series 300 stainless steel shield and clamp assembly. Sealing sleeve with center-stop to prevent contact between pipes/fittings being joined shall be marked ASTM C564.
      - 2) Cast Iron coupling with neoprene gasket and stainless steel bolts and nuts (sanitary only).

- d. Mechanical Grooved Couplings: Shall consist of ductile iron (ASTM A536, Grade 65-45-12), or malleable iron (ASTM A47, Grade 32510) housings, a pressure responsive elastomeric gasket (ASTM D2000), and steel track head bolts. Shall be for use on pipe and fittings grooved to the manufacturer's specifications. Couplings and fittings to be of the same manufacturer.
  - e. Adapters: Where service weight pipe is connected to extra heavy pipe and extra heavy fittings of chair carriers, provide adapters or similar system to make tight, leakproof joints.
- B. Steel Pipe and Fittings: May be used for vent piping and storm water piping above grade.
  - 1. Pipe Galvanized: ASTM A53, standard weight.
  - 2. Fittings:
    - a. Soil, Waste and Drain Piping: Cast iron, ANSI B16.12, threaded, galvanized.
    - b. Sanitary and Exhaust Vent Piping: Malleable iron, ANSI B16.3, or cast iron, ANSI B16.4. All piping shall be of the same kind. Couplings of vent piping may be standard couplings furnished with pipe.
    - c. Unions: Tucker connection or equivalent type throughout.
    - d. Mechanical Grooved Couplings: Shall consist of ductile iron (ASTM A536, Grade 65-45-12), or malleable iron (ASTM A47, Grade 32510) housings, a pressure responsive elastomeric gasket (ASTM D2000), and steel track head bolts. Shall be for use on pipe and fittings grooved to the manufacturer's specifications. Couplings and fittings to be of the same manufacturer.
- C. Copper Tube, (DWV): May be used for piping above ground, except for urinal drains.
  - 1. Tube: ASTM B306.
  - 2. Fittings:
    - a. Solder type.
    - b. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper conforming to ASTM B75 C12200, 125 to 150 mm (5 to 6 inch) bronze casting conforming to ASTM B584, CDA 844(81-3-7-9). Mechanical grooved couplings, ductile iron, ASTM A536 (Grade 65-45-12), or malleable iron, ASTM A47 (Grade 32510) housings, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.

3. Joints: ASTM B32, 50/50, special alloy, lead free. Solder using non-corrosive flux.

## **2.2 INTERIOR DOMESTIC WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, type K or L, drawn.
- B. Fittings for Copper Tube:
  1. Wrought copper or bronze castings conforming to ANSI B16.18 and B16.22. Unions shall be bronze, Fed. Spec. WW-U-516. Solder or braze joints.
  2. 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. Adapters: Provide adapters for joining screwed pipe to copper tubing.
- D. Solder: ASTM B32 Composition Sb5 HA or HB. Provide non-corrosive flux.
- E. Brazing alloy: AWS A5.8, Classification BcuP.

## **2.3 EXPOSED WATER, WASTE, AND MEDICAL GAS PIPING**

- A. Finished Room: Use full iron pipe size chrome plated brass piping for exposed water, waste, fuel gas, medical and laboratory gas piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
  1. Pipe: Fed. Spec. WW-P-351, standard weight.
  2. Fittings: ANSI B16.15 cast bronze threaded fittings, (125 and 250).
  3. Nipples: ASTM B 687, Chromium-plated.
  4. Unions: Fed. Spec. WW-U-516, Brass or Bronze. Unions 65 mm (2-1/2 inches) and larger shall be flange type with approved gaskets.
  5. Valves: Fed. Spec. WW-V-35, Brass or bronze.
- B. Unfinished Rooms, Mechanical Rooms and Kitchens: Chrome-plated brass piping is not required. Paint piping systems as specified in Section 09900, PAINTING.

#### **2.4 TRAP PRIMER WATER PIPING:**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- C. Fittings: Bronze castings conforming to ANSI B16.18 Solder joints.
- D. Solder: ASTM B32 composition Sb5. Provide non-corrosive flux.

#### **2.5 VALVES**

- A. Asbestos packing is prohibited.
- B. Shut-off:
  - 1. Cold, Hot and Recirculating Hot Water:
    - A. 2 inches and smaller:
      - A. Ball, Fed. Spec. WW-V-35, Type II, Class 125, Style 1, three piece or double union end construction, full ported, full flow, with solder end connections, 2750 kPa (400 psi) WOG, MSS-SP-67.
      - B. Larger than 2 inches: Butterfly, iron body, aluminum bronze disc, 416 stainless steel stem, EPDM seat, wafer design, lever operator to six 6 inch size, Fed. Spec WW-V-1967.
- C. Balancing:
  - 1. Hot Water Recirculating, 2 inches and smaller: Combination type, calibrated, bronze with bronze disc, equipped with readout valves with integral check valve, indexing position pointer and calibrated name plate, internal EPT O-ring seals and factory molded insulating enclosures.
- D. Check:
  - 1. Less than 3 inches: Bronze body and trim, swing type, MSS-SP-80, 125 pound WSP.
  - 2. Larger than 4 inches and larger:
    - a. Iron body, bronze trim, swing type, vertical or horizontal installation, flange connections, 1375 kPa (200 pound) WOG.
    - e. Ductile iron (ASTM A536) or malleable iron (ASTM A47) body, stainless steel or aluminum bronze trim, dual disc, spring loaded, non-slamming design with grooved ends for connection with mechanical grooved couplings. Consult manufacturer for appropriate elastomeric seal for intended service. Maximum working pressure 500 pounds psi, depending on size.



E. Globe:

1. 3 inches or smaller: Bronze body and bonnet, MSS-SP-80, 125 pound WSP.
2. Larger than 3 inches: Similar to above, except with cast iron body and bronze trim.

**2.6 WATER PRESSURE REDUCING VALVE AND CONNECTIONS**

- A. Single-seated, for dead end service for 30 to 125 pounds range on low pressure side. Composition diaphragm and stainless steel springs, bronze body with threaded connections for sizes 1/2 to 2 inches, cast iron or semi-steel body with brass or bronze trimmings and flanged connections for sizes 2-1/2 to 4 inches.
- B. Operation: Diaphragm and spring to act directly on valve stem. Delivered pressure shall vary not more than one pound for each 10 pounds variation on inlet pressure.
- C. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- D. Connections Valves and Strainers: Install shut off valve on each side of reducing valve and full sized bypass with shut off valve. Install strainer on inlet side of, and same size as pressure reducing valve.

**2.7 AIR PRESSURE REDUCING VALVE AND CONNECTIONS**

Under 3 inches, bronze body and trim, 3 inches and over, cast-iron body with bronze trim. Single seated, for dead end service for 30 to 150 pounds range on low pressure side. Composition diaphragm and bronze spring to act directly on valve stem. Delivered pressure shall not vary more than one pound for each 10 pounds variation in inlet pressure.

**2.8 BACKWATER VALVE**

- A. Flat type, hinged or pivoted, with revolving disc. Cast iron body with cleanout of sufficient size to permit removal of interior parts. Hinge, pivot, disc and seat shall be nonferrous metal. Normal position of disc shall be slightly open. Extend the cleanout to the finished floor and fit with threaded countersunk plug. Provide clamping device wherever the cleanout extends through the membrane waterproofing.

**2.9 CLEANOUTS**

- A. Same size as the pipe, up to 4 inches; not less than 4 inches for larger pipe. Cleanouts shall be easily accessible. Provide a minimum clearance of 24 inches for the rodding.
- B. In Floors: Floor cleanouts shall have cast iron body and frame with square adjustable scoriated secured nickel bronze top. Unit shall be vertically adjustable for a minimum of 2 inches. When a waterproof membrane is used in the floor system, provide clamping collars on the cleanouts. Cleanouts shall consist of "Y" fittings

and 1/8 inch 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, provide carpet cleanout markers. Provide two way cleanouts where indicated on drawings.

- C. Provide cleanouts at or near the base of the vertical stacks with the cleanout plug located approximately 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. Extend the cleanouts to the wall access cover. Cleanout shall consist of sanitary tees. Furnish nickel-bronze square frame and stainless steel cover with minimum opening of 6 by 6 inches at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed roughing work, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required by the NPHCC National Standard Plumbing Code.
- 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.

## **2.10 FLOOR DRAINS**

- A. ANSI A112.21.1. Provide a caulking flange for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe, and side outlet when shown. Provide membrane clamp and extensions if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, provide a 16-ounce soft copper membrane, 24 inches square.
- B. Type B: Galvanized cast iron with medium duty nickel bronze grate, double drainage pattern, clamping device, without sediment bucket but with secondary strainer in bottom.
- C. Type C: Cast iron body, double drainage pattern, clamping device, light duty square or round nickel bronze adjustable strainer and grate with vandalproof screws. 6 inch minimum square grate.
- D. Type D: Cast iron drain with flange, integral reversible clamping device, seepage openings and 7 inch diameter or square satin nickel bronze or satin bronze strainer with 4 inch flange for synthetic covering.
- E. Type E: Heavy, japanned cast iron body, double drainage pattern, heavy non-tilting nickel bronze ductile iron grate not less than 12 inches square, removable sediment bucket. Clearance between body and bucket shall be ample for free flow of waste water. For traffic use ductile iron grate.

- F. Type F: Cast iron drain with flange, integral reversible clamping device, seepage openings and a 9 inch two-piece satin nickel-bronze or satin bronze strainer for use with seamless vinyl floors.
- G. Type G: Cast iron body, shallow type with double drainage flange with removable, perforated aluminum sediment bucket with all interior exposed surfaces provided with acid resistant porcelain enamel finish and clamping device. Frame and grate, shall be nickel bronze. Grate shall be approximately 8 inches in diameter. Space between body of drain and basket to be ample for free flow of waste water.
- H. Type H: Cast iron body, double drainage pattern, without sediment bucket but with loose set nickel bronze grate, secondary strainer, and integral clamping collar; 12 inches in diameter or 12 inches square and approximately 6 inches deep.
- I. Type I: Cast iron body, wide flange for seamless floor, double drainage pattern, with all interior exposed surfaces provided with acid resistant enamel finish, clamping device, secured nickel bronze rim, aluminum enameled finish sediment basket, perforated with not less than 30 square inches of free area, approximately 4 inches deep, and be provided with grips for easy handling; loose-set, nickel bronze grate approximately 12 inches square and of sufficient strength to support pedestrian traffic. Provide ample space between body of drain and sediment basket for free flow of waste liquids.
- J. Type J: Flushing Rim Drain. Heavy cast iron body, double drainage pattern with flushing rim and clamping device. Nickel bronze grate approximately 11 inches in diameter, flush with floor. Attach deep-seal P-trap to drain. Body and trap shall have pipe taps for water supply connections.
1. Drain Flange: Flange for synthetic flooring.
  2. Flush Valve: Large diaphragm flushometer, exposed, side oscillating handle, see detail shown on drawings.
- K. Type K: Flushing Rim Drain. Heavy cast iron body, double drainage pattern with flushing rim and clamping device. Solid bronze gasketed grate approximately 11 inches in diameter, flush with floor. Attach deep-seal P-trap to drain. Body and trap shall have pipe taps for water supply connections.
1. Drain Flange: Flange for synthetic flooring.
  2. Flush Valve: Large diaphragm flushometer, exposed, side oscillating handle, see detail shown on drawing.
- L. Type L: Flushing Rim Drain. Heavy cast iron body, double drainage pattern with flushing rim and clamping device. Solid bronze gasketed grate approximately 11 inches in diameter, with 2 inch length of 3/4 inch brass pipe brazed or threaded into the center of the solid grate, pipe shall be threaded and provide brass cap with inter gasket (neoprene) to provide a gas tight installation.

Attach deep-seal P-trap to drain. Body and trap shall have pipe taps for water supply connections.

1. Drain Flange: Flange for synthetic flooring.
- M. Type M: Cast iron body, nickel bronze adjustable funnel strainer and clamping device. Funnel strainer shall consist of a perforated floor-level square or round grate and funnel extension. Minimum dimensions as follows:
1. Area of strainer and collar - 36 square inches.
  2. Height of funnel - 3-3/4 inches.
  3. Diameter of lower portion of funnel - 2 inches.
  4. Diameter of top portion of funnel - 4 inches.
  5. Provide paper collars for construction purposes.

## **2.11 TRAPS**

Provide 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 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.

## **2.12 TRAP PRIMERS**

- A. Trap Primer: Hydraulic.
1. 1/2 inch Inlet/1/2 inch Outlet fully automatic, all brass trap primer valve, activated by a drop in building water pressure, no adjustment required. Model for one (1) to four (4) traps with distribution unit, may be located anywhere in an active cold water line, as indicated on the drawings or as required by code. ASSE Standard 1018. Omit distribution unit when serving a single trap.

## **2.13 BACKFLOW PREVENTERS**

- A. Provide a backflow prevention device at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. Device shall be certified by the American Society of Sanitary Engineers. Listed below is a partial list of connection to the potable water system which shall be protected against backflow or back siphonage.
- B. Reduced Pressure Backflow Preventer: ASSE 1013.
1. Deionizers.
  2. Sterilizers.

3. Stills.
  4. Dialysis, Deionized or Reverse Osmosis Water Systems.
  5. Water make-up to heating systems, cooling tower, chilled water system, and generators.
  6. Water service entrance from loop system.
- C. Pressure Type: ASSE 1020
1. Water make-up to heating systems, cooling tower, chilled water system, and generators.
- D. Atmospheric Vacuum Breaker: ASSE 1001
1. Hose bibs and sinks w/threaded outlets.
  2. Disposers.
  3. All kitchen equipment, if not protected by air gap.

#### **2.14 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.

#### **2.15 STRAINERS**

- A. Provide on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Gas Lines: "Y" type with removable mesh lined brass strainer sleeve.
- C. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- D. Body: Smaller than 3 inches, brass or bronze; 3 inches and larger, cast iron or semi-steel.

#### **2.16 DIELECTRIC FITTINGS**

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

#### **2.17 STERILIZATION CHEMICALS**

- A. Liquid Chlorine: Fed. Spec. BB-C-120.

- B. Hypochlorite: Fed. Spec. 0-C-114, or Fed. Spec. 0-S-602, grade B.

## **2.18 WATER HAMMER ARRESTER:**

- A. Closed copper tube chamber with permanently sealed 60 psig air charge above a triple o-ring piston. Three 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. 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 and 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.
  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 valves with stem in horizontal position whenever possible. All valves shall be easily accessible. Install valve in each water connection to fixture.
  5. Install union and shut-off valve on pressure piping at connections to equipment.
  6. All gravity waste drain lines inside the building with vertical drops over 20 feet shall be provided with joint restraint on the vertical drop and horizontal offset or branch below the vertical drop. Joint restraint shall be accomplished by threaded, soldered, lead and oakum or grooved joints or a combination of pipe clamps and tie-rods as detailed in NFPA 24. Vertical joint restraint shall be provided from the fitting at the bottom of the vertical drop through every joint up to the riser clamp at the floor penetration of the floor above. Horizontal joint restraint shall be provided from the same fitting at the bottom of the vertical drop through every joint on the horizontal offset or branch for a minimum of 60 feet or to anchoring point

from the building structure. Joint restraint below ground shall be accomplished by thrust blocks detailed in NFPA 24.

7. All piping shall be supported per of the National Standard Plumbing Code, Chapter No. 8. If the vertical distance exceeds 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.
8. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
9. Penetrations (see Section 07270) - Fire Stopping):
  - 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 07270, 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 07920, SEALANTS AND CAULKING.

B. Piping shall conform to the following:

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

	Pipe Size	Minimum Pitch
a.	2 inches and smaller	1/4" to the foot.
b.	4 inches and larger	1/8" to the foot.
2. Exhaust Vent: Extend separately through roof. Sanitary vents shall not connect to exhaust vents.
3. 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.
  - c. Core Drilling - where core drilling, cutting of floors or wall is required, the contractor shall x-ray areas to determine and avoid interference with existing concealed feeders, pipes or other utilities.

### 3.2 TESTS

- A. General: Test system either in its entirety or in sections.
- B. Soil, Waste, Storm Water Drain, Vent: Conduct water test or air test, as directed.
  - 1. Water Test: If entire system is tested, tightly close all openings in pipes except 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 10 foot head of water. In testing successive sections, test at least upper 10 feet of next preceding section so that each joint or pipe except upper most 10 feet of system has been submitted to a test of at least a 10 foot head of water. Keep water in system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
  - 2. Air Test: Maintain air pressure of 5 psi gage for at least 15 minutes without leakage. Use force pump and mercury column gage.
  - 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 one inch of water with a smoke machine. Chemical smoke is prohibited.
    - b. Peppermint Test: Introduce (two ounces) of peppermint into each line or stack.
- C. Potable Water System: Test after installation of piping but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 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.
- D. Fuel Gas System: NFPA 54.
- E. 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.
- C. Furnish Testing Lab Report prior to beneficial occupancy.

- - - E N D - - -



PART 1 - GENERAL

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

- A. Sealing between fixtures and other finish surfaces: Section 07920, SEALANTS AND CAULKING.
- B. Flush panel access doors: Section 08305, ACCESS DOORS.
- C. Through bolts: Section 10162, TOILET PARTITIONS AND URINAL SCREENS.
- D. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.

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

VA Hines Emergency Dept.

- D. National Association of Architectural Metal Manufacturers (NAAMM):  
Metal Finishes Manual (1988)
- E. American Society of Sanitary Engineers (ASSE):  
1016-88 . . . . . Individual Thermostatic, Pressure  
Balancing and Combination Control Valves  
for Bathing Facilities

## **PART 2 - PRODUCTS**

### **2.1 STAINLESS STEEL**

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

### **2.2 STOPS**

- A. Provide lock-shield loose key or screw driver pattern angle stops, straight stops or stops integral with faucet, with each compression type faucet whether specifically called for or not, including sinks in wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.
- B. Furnish keys for lock shield stops to Resident Engineer.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe
- E. Psychiatric Area: Provide stainless steel drain guard for all lavatories not installed in casework.

### **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 LAMINAR FLOW CONTROL DEVICE**

- A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear,

coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.

B. Flow Control Restrictor:

1. Capable of restricting flow from 1.5 to 1.7 gpm for lavatories; 2.0 to 2.2 gpm for clinic service sink; and 2.75 to 3.0 gpm for dietary food preparation and rinse sinks.
2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 25 and 80 psi.
3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-clearing action, and is capable of easy manual cleaning.

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

## **2.5 CARRIERS**

- A. ASME/ANSI A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down.
- B. ASME/ANSI A112.6.1M, lavatory, chair carrier for thin wall construction steel plate as detailed on drawing. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.
- C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers.

## **2.6 FIXTURES**

- A. Plumbing fixture type designation are indicated on the drawings.

## **PART 3 - EXECUTION**

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section, SEALANTS AND CAULKING.
- 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 TOILET PARTITIONS AND URINAL SCREENS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 1/4-inch diameter bolts, and to extend at least 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 1/4-inch threaded studs, and shall extend at least 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.

- - - E N D - - -

**SECTION 15705  
HVAC PIPING SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Water piping to connect HVAC equipment, including the following:
  - 1. Chilled water, heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping.
  - 3. Glycol-water piping.
- B. Steam, condensate and vent piping inside buildings.

**1.2 RELATED WORK**

- A. General mechanical requirements and items, which are common to more than one section of Division 15: Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Piping insulation: Section 15250, INSULATION.
- C. Temperature and pressure sensors and valve operators: Section 15902, CONTROLS AND INSTRUMENTATION.

**1.3 QUALITY ASSURANCE**

Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL), which includes welding qualifications.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
  - 1. Pipe and equipment supports.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Valves of all types.
  - 6. Strainers.
  - 7. Flexible connectors for water service.

8. Pipe alignment guides.
  9. Flexible ball joints: Catalog sheets, performance charts, schematic drawings, specifications and installation instructions.
  10. All specified steam system components.
  11. All specified hydronic system components.
  12. Gages.
  13. Thermometers and test wells.
- C. Coordination Drawings: Refer to Article, SUBMITTALS of Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- D. As-Built Piping Diagrams: Provide drawing as follows for chilled water, and heating hot water system and other central plant equipment.
1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.
  2. One set of reproducible drawings.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American National Institute Standard (ANSI):
- B1.20.1-01 . . . . . Pipe Threads, General Purpose (Inch)
- C. American Society of Mechanical Engineers (ASME):
- B16.1-98 . . . . . Cast Iron Pipe Flanges and Flanged Fittings
- B16.3-98 . . . . . Malleable Iron Threaded Fittings
- B16.4-98 . . . . . Gray Iron Threaded Fittings
- B16.9-01 . . . . . Factory-Made Wrought Butt welding Fittings
- B16.11-02 . . . . . Forged Fittings, Socket-Welding and Threaded
- B16.14-91 . . . . . Ferrous Pipe Plugs, Bushings, and Locknuts with Pipe Threads
- B16.22-98 . . . . . Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

B16.23-92 . . . . . Cast Copper Alloy Solder Joint Drainage Fittings

B16.24-01 . . . . . Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500

B16.39-98 . . . . . Malleable Iron Threaded Pipe Unions, Classes 150, 250, and 300

B31.1-01 . . . . . Power Piping

B31.9-96 . . . . . Building Services Piping

B40.100-98 . . . . . Pressure Gauges and Gauge Attachments

Boiler and Pressure Vessel Code: SEC VIII D1-2001, Pressure Vessels, Division 1

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

A47-99 . . . . . Ferritic Malleable Iron Castings

A53-01 . . . . . Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A106-99 . . . . . Seamless Carbon Steel Pipe for High-Temperature Service

A126-01 . . . . . Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

A181-01 . . . . . Carbon Steel Forgings, for General-Purpose Piping

A183-98 . . . . . Carbon Steel Track Bolts and Nuts

A216-98 . . . . . Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service

A285-01 . . . . . Pressure Vessel Plates, Carbon Steel, Low-and-Intermediate-Tensile Strength

A307-00 . . . . . Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

A516-01 . . . . . Pressure Vessel Plates, Carbon Steel, for Moderate-and- Lower Temperature Service

A536-99 . . . . . Standard Specification for Ductile Iron Castings

B32-00 . . . . . Solder Metal

- B61-93 . . . . . Steam or Valve Bronze Castings
- B62-93 . . . . . Composition Bronze or Ounce Metal Castings
- B88-99 . . . . . Seamless Copper Water Tube
- F439-01 . . . . . Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
- F441-99 . . . . . Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
- E. American Welding Society (AWS):
  - A5.8-92 . . . . . Filler Metals for Brazing and Braze Welding
  - B2.1-00 . . . . . Welding Procedure and Performance Qualifications
- F. Manufacturers Standardization Society (MSS) of the Valve and Fitting Industry, Inc.:
  - SP-67-95 . . . . . Butterfly Valves
  - SP-70-98 . . . . . Cast Iron Gate Valves, Flanged and Threaded Ends
  - SP-71-97 . . . . . Gray Iron Swing Check Valves, Flanged and Threaded Ends
  - SP-72-99 . . . . . Ball Valves with Flanged or Butt-Welding Ends for General Service
  - SP-78-98 . . . . . Cast Iron Plug Valves, Flanged and Threaded Ends
  - SP-80-97 . . . . . Bronze Gate, Globe, Angle and Check Valves
  - SP-85-94 . . . . . Cast Iron Globe and Angle Valves, Flanged and Threaded Ends
- G. Military Specifications (Mil. Spec.):
  - MIL-S-901D-1989 . . . . . Shock Tests, H.I. (High Impact) Shipboard Machinery, Equipment, and Systems
- H. National Board of Boiler and Pressure Vessel Inspectors (NB):  
Relieving Capacities of Safety Valves and Relief Valves
- I. Tubular Exchanger Manufacturers Association: TEMA 18th Edition, 2000



## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

Provide in accordance with Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

### **2.2 PIPE AND TUBING**

- A. Chilled Water, Heating Hot Water, Glycol-Water, and Vent Piping:
  - 1. Steel: ASTM A53 Grade B, seamless or ERW, Schedule 80.
- B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.
- C. Steam Piping: Steel, ASTM A53, Grade B, seamless or ERW; A106 Grade B, Seamless; Schedule 80.
- D. Steam Condensate Piping:
  - 1. Concealed above ceiling, in wall or chase: Steel, ASTM A53, Grade B, seamless or ERW.
  - 2. All other locations: Steel, ASTM A53, Grade B, Seamless or ERW, or A106 Grade B Seamless, SCH 80.
- E. Cooling Coil Condensate Drain Piping:
  - 1. From air handling units: Copper water tube, ASTM B88, Type L.
  - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type L for runouts and mains.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. Chilled water, heating hot water, glycol-water, and vent piping:
  - 1. 2" inches and Smaller: Screwed or welded
    - a. Butt welding: ASME D16.9 with same wall thickness as connecting piping, 300 lb.
    - b. Forged steel, socket welding or threaded: ASME B16.11 with same wall thickness as connecting pipe, 300 lb.
    - c. Screwed: ASME B16.3, 300 lb cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
    - d. Unions: ASME B16.39.
    - e. Water hose connectin adapter: Brass, pipe thread to 3/4 inch garden hose thread, with hose cap nut.

2. 2-1/2 inches and Larger: Welded or flanged joints, 300 lbs.
    - a. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, 300 lb.
    - b. Welding flanges and bolting: ASME B16.5: 300 lb weld neck or slip on, plain face, with 1/8 inch thick full face neoprene gasket suitable for 220 degree F.
    - c. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- B. Steam and Steam Condensate Piping:
1. 2" inches and smaller: Screwed or welded
    - a. Butt welding: ASME B16.9 with same wall thickness as connecting piping, 300 lb.
    - b. Forged steel, socket welding or threaded: ASME B16.11 with same wall thickness as connecting pipe, 300 lb.
    - c. Screwed: Provide 300 pound malleable iron, ASME B16.3 for steam and steam condensate piping. Cast iron fittings for piping are not acceptable for steam and steam condensate piping. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
    - d. Unions: ASME B16.39.
    - e. Steam line drip station and strainer quick-couple blowdown hose connection: straight through, plug and socket, screw or locking type.
  2. 2-1/2 inches and larger: Welded or flanged joints, 300 lbs.
    - a. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, 300 lb.
    - b. Welding flanges and bolting: ASME B16.5: weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall be designed for the service conditions such as "Lamons Spiraseal", "Flexitallic Spiral-round", Lamons Grafoil Grade GHR", or equal.
    - c. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and thredolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gage connections.
- D. Dielectric not allowed for steam, condensate and steel piping - use brass.

E. Sprinkler Piping:

1. Mechanical Pipe Couplings and Fittings: May be used, with cut or roll grooved pipe, in water service up to 230 degrees F in lieu of welded, screwed or flanged connections.
  - a. Grooved mechanical couplings: Malleable iron, ASTM A47 or ductile iron, ASTM A536, fabricated in two or more parts, securely held together by two or more track-head, square, or oval-neck bolts, ASTM A183.
  - b. Gaskets: Rubber product recommended by the coupling manufacturer for the intended service.
  - c. Grooved and fittings: Malleable iron, ASTM A47; ductile iron, ASTM A536; or steel, ASTM A53 or A106, designed to accept grooved mechanical couplings. Tap-in type branch connections are acceptable.

**2.4 FITTINGS FOR COPPER TUBING**

A. Solder Joint:

1. Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall insure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.

B. Bronze Flanges and Flanged Fittings: ASME B16.24.

**2.5 DIELECTRIC FITTINGS (DOMESTIC WATER PIPING ONLY)**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 2 inches and Smaller: Threaded dielectric union, ASME B16.39.
- A. 2 1/2 inches and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- B. Temperature Rating, 210 degrees F for water systems, 250 degrees F for steam condensate and as required for steam service.

**2.6 SCREWED JOINTS**

- A. Pipe Thread: ANSI B1.20.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## 2.7 VALVES

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer. Provide gate and globe valves with packing that can be replaced with the valve under full working pressure.
- C. Provide chain operators for valves 4 inches and larger when the centerline is located 8 feet or more above the floor or operating platform.
- D. Gate Valves:
  - 1. Domestic, Chilled and Heating Water Piping:
    - a. 2 inches and smaller: MSS-SP80, Bronze, 150 lb., wedge disc, rising stem, union bonnet.
    - b. 2 1/2 inches and larger: Flanged, outside screw and yoke.
  - 2. Steam and Steam Condensate Piping:
    - a. All pressure steam 0 psig to 60 psig and above nominal MPS system: Cast steel body, 250/300 lb. ASTM A216 grade WCB, 150 psig at 500 degrees F, 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide factory installed bypass with globe valve on valves 4 inches and larger.
    - b. All other services: MSS-SP 70, iron body, bronze mounted, 150 psig wedge disc.
- E. Globe, Angle and Swing Check Valves:
  - 1. Domestic, Chilled and Heating Water Piping:
    - a. 2 inches and smaller domestic, chilled water: MSS-SP 80, bronze, 150 lb. Globe and angle valves shall be union bonnet with metal plug type disc.
    - b. 2 1/2 inches and larger: MSS-SP 70, iron body, bronze mounted, 150 psig wedge disc.
- F. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
  - 1. Body: Cast iron, ASTM A126, Class B, or steel, ASTM A216, Class WCB, or ductile iron, ASTM 536, flanged, grooved, or wafer type. 150 lb.
  - 2. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.

3. Steam and Condensate: All pressure steam 0 psig to 60 psig and above nominal MPS system: Cast steel body, 250/300 lb. ASTM A216 grade WCB, 150 psig at 500 degrees F, 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide factory installed bypass with globe valve on valves 4 inches or larger.
- G. Butterfly Valves: May be used in lieu of gate valves in water service except for direct buried pipe. Provide stem extension to allow 2 inches of pipe insulation without interfering with valve operation.
1. MSS-SP 67, flange lug type (for end of line service) or grooved end rated 175 psig working pressure at 200 degrees F.
    - a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47 electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated. 150 lbs.
    - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
    - c. High pressure steam 60 psig plus and above nominal MPS system: Cast steel body, 250/300 lb. ASTM A216 grade WCB, 150 psig at 500 degrees F, 11-1/2 to 13 percent chrome stainless steel solid disc and seals. Provide factory installed bypass with globe valve on valves 4 inches and larger.
    - d. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
      - 1) Valves 6 inches and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
      - 2) Valves 8 inches and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.

**(Note: H through K not for steam or steam condensate.)**

- H. Ball Valves: Brass or bronze body with chrome-plated ball with full port and Teflon seat at 400 psig working pressure rating. Screwed or solder connections. Provide stem extension to allow operation without interfering with pipe insulation.
- I. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size and be one of the following types.
1. Butterfly valve as specified herein with memory stop.

2. Eccentric plug valve: Iron body, bronze or nickel-plated iron plug, bronze bearings, adjustable memory stop, operating lever, rated 125 psig and 250 degrees F.
- J. Circuit Setter Valve: A dual purpose flow balancing valve and adjustable flow meter, with bronze or cast iron body, calibrated position pointer, valved pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case. \
- K. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
1. Gray iron (ASTM A126) or brass body, rated 175 psig at 200 degrees F, with stainless steel piston and spring.
  2. Brass or ferrous body designed for 300 psig service at 250 degrees F, with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
  3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
  4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

## 2.9 FLEXIBLE CONNECTORS FOR WATER SERVICE

- A. Flanged Spool Connector:
1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
  2. Working pressures and temperatures shall be as follows:
    - a. Connector sizes 2 inches to 4 inches, 165psig at 250 degrees F.
    - b. Connector sizes 5 inches to 12 inches, 140 psig at 250 degrees F.
  3. Provide ductile iron retaining rings and control units.
- B. Mechanical Pipe Couplings:

See other fittings specified under Part 2, PRODUCTS.

## **2.10 GAGES, PRESSURE AND COMPOUND**

- A. ASME B40.1, Accuracy Grade 1A, (pressure, vacuum, or compound for air, steam, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 4-1/2 inches in diameter, 1/4 inch NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass, lever handle union cock. Provide brass/bronze pressure snubber for gages in water service. Provide brass pigtail syphon for steam gages.
- C. Range of Gages: For services not listed provide range equal to at least 130 percent of normal operating range:

## **2.11 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Pete's Plug: 1/4 inch MPT by 3 inches long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gage test connections shown on the drawings.
- B. Provide one each of the following test items to the Resident Engineer:
  - 1. 1/4 inch FPT by 1/8 inch diameter stainless steel pressure gage adapter probe for extra long test plug. PETE'S 500 XL is an example.
  - 2. 3-1/2 inch diameter, one percent accuracy, compound gage, 30 inches Hg to 100 psig range.
  - 3. 0 - 220 degrees F pocket thermometer one-half degree accuracy, one inch dial, 5 inch long stainless steel stem, plastic case.

## **2.12 THERMOMETERS**

- A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 6 inch brass stem, straight, fixed or adjustable angle as required for each in reading.
- B. Case: Chrome plated brass or aluminum with enamel finish.
- C. Scale: Not less than 9 inches, range as described below, two degree graduations.
- D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.
- E. Scale ranges may be slightly greater than shown to meet manufacturer's standard. Required ranges in degrees F:

Chilled Water and Glycol- Water 0 to 32-100 degrees F	Hot Water and Glycol-Water - 30 to 240 degrees F.
--	--

## **2.13 FIRESTOPPING MATERIAL - See Section 07270**

Refer to Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- B. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- C. Support piping securely. Refer to PART 3, Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL). Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
- D. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide one inch minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than one inch in 40 feet. Provide eccentric reducers to keep bottom of sloped piping flat.
- E. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.
- F. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.



- G. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- H. Thermometer Wells: In pipes 2-1/2 inches and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- I. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 15250, INSULATION.
- J. Where copper piping is connected to steel piping, provide dielectric connections.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1. See Welder's qualification requirements under "Quality Assurance" in Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Screwed: Threads shall conform to ASME B1.20; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. Mechanical Joint: Pipe grooving shall be in accordance with joint manufacturer's specifications. Lubricate gasket exterior including lips, pipe ends and housing interiors to prevent pinching the gasket during installation. Lubricant shall be as recommended by coupling manufacturer.
- D. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- E. Solvent Welded Joints: As recommended by the manufacturer.

### **3.3 STEAM TRAP PIPING**

Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 25 pounds independently of connecting piping.

### **3.4 LEAK TESTING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the Resident Engineer. Tests may be either of those below, or a combination, as approved by the Resident Engineer.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems the design maximum pressure would usually be the static head, or

expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.

### **3.5 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Steam, Condensate and Vent Piping: No flushing or chemical cleaning required. Accomplish cleaning by pulling all strainer screens and cleaning all scale/dirt legs during start-up operation.
- B. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 15704, WATER TREATMENT (HVAC).
  - 1. Initial flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless acceptable means of protection are provided and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/S (6 feet per second), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the Resident Engineer.
  - b. Cleaning: Using products supplied in Section 15704, WATER TREATMENT, (HVAC), circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 6 feet per second. Circulate each section for not less than four hours. Blow-down all strainers, or remove and clean as frequently as necessary. Drain and prepare for final flushing.
  - c. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### 3.6 OPERATING AND PERFORMANCE TEST AND INSTRUCTION

- A. Refer to PART 3, Section 15050, BASIC METHOD AND REQUIREMENTS (MECHANICAL).
- B. Adjust red set hand on pressure gages to normal working pressure.

- - - E N D - - -

**SECTION 15740  
TERMINAL UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Air terminal units, air flow control valves, fan-coil units, and unit heaters.

**1.2 RELATED WORK**

- A. Section 01001, GENERAL CONDITIONS;
- B. Section 01010, GENERAL REQUIREMENTS;
- C. Section 01340, SAMPLES AND SHOP DRAWINGS;
- D. Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL);
- E. Section 15200, NOISE AND VIBRATION CONTROL;
- F. Section 15840, DUCTWORK AND ACCESSORIES;
- G. Section 15902, CONTROLS AND INSTRUMENTATION;
- H. Section 15980, TESTING, ADJUSTING, AND BALANCING.

**1.3 QUALITY ASSURANCE**

Refer to Paragraph, QUALITY ASSURANCE, in Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
  - 1. Air Terminal Units: Submit test data.
  - 2. Air flow control valves.
  - 3. Fan-Coil units.
- C. Samples: Provide one typical air terminal unit for approval by the Resident Engineer. This unit will be returned to the Contractor after all similar units have been shipped and deemed acceptable at the job site.

- D. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- E. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01010, GENERAL REQUIREMENTS.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (ARI):
  - 440-97 . . . . . Room Fan-coil and Unit Ventilator
- C. ARI/ADC (Air Diffusion Council) Industry Standard:
  - 880-94 . . . . . Air Terminals
- D. Underwriters Laboratories, Inc. (UL):
  - 181-96 . . . . . UL Standard for Safety Factory-Made Air Ducts and Air Connectors
  - 883-86 . . . . . UL Standard for Safety Fan-Coil Units and Room Fan-Heater Units
- E. National Fire Protection Association (NFPA)
  - 90A-96 . . . . . Standard for the Installation of Air Conditioning and Ventilating Systems
  - 70-96 . . . . . National Electrical Code

#### **1.6 GUARANTY**

In accordance with Section 01001, GENERAL CONDITIONS.

### **PART 2 - PRODUCTS**

#### **2.1 AIR TERMINAL UNITS (BOXES)**

- A. General: Factory built, pressure independent units, factory set-field adjustable volume, suitable for single or dual duct applications, as indicated. Clearly show on each unit the unit number and factory set air volumes corresponding to the contract drawings. Section 15980, TESTING, ADJUSTING AND BALANCING work shall recalibrate in field the factory set air volumes. Coordinate flow controller sequence and damper operation details with Section 15902, CONTROLS AND INSTRUMENTATION (DDC).

- B. Rating and Performance Certification: ARI/ADC Industry Standard 880.
1. Maximum pressure drop: 0.2 in WG (unit alone).
  2. Maximum room sound levels: Not to exceed criteria in Section 15200, NOISE AND VIBRATION CONTROL (Low-pressure duct is usually unlined) at the inlet pressure of not less than 1-1/2 inches WG, if not shown. Provide hospital-grade packless galvanized terminal sound attenuators where necessary to comply with the noise criteria. Sound tests and correction of deficiencies is specified in Section 15980, TESTING, ADJUSTING AND BALANCING.
- C. Casing: Construct portions of casing exposed to high upstream static pressures of die cast aluminum, 24 gage galvanized sheet metal, or equivalent strength aluminum sheet. Downstream portions of casing may be constructed of not lighter than 24 gage galvanized sheet metal, or equivalent strength aluminum sheet. Provide hanger brackets for attachment of supports.
1. Lining material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A and comply with UL 181 for erosion, one-half inch minimum thickness, secured to supporting surfaces in such a manner that it will not sag, delaminate, or settle. Comply with UL Standard 181 for erosion. Surfaces, including all edges, shall be faced with perforated metal or coated so that the air stream will not detach material.
  2. Access panels (or doors): Provide panels large enough for access to all moving parts (except neoprene bellows when bellows are the only moving part) for inspection, adjustment and maintenance without disconnecting ducts, and for access for cleaning heating coil attached to unit. Panels shall be flush, gasketed airtight and shall have cam-locks, and require no tool other than a screwdriver to remove.
  3. Total leakage from casing: Not to exceed 3 percent of the nominal capacity of the unit when subjected to a static pressure of 1/2-inch water gages, with all outlets sealed shut and inlets fully open.
- D. Construct dampers and other internal devices of corrosion resisting materials which do not require lubrication or other periodic maintenance.
- E. Dual Duct Terminals (Mixing Boxes): Units shall be complete with hot and cold duct inlet valves or dampers to be controlled in unison by a single actuator or by individual actuators. Provide integral temperature equalizing grids within the box to produce an effectively equalized mixed air temperature at the box discharge. Temperature gradient at the box discharge shall not exceed one degree F for every 10 degree temperature difference at the box inlets. Internal leakage shall be limited to two percent of

nominal box capacity when the internal pressure is 0.5 inch water gage.

1. Constant volume units: Provide pressure independent electronic controls to maintain outlet volume with a maximum variation of five percent through a range in incoming air pressure from 0.25 to 5.0 inches water gage.
  2. Variable volume units: Provide pressure independent electronic controls with a variable constant volume controller with factory set, field adjustable, minimum and maximum CFM. Unless indicated otherwise the intent is to provide variable volume cold air down to preselected minimum, then mix hot and cold air at the minimum CFM to satisfy the room. The hot air CFM is not to exceed the minimum set CFM.
- F. Terminal Sound Attenuators: Construction shall be similar to sound attenuators in section 15840, DUCTWORK AND ACCESSORIES.

## **2.2 AIR FLOW CONTROL VALVE (AFCV)**

- A. Provide where shown to control isolation room exhaust and supply.
- B. Units shall be normally open, constant volume, DDC control type with attenuators required to meet room NC criteria. Air terminal units (boxes) may be used for this service.

## **2.3 ROOM FAN-COIL UNITS**

- A. Capacity Certification: ARI 440.
- B. Safety Compliance: NEC and UL 833.
- C. Noise Levels: Operating at full cooling capacity, sound power level shall not exceed by more than 5 dB the numerical value of sound pressure levels associated with noise criteria specified in Section, NOISE AND VIBRATION CONTROL. Select units at intermediate speed, if necessary, to meet the noise criteria.
- D. Chassis: Galvanized steel acoustically and thermally insulated where necessary to attenuate noise and prevent condensation.
- E. Cabinet Type: Not lighter than 18 gage steel for horizontal units, reinforced and braced. Arrange components and provide adequate space for installation of piping package and control valves. Finish shall be factory-baked enamel in manufacturer's standard color as selected by the architect. Provide synthetic rubber or polyurethane gasket for air-tight installation to the wall for wall units.
  1. Vertical Unit: Provide 16 gage steel front panel with 1/2-inch thick fiberglass liner with NFPA-90A coating and provide screw-type levelers.
    - a. Air outlet grilles: One-way fixed air deflection located in the top panel.

- b. Provide two hinged access doors (one each side) equipped with key operated cam-lock fasteners in the unit top panel located to provide access to the unit controls.
  - 2. Horizontal Unit: Hinged bottom access panel with cam-lock fasteners. Provide stamped integral discharged grilles in front of cabinet, if exposed.
- F. Concealed Units: Enclosed type with inlet and outlet duct collars.
- G. Fans: Centrifugal, direct drive, galvanized steel or polyester resin.
  - 1. Motors: Three speed permanent split capacitor type with integral thermal overload protection, for operation at not more than 1200 RPM.
  - 2. Provide a fan speed selector switch, with off position, mounted in a junction box in the cabinet of each unit. Switch shall have a set of auxiliary contacts which are open when the switch is in the "off" position and closed when the switch in either of the other positions.
- H. Cooling and Heating Coils:
  - 1. Hydronic (two separate coils): Copper tubes, three-eighths inch minimum inside diameter, not less than 0.028 inch thick with aluminum fins. Coils shall be designed for minimum 250 psig working pressure and pressure tested at 375 psig for bursting and strength in accordance with Underwriters Laboratories, Inc., requirements for pressure tested coils, and shall be designed to provide adequate heat transfer capacity. Provide manual air vent at high point of coil.
- I. Piping Package: Furnished with unit by the manufacturer to fit control valves provided by the controls supplier. Submit manufacturer's detailed drawings of the piping in the end compartments, for approval, prior to fabrication of the piping packages. Provide gate or globe shutoff valves on the supply and return pipes and balancing fittings on the return pipes.
- J. Drain Pan: Galvanized steel, or carbon steel bonderized and finished with not less than two coats of baked enamel or equally durable finish, and of strength to requirement of function it performs in unit. Inside or outside surfaces of drain pan shall be coated with mastic type insulation or closed cell polyurethane. Provide a similar secondary drain pan, which may be steel or PVC, provided with a drain connection to catch condensation from all piping, coils and primary drain pan.
- K. Air Filter: Manufacturer's standard throwaway type, not less than one inch thick, supported to be concealed from sight and be tight fitting to prevent air by-pass. Filters shall have slide out frames and be easily replaced without removing enclosure or any part thereof.



- L. Control valves and unit mounted return air thermostats are to be field installed.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Handle and install units in accordance with manufacturer's written instructions.
- B. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- C. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. Do not install terminal units over light fixtures.
- D. Protect air terminal units, thermostats, wiring, and accessories from construction dust and damage. After installation, all non-working air terminal units, thermostats, and accessories shall be replaced at no charge.

#### **3.2 OPERATIONAL TEST**

- A. Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).

- - - E N D - - -

**SECTION 15750  
HEATING AND COOLING COILS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Heating and cooling coils for air handling unit and duct applications.

**1.2 RELATED WORK**

- A. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Reheat coils for Air Terminal Units: Section 15740, TERMINALS UNITS.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with ARI Standard 410 and shall bear the ARI certification label.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves. Provide installation, operating and maintenance instructions.
- C. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.
- D. Coils may be submitted with Section, AIR HANDLING UNITS.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning and Refrigeration Institute (ARI):  
Directory of Certified Applied Air Conditioning Products  
  
ARI 410-91 . . . Forced Circulation Air Cooling and Air Heating Coils.
- C. Underwriters Laboratories, Inc. (UL):  
  
1996-96 . . . . . Electric Duct Heaters

## **PART 2 - PRODUCTS**

### **2.1 HEATING AND COOLING COILS**

- A. Tubes: Seamless copper tubing.
- B. Fins: 0.0055 inch aluminum or 0.0045 inch copper mechanically bonded or soldered or helically wound around tubing. Provide copper fins for sprayed coil applications and reheat coils for Operating Rooms.
- C. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.
- D. "U" Bends, Where Used: Machine die formed, silver brazed to tube ends.
- E. Coil Casing: 16 gage galvanized steel with tube supports at 48 inch maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.

- F. Pressures PSIG:

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	300	250	300
Working	200	75	250

- G. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.
- H. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.
- I. Cooling Coil Condensate Drain Pan: Section, AIR HANDLING UNITS.

### **2.2 REHEAT COILS, DUCT MOUNTED**

Continuous circuit booster type for hot water.

### **2.3 WATER COILS, INCLUDING GLYCOL-WATER**

- A. Drainable Type (Self-Draining, Self-Venting):
  - 1. Heating.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Follow coil manufacturer's instructions for handling and installation.
- B. Comb fins if damaged. Eliminate air bypass or leakage at coil sections.

- - - E N D - - -

**SECTION 15822**  
**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 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Section 15200, NOISE AND VIBRATION CONTROL.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, in Section, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- 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. Vibration Tolerance for Fans and Power Ventilators: Section, NOISE AND VIBRATION CONTROL.
- F. Performance Criteria:
  - 1. The fan schedule shows cubic meters per minute (CFM) and design static pressure. Scheduled fan motors, 0.37 kw (1/2 horsepower) and larger, are sized for design cubic meters per minute (CFM) at 110 percent design static pressure, but not to exceed 185 Pa (3/4-inch) additional pressure.
  - 2. Provide fans and motors capable of stable operation at design conditions and at 110 percent pressure as stated above.
  - 3. Lower than design pressure drop of approved individual components may allow use of a smaller fan motor and still provide the safety factor. When submitted as a deviation a smaller motor may be approved in the interest of energy conservation.

4. Select fan operating point as follows:
  - a. Forward curved and axial fans: Right hand side of peak pressure point.
  - b. Airfoil, backward inclined or tubular: Near the peak of static efficiency.
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge exposed to operating and maintenance personnel.
- H. Corrosion Protection: 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 G23 weathermeter.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturers Literature and Data:
  1. Fan sections, motors and drives.
  2. Centrifugal fans, motors, drives, accessories and coatings.
  3. Prefabricated roof curbs.
  4. Roof and wall power ventilators.
- C. Sound power levels for each fan.
- H. Maintenance and operating manuals in accordance with Section 01010, GENERAL REQUIREMENTS.
- I. Fan curves for each fan showing cubic meters per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation and at 110 percent of design static pressure. Include product application data to indicate the effect of capacity control devices such as inlet vane dampers on flow, pressure and Kw (horsepower).

#### **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 Moving and Control Association (AMCA):
  - 99-86 . . . . . Standards Handbook
  - 210-85 . . . . . Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
  - 261 . . . . . Directory of Products Licensed To use the AMCA Certified Ratings Seal - Published Annually
  - 300-96 . . . . . Reverberant Room Method for Sound Testing of Fans
- C. American Society for Testing and Materials (ASTM):
  - B117-97 . . . . . Standard Practice for Operating Salt Spray(Fog) Apparatus.
  - D1735-97 . . . . . Standard Practice for Testing Water Resistance of Coatings Using Water Fog Apparatus
  - D3359-97 . . . . . Standard Test Method for Measuring Adhesion by Tape Test
  - G23-96 . . . . . Standard Practice for Operating Light-Exposure Apparatus(Carbon-Arc Type) with and without Water for Exposure of Non-Metallic Materials
- D. Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA):
  - 9-90 . . . . . Load Ratings and Fatigue Life for Ball Bearings
- E. National Fire Protection Association (NFPA):
  - NFPA 96-98 . . . . . Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- F. National Sanitation Foundation (NSF):
  - 37-92 . . . . . Air Curtains for Entrance Ways in Food and Food Service Establishments

## **PART 2 - PRODUCTS**

### **2.1 CENTRIFUGAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.
- B. Fan arrangement, unless noted or approved otherwise:
  - 1. DWD1 fans: Arrangement 3.
  - 2. SWS1 fans: Arrangement 1, 3, 9 or 10.

- C. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.
1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 1/2" wire mesh screens for fan inlets without duct connections.
  2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
  3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
  4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 40,000 hours, and an average fatigue life of 200,000 hours. Extend lubrication tubes for interior bearings or ducted units to outside of housing.
  5. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section, BASIC METHODS AND REQUIREMENTS (MECHANICAL) for specifications. Provide protective sheet metal enclosure for fans located outdoors.
  6. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section, MOTOR STARTERS. Refer to Section, BASIC METHODS AND REQUIREMENTS (MECHANICAL) for controller/motor combination requirements.
- D. In-line Centrifugal Fans: In addition to the requirements of paragraphs A and C, provide inlet and outlet flanges, bolted access door and arrangement 1, 4 or 9 supports as required.
- E. In-line centrifugal, arrangement 9, vertical up-blast fans, mounting bracket and curb cap, sheet metal weather cover for motor and drive, wind band discharge cap with gravity dampers, and bolted access door, in addition to requirements of paragraphs A and C.
- F. Industrial Fans: Use where scheduled or in lieu of centrifugal fans for low volume high static service. Construction specifications paragraphs A and C for centrifugal fans shall apply. Provide air handling type wheel.
- G. Utility Fans, Vent Sets and Small Capacity Fans: Class 1 design, arc welded housing, spun intake cone. Applicable construction specifications, paragraphs A and C, for centrifugal fans shall apply for wheel diameters 12 inches and larger. Requirement for AMCA seal is waived for wheel diameters less than 12 inches and housings may be cast iron.



## **2.2    PREFABRICATED ROOF CURBS**

- A.    Construction: Galvanized steel, with continuous welded corner seams, two inch wall thickness, treated wood nailer, 1-1/2 inch thick, 3 pound density rigid mineral fiberboard insulation with metal liner, built-in cant strip, (except for gypsum or tectum decks). For surface insulated roof deck provide raised cant strip to start at the upper surface of the insulation. Curbs shall be built for pitched roof or ridge mounting as required to keep top of curb level.
- B.    Curb Height: 12 inches overall curb height.

## **2.3    ROOF OR WALL POWER 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 curb or 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, BASIC METHODS AND REQUIREMENTS (MECHANICAL). Bearings shall be pillow block with B-10 average life of 200,000 hours.
- E.    Prefabricated Roof Curb: As specified in this section.
- F.    TRV Unit: Top discharge exhauster, motor out of air stream, grease trough on base.

## **2.4    CENTRIFUGAL CEILING FANS (SMALL CABINET FAN)**

- A.    Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B.    Steel housing, baked enamel finish, direct connected fan assembly, attached grille. Provide back draft assembly, aluminum wall cap and insect screen.
- C.    Acoustical Lining: One-half inch thick mineral fiber, dark finish.
- D.    Motor: Shaded pole or permanent split capacitor, sleeve bearings, supported by steel brackets in combination with rubber isolators.
- E.    Ceiling Grille, (Where indicated): White plastic egg crate design, 80 percent free area.

## **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.

### **3.2 PRE-OPERATION MAINTENANCE**

- A. Grease bearings.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.

### **3.3 START-UP AND INSTRUCTIONS**

- A. Check vibration and correct as necessary for air balance work.
- B. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section, NOISE AND VIBRATION CONTROL.

### **3.4 GUARANTEE PERIOD SERVICES**

- A. Guarantee Period Services: Guarantee period for mechanical systems shall be for a period of (2) years.
  - 1. Qualifications: All service technicians assigned to perform work under this contract shall be qualified and factory trained by the Original Equipment Manufacturer (O.E.M.). The contractor shall furnish, for the Department of Veterans Affairs (VA) review and approval, resumes of all service technicians scheduled to service the equipment and systems. The resume shall include details of experience, training, and educational qualifications and performance evaluations.
  - 2. Replacement Parts: The contractor shall be equipped with all replacement parts of all equipment and systems to be serviced and the manufacturer's standard service and repair procedures. All replacement parts shall be brand new and current design. The replacement parts shall be O.E.M. items. Obsolete or refurbished parts are unacceptable. "Approved Equal" parts must have prior approval of the Contracting Officer. Contractor shall furnish evidence of guaranteed supply of parts for the life of the system.
  - 3. Service Supplies: The services shall include, without any additional cost to the government, all replacement parts, special tools and equipment, and consumable materials, that is, lubrication oil, grease, and cleaning materials, as required. The requirement of UL listing, where applicable,

shall not be voided by any replacement parts, components,  
software, or modifications provided by the contractor.

- - - E N D - - -

**SECTION 15840**  
**DUCTWORK AND ACCESSORIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, and relief systems.
  - 2. Exhaust duct with HEPA filters for isolation room.
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the 1985 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, 1st Edition, 1985.
  - 4. Exposed Duct: Exposed to view in a finished room.

**1.2 RELATED WORK**

- A. Section 07270, FIRESTOPPING.
- B. Section 10200, LOUVERS AND WALL VENTS.
- C. Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).
- D. Section 15200, NOISE AND VIBRATION CONTROL.
- E. Section 15740, TERMINAL UNITS.
- F. Duct Mounted Coils: Section 15750, HEATING AND COOLING COILS.
- G. Section 15822, FANS.
- H. Section 15885, AIR FILTERS.
- I. Section 15902, CONTROLS AND INSTRUMENTATION.
- J. Section 15980, TESTING, ADJUSTING, AND BALANCING
- K. Smoke Detectors: Section 16721, FIRE ALARM - LOCAL BUILDING SYSTEM.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).
- 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:
  - 1. All ducts shall be sealed as per Seal Class A (leakage Class 3) as defined by SMACNA duct sealing requirements in section 1 of SMACNA HVAC Air Duct Leakage Test Manual for all duct pressure classes.
- 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 and provide at least the same level of corrosion resistance.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data, and Contractor's Duct Construction Brochure:
  - 2. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Sealants and gaskets.
    - c. Access doors.
  - 2. Round and flat oval duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Sealants and gaskets.
    - c. Access sections.
    - d. Installation instructions.
  - 3. Volume dampers, back draft dampers.
  - 4. Upper hanger attachments.
  - 5. Fire dampers, fire doors, and smoke dampers with installation instructions.

6. Sound attenuators, including pressure drop and acoustic performance.
  7. Flexible ducts and clamps, with manufacturer's installation instructions.
  8. Flexible connections.
  9. Air intake/exhaust hoods.
  10. Instrument test fittings.
  11. Perforated distribution plates.
  12. Diffusers, registers, grilles and accessories.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Diffusion Council Test Code:
- |                  |   |
|------------------|---|
| 1062R4 . . . . . | Certification, Rating, and Test Manual (1977) |
|------------------|---|
- C. Air Movement and Control Association, Inc. (AMCA):
- |                  |   |
|------------------|---|
| 500-75 . . . . . | Test Method and Louvers, Dampers and Shutters |
|------------------|---|
- D. American Society for Testing and Materials (ASTM):
- |                    |  |
|--------------------|--|
| A167-94 . . . . .  | Standard Specification for Stainless and Heat-Resisting Chromium-Nickel, Steel Plate, Sheet and Strip            |
| A527-90 . . . . .  | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality    |
| A569-91 . . . . .  | Standard Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality |
| B209-95 . . . . .  | Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate   |
| C1071-91 . . . . . | Standard Specification for Thermal and Acoustical Insulation (Mineral Fiber, Duct Lining Material)               |

- E84-95 . . . . . Standard Test Method for Surface Burning Characteristics of Building Materials
- E. National Fire Protection Association (NFPA):
  - 90A-96 . . . . . Standard for the Installation of Air Conditioning and Ventilating Systems
  - 96-94 . . . . . Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment
- F. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - HVAC Duct Construction Standards, Metal and Flexible, 1st Edition - 1985
  - HVAC Air Duct Leakage Test Manual, 1st Edition, 1985
- G. Underwriters Laboratories, Inc. (UL):
  - 33-87 . . . . . UL Standard for Safety Heat Responsive Links for Fire Protection Service
  - 181-90 . . . . . UL Standard for Safety Factory-Made Air Ducts and Connectors
  - 555-90 . . . . . UL Standard for Fire Dampers
  - 555S-83 . . . . . UL Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems

## **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 A527, 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 Standards.
  - 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 such as DUCTMATE SYSTEM may be used. All joint systems shall have bolted corner inserts. Tie rods shall attach to stiffeners, not duct wall. Tie rod inserts shall be welded (not crimped) to conduit.

## **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Follow SMACNA HVAC Duct Construction Standards, 1st Edition, 1985.
- B. Duct Pressure Classes: As shown on the drawings.
- C. Seal Classes: All ducts shall be Seal Class A (leakage Class 3) as defined by SMACNA HVAC Air Duct Leakage Test Manual.
- D. Duct for Negative Pressure Up to 3 Inches Water: Provide for exhaust duct between HEPA filters and exhaust fan inlet including systems for isolation room exhaust.
  1. Round Duct: Galvanized steel, spiral lock seam construction with standard slip joints.
  2. Rectangular Duct: Galvanized steel, minimum 20 gage, Pittsburgh lock seam. DUCTMATE SYSTEM or equal manufactured joints are acceptable in lieu of companion angles, provided they comply with the 1985 SMACNA Standards.
- E. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.
  1. Elbows: Diameters 3 through 12 inches, except 11 inches, shall be two section die stamped, all others shall be gored construction, each gore maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
  2. Provide bellmouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA Standards.
  3. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement.



- F. Casings and Plenums: Construct in accordance with SMACNA Standards, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls. Provide viewport 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.
- G. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards.
- H. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

### **2.3 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
  - 4. Each duct mounted coil and humidifier.
  - 5. Each fire damper (for link service), smoke damper and automatic control damper.
  - 6. Each duct mounted smoke detector.
- B. Openings shall be as large as feasible in small ducts, (18 inch by 18 inch) minimum where possible, or 24 inches long and full width of duct for widths less than 18 inches. Access sections in insulated ducts shall be double-wall, insulated.
  - 7. For rectangular ducts: Refer to SMACNA Standards (Figure 2-12).
  - 8. For round and flat oval duct: Access sections shall be not less than 20 gage housing welded or riveted to a duct section.

### **2.4 FIRE DAMPERS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, (160°F) fusible link, 100 percent free opening with no part of the blade stack or damper frame in the air stream (Type "C").
- B. Fire dampers in fume hood exhaust or wet air exhaust shall be stainless steel construction, all others may be galvanized steel.
  - 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 14 gage, required to provide installation equivalent to the damper manufacturer's UL test installation.

2. Submit manufacturers installation instructions conforming to UL rating test.
3. Combination fire and smoke dampers: Multi-louver or curtain type units meeting all requirements of both dampers shall be used where shown and may be used at the Contractor's option where applicable.

## **2.5 SMOKE DAMPERS**

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 1500 fpm. Maximum static pressure loss: 0.13 inch WG.
- B. Maximum air leakage, closed damper: 4.0 cfm per square foot at 3 inches wg differential pressure.
- C. Minimum requirements for dampers:
  1. Meet requirements of Table 6-1 of UL 555S, except 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, 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.
- D. Motor operator (actuator): Provide electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

## **2.6 FIRE DOORS**

Galvanized steel, interlocking blade type, UL listing and label, 160°F fusible link, 3 hour rating and approved for openings in Class A fire walls with rating up to 4 hours, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

## **2.7 FLEXIBLE AIR DUCT CONNECTORS**

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts

shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 5 feet. Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.

- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 8 inches in diameter shall be Class 1. Ducts 8 inches in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at (75 °F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per (foot) of straight duct, at 500 Hz, based on (6 inch) duct, (2500 fpm).
- D. Application Criteria:
  - 1. Temperature range: (0 to 200 °F) internal.
  - 2. Maximum working velocity: (4000 feet per minute).
  - 3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.
- E. Duct Clamps: 100 percent nylon strap, (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

## **2.8 FLEXIBLE CONNECTIONS**

- A. Where duct connections are made to fans and air handling units, install a non-combustible flexible connection of 29 ounce neoprene coated fiberglass fabric approximately 6 inches wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 2 inches on center. Fabric shall not be stressed other than by air pressure. Allow at least one inch slack to insure that no vibration is transmitted.

## **2.9 SOUND ATTENUATING UNITS NO PART OF PACKAGED OR BUILT-UP UNITS**

- A. Casing, not less than 20 gage galvanized sheet steel, or 18 gage aluminum fitted with suitable flanges to make clean airtight connections to ductwork. Sound-absorbent material faced with glass fiber cloth and covered with not less than 24 gage or heavier galvanized perforated sheet steel, or 20 gage or heavier perforated aluminum. Perforations shall not exceed 5/32-inch

diameter, approximately 25 percent free area. Sound absorbent material shall be long glass fiber acoustic blanket meeting requirements of NFPA 90A, and shall be mylar encased for Hospital and clean room applications.

- B. Entire unit shall be completely air tight and free of vibration and buckling at internal static pressures up to 8 inch water gage at operating velocities.
- C. Pressure drop through each unit: Not to exceed indicated value at design air quantities indicated.
- D. Submit complete independent laboratory test data showing pressure drop and acoustical performance.
- E. Cap open ends of attenuators at factory with plastic, heavy duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuator. Caps shall not be removed until attenuator is installed in duct system.

#### **2.10 GRAVITY TYPE AIR INTAKE/EXHAUST HOODS**

- A. Aluminum, ASTM B209, louvered, spun, or fabricated using panel sections with roll-formed edges, 1/2 inch mesh aluminum or galvanized welded wire bird screen, with gravity or motorized dampers where shown, accessible interior, designed for 100 mph winds.

#### **2.11 PREFABRICATED ROOF CURBS**

Galvanized steel or extruded aluminum 12 inches above finish roof service, continuous welded corner seams, treated wood nailer, 1-1/2 inch thick, 3 pound/cubic feet density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

#### **2.12 EQUIPMENT SUPPORTS**

Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).

#### **2.13 FIRESTOPPING MATERIAL**

Refer to Section 07270, FIRESTOPPING.

#### **2.14 THERMOMETER (AIR)**

Section 15902, CONTROLS AND INSTRUMENTATION (DDC).

#### **2.15 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum two inch length for insulated duct, and a minimum one inch length for duct not insulated. Test hole shall have a flat gasket for rectangular ducts and a concave

gasket for round ducts at the base, and a screw cap to prevent air leakage.

- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, humidifier, fan, filter, and heat recovery unit.

## **2.16 AIR FLOW CONTROL VALVES (AFCV)**

Section 15740, TERMINAL UNITS.

## **2.17 AIR OUTLETS AND INLETS**

### **A. Materials:**

1. Steel or aluminum. Provide manufacturer's standard gasket.
2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.

- B. Performance Test Data: In accordance with Air Diffusion Council code 1062R4. Refer to Section 15200, NOISE AND VIBRATION CONTROL for NC criteria.

### **C. Air Supply Outlets:**

1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
  - b. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
  - c. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
  - d. Perforated face type: Manual adjustment for 1, 2, 3, or 4 way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. Perforated face diffusers for VAV systems shall have the pattern controller on the inner face, rather than in the neck and designed to discharge air horizontally at the ceiling maintaining a constant effect.
  - e. Slot diffuser/plenum:

- 1) Galvanized steel boot lined with 1/2 inch thick fiberglass conforming to NFPA 90A and complying to UL 181 for erosion. Form slots or use adjustable pattern controllers, to provide stable, horizontal air flow pattern over a wide range of operating conditions.
  - 2) Provide inlet connection diameter equal to duct diameter shown on drawings or provide transition coupling if necessary.
  - 3) Maximum pressure drop at design flow rate: 0.15 inch wg.
2. Linear Grilles and Diffusers: Extruded aluminum, manufacturer's standard finish, positive holding concealed fasteners.
- a. Margin: Flat, 3/4 inch wide.
  - b. Bars: Minimum 3/16 inch wide by 3/4 inch deep, zero deflection unless otherwise shown. Reinforce bars on 18 inch center for sidewall units and on 6 inch center for units installed in floor or sills.
  - c. Provide opposed blade damper and equalizing or control grid where shown.
3. Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
- a. Margin: Flat, 1-1/4 inches wide.
  - b. Bar spacing: 3/4 inch maximum.
  - c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.
4. Grilles: Same as registers but without the opposed blade damper.
- D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
  2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 1-1/4 inch margin.
  3. Perforated Face Type: To match supply units.
  4. Linear Type: To match supply units.

5. Door Grilles: Are furnished with the doors.
6. Filter Grilles: Standard face hinged to a mounting frame with space for a one inch throwaway filter. Hold face closed by a locking screw. Provide retaining clips to hold filter in place. Provide one inch thick fiberglass throwaway filter.

#### **2.18 WIRE MESH GRILLE (WMG)**

- A. Fabricate grille with 2 x 2 mesh (1/2 inch) galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately (1-1/2 inch) margin.
- B. Use grilles where shown in unfinished areas such as mechanical rooms.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with provisions of Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL), 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 1985 SMACNA Standards. 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 1985 SMACNA Standards.
  4. Construct casings, eliminators, and pipe penetrations in accordance with 1985 SMACNA Standards. 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, 1st Edition, 1985. Submit Duct Construction Brochure for review.
- D. Install fire and smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to 1985 SMACNA Standards. Ducts shall be continuous, single pieces not over 5 feet long (NFPA 90A), as straight and short as feasible, adequately supported. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition, or any fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts per SMACNA 1985 Standards. Bends shall be made only with solid sheet metal fittings.
- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Control Damper Installation:
  - 1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
  - 2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
  - 3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
  - 4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- I. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- J. Smoke Detectors: Provide duct openings and access doors.
- K. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- L. 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.

- M. Close all supply and return grille duct dampers (or floor dampers) within dust barrier boundary, and cover grilles, registers, and diffusers. Adjust respective air terminals for reduced cfm and rebalance when work has been completed. Contractor shall keep construction areas under a negative pressure.

### **3.2 DUCT LEAKAGE TESTS AND REPAIR**

- A. Perform tests AS required. See article, QUALITY ASSURANCE.
- B. Seal all unused openings in ducts and structure.

- - - E N D - - -

**SECTION 15885**  
**AIR FILTERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE 52.1-92 for definitions of face velocity, net effective filtering area, media velocity, resistance (pressure drop), atmospheric dust spot efficiency and dust-holding capacity.

**1.2 RELATED WORK**

- A. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).
- B. Section 15763, AIR HANDLING UNITS.

**1.3 QUALITY ASSURANCE**

- A. Air Filter Performance Report For Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall be less than five years old and will have been prepared by an independent testing laboratory using test equipment, method and duct section as specified by ASHRAE Standard 52.1-92 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.
  - 2. Selection procedures: All filters tested shall have been procured by the independent testing laboratory from the open market independent of manufacturer of these filters and a statement to this effect must accompany test report.
  - 3. Government Option: The Government at its option may take one of the filters for each different type submitted and run an independent test to determine if the filter meets the requirements of this specification. When the filter meets the requirements, the Government will pay for the test. When the filter does not meet the specification requirements, the manufacturer will be required to pay for the test and replace the filters with filters that will perform as required by the specifications.
- B. Filter Supplier Warranty for Extended Surface Filters: Guarantee the filters against leak, blow-outs, and other deficiencies during their normal useful life. Defective filters shall be replaced at no cost to the Government.

- C. Nameplates: Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency, UL classification, and file number.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's Literature and Data:
  - 1. Extended surface filters.
  - 2. Holding frames. Identify locations.
  - 3. Side access housings. Identify locations, provide insulated doors.
  - 4. HEPA filters.
  - 5. Magnehelic gages (low temperature ambient type for outdoor units).
- C. Air filter performance reports.
- D. Suppliers warranty.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):
  - 52.1-92 . . . . . Methods of Testing Air Cleaning Devices Used in General Ventilation For Removing Particulate Matter
- C. Underwriters Laboratories, Inc. (UL):
  - 586-90 . . . . . UL Standard for Safety High-Efficiency, Particulate, Air Filter Units
  - 900-87 . . . . . UL Standard for Safety Test Performance of Air Filter Units
- D. Federal Specification (Fed. Spec.):
  - A-A-1419D . . . . . Filter, Element Air Conditioning (Viscous-Impingement and Dry Type, Replaceable).

## **PART 2 - PRODUCTS**

### **2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED**

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01010, GENERAL REQUIREMENTS, provide one complete set of additional (replacement) filter elements.

### **2.2 EXTENDED SURFACE AIR FILTERS**

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL approved Class 1 or Class 2 conforming to UL Standard 900.
- C. Filter Grades, Percent, Nominal Efficiency and Application:
  - 1. Grade A: 90-95 after-filter.
  - 2. Grade D: 25-30 pre-filter.
- D. Filter Media:
  - 1. Grade A, B and C Supported (Rigid Pleated) Type: Media shall be composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, (metal backing or aluminum separators) shall be sealed in a proper enclosing frame to insure no air leakage for life of filter. Staples and stays are prohibited.
  - 2. Grade D (Pleated) Type: Media shall be composed of synthetic/natural fibers. A metal grid backing shall be bonded to the air leaving side of the media to maintain uniform pleat shape and stability for proper air flow and maximum dust loading. The media frame shall be constructed of high strength moisture resistant fiber or beverage board. Bond the pleated media pack on all four edges to insure no air leakage for the life of the filter. Staples and stays are prohibited.
- E. Filter Efficiency and Arrestance: Efficiency and arrestance of filters shall be determined in accordance with ASHRAE 52.1-92. Atmospheric dust spot efficiency and synthetic dust weight arrestance shall not be less than the following:

	Percentage of Initial Efficiency	Percentage of Average Efficiency	Percentage of Average Arrestance
Grade A	75.4	86.4	99.0
Grade B	58.0	79.0	98.0
Grade C	25.0	53.0	97.0
Grade D	Less than 20.0	22.0	89.0

- F. Maximum initial and final resistance, inches of water, for each filter cartridge when operated at 500 feet per minute face velocity:

	Initial Resistance	Final Resistance
Grade A (Rigid Pleated)	0.74	1.00
Grade B (Bag)	0.40	1.00
Grade B (Rigid Pleated)	0.60	1.00
Grade C (Bag)	0.28	0.80
Grade C (Rigid Pleated)	0.35	0.80
Grade D (2-inch Deep)	0.27	0.70
Grade D (4-inch deep)	0.27	0.70

- G. Dust Holding Capacity: When tested to 1.00-inch water at 500 fpm face velocity, the dust holding capacity for each 24 inches by 24 inches face area filter shall be at least the values listed below. For other filter sizes the dust holding capacity shall be proportionally higher or lower to the face area.

Grade A (Rigid Pleated)	90 grams
Grade B (Rigid Pleated)	175 grams
Grade C (Rigid Pleated)	250 grams
Grade D (2 inch deep)	150 grams
Grade D (4 inch deep)	300 grams

- H. Minimum Media Area: The minimum net effective media area in square feet for each 24 inches by 24 inches face area filter at 500 fpm face velocity shall be at least the values listed below. For other filter sizes the net effective media area shall be proportionally higher or lower.

Grade A (Rigid Pleated)	57.0
Grade B (Bag)	91.0
Grade B (Rigid Pleated)	57.0
Grade C (Bag)	91.0
Grade C (Rigid Pleated)	97.0
Grade D (2-inch Deep)	14.8
Grade D (4-inch deep)	23.0

I. Side Servicing Housings:

1. Minimum 16 gage galvanized steel, or aluminum, completely factory assembled with upstream and downstream flanges for connection into the duct system. Furnish housing length sufficient to provide for fully extended operating filter elements.
2. Access doors: Double skin insulated, at each end of the housing with continuous gasketing on the perimeter and positive locking devices. Design doors to withstand a minimum positive/negative four inches of water static pressure.
3. Filter slide channels: Channels shall incorporate a positive-sealing gasket material to seal the top and bottom of the filter cartridge frames to prevent bypass. Provide factory installed gasketing to prevent leakage between cartridges, and between cartridges and doors.

J. Holding Frame System:

1. Minimum 16 gage galvanized steel, 4 inches deep, factory complete with hardware necessary for field assembly, suitable for either upstream or downstream filter servicing. All members shall be cut to size and prepunched for easy assembly into modules of the size and capacity noted in the schedules.
2. The framing members shall be permanently gasketed to prevent the bypass of unfiltered air. Provide suitable vertical support members to prevent deflection of horizontal members. The vertical support members shall not interfere with either the installation or operation of the filters.
3. The framing system shall incorporate a factory installed positive sealing device for each filter. This device shall allow for easy installation and removal of cartridges, bags, and pre-filters, and shall insure the seal between the gasketed filter elements while the bank is in operation.

K. Magnehelic Differential Pressure Filter Gages: Nominal four inch diameter, zero to two inch water gage range, flush mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment. Provide one gage for each extended surface filter section. Provide Petcocks for each gauge. Provide low ambient type for outdoor units.

- L. Equipment Identification: Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).

### **2.3 HEPA FILTERS**

- A. High Efficiency Particulate Air (HEPA) filters shall be individually tested and certified to be 99.97 percent minimum efficient when handling 0.3 micron particles in accordance with DOP test method. Filters shall be factory scanned. The DOP efficiency along with filter serial number and name of manufacturer shall be marked on the filter. HEPA filter shall be high capacity type and have maximum pressure drop of (1.35" WG) when clean at 2000 cfm rated flow with a final pressure drop of (2.5" WG).
- B. Filter media: Factory constructed by pleating a continuous sheet of media into closely spaced pleats with aluminum separators. Sealer shall be self-extinguishing. Gaskets shall be neoprene.
- C. Enclosing frame shall be 16 gauge galvanized steel. Provide pre-filters in the same housing with a separate removal assembly that operates independently from the HEPA filters. Gaskets shall be on the filter, not the frame, so they are renewable at each filter changeout. Where shown, provide frame, but without filters.
- D. Pre-filter: Type D, 4 inches deep.
- E. Bag-In/Bag-Out Housing for HEPA Filters:
  - 1. Housing shall be fabricated of minimum 16 gauge type 304 stainless steel.
  - 2. Housing shall be equipped with weather covers, drilled face flanges and factory mounted Magnehelic gauges with Petcocks housed in stainless steel brackets.
  - 3. Housing shall be pressure tested in factory to withstand a positive or negative pressure of 10" WG.
  - 4. Housing shall incorporate a spring loaded clamping mechanism that is operated from outside and which is capable of exerting a 1,200 lb. sealing force across the sides, top and bottom of each filter.
  - 5. Each housing shall have a bagging ring around the access port that is sealed by a removable, gasketed access door. The bagging ring shall have two (2) continuous ribs to secure the plastic change-out bag and be hemmed on its outer edge to prevent the bag from tearing.
  - 6. One 87 mil thick PVC change-out bag shall be supplied for each access door. The bag shall include approximately 12 inches of transparent PVC at the open end and three glove sleeves built into the body to assist in filter change-out. Bag-In/Bag-Out housings shall be manufactured under a quality assurance program that addresses the requirements of

ANSI N45.2, "Quality Assurance Requirements for Nuclear Power Plants."

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

Install supports, filters and gages in accordance with manufacturer's instructions.

#### **3.2 START-UP AND TEMPORARY USE**

- A. Clean, vacuum, and wet wipe air handling units and plenums to the satisfaction of the Resident Engineer prior to starting air handling systems.
- B. Install or deliver replacement filter units as directed by the Resident Engineer.

- - - E N D - - -



**SECTION 15902**  
**CONTROLS AND INSTRUMENTATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. The control system(s) shall be as indicated on the drawings and described in these specifications.
- B. Following control devices and systems shall be used to provide the functional requirements of HVAC equipment and systems.
  - 1. Direct Digital Control (DDC) of HVAC equipment and systems with positioning of valves and dampers.
  - 2. Direct Digital Control (DDC) of terminal units, fans, heaters, and similar units for control of room environment conditions.
- C. Connect the new work to the ECC located in Building 200 C-017 Computer Room. The existing CPU/CRT, printer, and other peripherals may be used to form a single operator workstation.
- D. The control subcontractor shall supply as required, the necessary equipment to interface between the existing Johnson Controls Metasys system and the new Johnson Controls system Network Area Controllers (NAC) as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided. The control subcontractor shall provide/perform any necessary software or hardware revision changes or upgrades necessary to maintain compatibility between new and existing controls. Network area controllers are same as remote controller units (RCU).
- E. The control systems shall be designed such that each mechanical system will be able to operate under stand-alone mode. As such, in the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
- F. The Top End of the NAC shall communicate using American Society of Heating and Refrigerating Engineers/American National Standards Institute (ASHRAE/ANSI) Standard 135-1995 **(BACnet) protocol**. The NAC shall reside on the BACnet Ethernet (ISO 8802-3) local area network, and provide information via standard BACnet object types and application services. The Bottom End of the NAC, the unit level controllers and all other field devices shall reside on the LonTalk FTT-10a network, and provide data using LonMark standard network variable types and configuration properties. Include any necessary hardware/software to establish compatibility between existing Johnson Metasys control system and new Johnson Controls BACnet/LonWorks controls.

- G. The intent of this specification is to provide a peer-to peer networked, stand-alone, distributed control system. The ECC requires the incorporation of LonWorks Technologies using Free Topology Transceivers (FTT-10), and specific conformance to the LONMARK Interoperability Association's v3.0 Physical and logical Layer guidelines in all unitary, terminal unit and other devices. The minimum Baud rate shall be 78,000 Baud for FTT-10 and 1,250,000 Baud for FTT-1250.
  - 1. LonTalk communications protocol will be used on the communication network between RCU controllers and other LonWorks devices to assure interoperability between all devices within the network.
  - 2. The ECC shall provide communication to all LonTalk data variables as defined in input/output point schedule. RCUs shall provide system communication in compliance with the ASHRAE Standard 135 for communication to the ECC. The ability to support bi-directional access to remote RCUs shall be supported by a single point of connection.
  - 3. There shall be power wiring run in conduit with communications trunk wiring.
- H. The control system shall accommodate simultaneously multiple user operation and the access to the system should be limited only by operator password.

## **1.2 RELATED WORK**

- A. Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL)
- B. Section 15705, HVAC PIPING SYSTEMS
- C. Section 15740, TERMINAL UNITS
- D. Section 15840, DUCTWORK AND ACCESSORIES
- E. Section 15980, TESTING, ADJUSTING AND BALANCING
- F. Section 16050, BASIC METHODS AND REQUIREMENTS ELECTRICAL
- G. Section 16111, CONDUIT SYSTEMS
- H. Section 16127, CABLES, LOW VOLT (600 VOLTS AND BELOW)
- I. Section 16140, WIRING DEVICES
- K. Section 16208, ENGINE GENERATORS
- L. Section 16722, FIRE ALARM SYSTEMS

## **1.3 DEFINITION:**

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or

processes for the solution of a problem in a finite number of steps.

- B. ACU: Auxiliary Control Unit (ACU) used for controls of air handling units, reports to RCU.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc).
- D. BACnet: Building Automation Control Network Protocol, ASHRAE Standard 135.
- E. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- F. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.
- G. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- H. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- I. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls. In this specification, there are three types of control units are used; Unitary Control Unit (UCU), Auxiliary Control Unit (ACU), and Remote Control Unit (RCU).
- J. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 72-78 degrees F, as opposed to a single point change over or overlap).
- K. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- L. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- M. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the subsystem level. System operational programs and information are provided to the remote subsystems and status is

reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.

- N. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- O. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- P. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- Q. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- R. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- S. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- T. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- U. FTT-10 Echelon Transmitter-Free Topology Transceiver.
- V. GIF: Abbreviation of Graphic interchange format.
- W. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- X. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.
- Y. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- Z. I/P: Internet Protocol-global network, connecting workstations and other host computers, servers etc. to share the information.

- AA. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- BB. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- CC. LonMark: An association comprising of suppliers and installers of LonTalk products. The Association provides guidelines for the implementation of the LonTalk protocol to ensure interoperability through Standard implementation.
- DD. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication.
- EE. LonWorks: Network technology developed by the Echelon Corporation.
- FF. Network: A set of computers or other digital devices communicating with each other over a medium such as wire, coax, fiber optics cable etc.
- GG. Network Repeater: A device that receives data packet from one network and rebroadcasts the packet to another network. No routing information is added to the protocol.
- HH. MS/TP: Master-slave/token-passing
- II. Operating system (OS): Software, which controls the execution of computer application programs.
- JJ. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- KK. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- LL. Peer-to-Peer: A networking architecture that treats all network stations as equal partners.
- MM. PICS: Protocol Implementation Conformance Statement.
- NN. RCU: Remote Control Unit, digital controller, supports a family of auxiliary control units and unitary control units, and communicates with peer-to-peer network for transmission of global data.
- OO. UCU: Unitary Control Unit, digital controller, dedicated to a specific piece of equipment, such as VAV boxes, chillers, fan coil units, heat exchangers etc.

#### **1.4 QUALITY ASSURANCE:**

- A. Criteria:

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegates the responsibility to a single source controls subcontractor. The controls subcontractor shall be responsible for the complete design and installation, and operation of the system. The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.
2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects, which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veteran's Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have (minimum of three years) experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
5. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next 5 years, and necessary test and diagnostic equipment to support the control systems.

B. Codes and Standards:

1. All electronic equipment shall confirm to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.
  - a. All peer-to-peer controllers, unitary controllers shall confirm to the requirements of UL 916, category PAZX.

C. Performance Tests

1. Preform pretests and tests in accordance with Article TSTS in Section 01010, GENERAL REQUIREMENTS, and in accordance with Test Plans and Specifications. Submit Test Report including Final Operational Test.

2. Demonstrate to the Resident Engineer that all controls are installed, adjusted, and can perform all functions required by the drawings and specifications. When coordinated with the Resident Engineer demonstration may be performed in conjunction with instructions to VA operations personnel.
- D. Final Operational Tests:
1. Performance Test Period: Not less than 168 consecutive hours to demonstrate proper functioning of the complete ECC system after complete installation and debugging of the system. Continue test on a day to day basis until the performance standard is met. This test shall be done after complete installation and debugging of the control systems, and before the final inspection of the control system.
  2. Acceptance Performance Standard: Operation at an average effectiveness level (AEL) of at least 95 percent for the performance test period. Whenever downtime occurs correct defects before resuming test. Failure due to an individual sensor or controller shall not count as system downtime provided that:
    - a. The system records the fault.
    - b. The AEL for all sensors and controllers together is at least 95 percent of the test period.

#### **1.5 PERFORMANCE:**

- A. The system shall conform to the following:
1. Graphic Display: The system shall display a graphic with a minimum of (20) dynamic points. All current data shall be displayed within (20) seconds of the request.
  2. Graphic Refresh: The system shall update all dynamic points with current data within (30) seconds. Data refresh shall be automatic, without operator intervention.
  3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be (10) seconds. Analog objects shall start to adjust within (10) seconds.
  4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current, within the prior (60) seconds.
  5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (45) seconds.
  6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once

every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

7. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every (5) seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within (5) seconds of each other.
9. Reporting Accuracy: Listed below are minimum acceptable reporting accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	±1 degrees F
Ducted air temperature	±2 degrees F
Outdoor air temperature	±2 degrees F
Water temperature	±1 degrees F
Relative humidity	±5 percent RH
Water flow	±5 percent of full scale
Air flow (terminal)	±10 percent of reading
Air flow (measuring stations)	±5 percent of reading
Air pressure (ducts)	±0.1" W.G.
Air pressure (space)	±3 Pa [±0.01 "W.G.]
Water pressure	±2 percent of full scale *Note 1
Electrical Power	5 percent of reading

Note 1: for both absolute and differential pressure

#### 1.6 GUARANTY:

- A. Labor and materials for control systems shall be warranted for a period of 2 years as specified under Guaranty in Section 01001, GENERAL CONDITIONS.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to



the job site to resolve the problem within 24 hours after the problem is reported.

**1.7 SUBMITTALS:**

- A. Submit shop drawings in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Manufacturer's literature and data for all components including the following:
  - 1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
  - 2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.
  - 3. Control dampers and control valves schedule, including the size and pressure drop.
  - 4. Installation instructions for smoke dampers and combination smoke/fire dampers, if furnished.
  - 5. Catalog cut sheets of all equipment used. This includes, but is not limited to DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.
  - 6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
  - 7. Color prints of proposed graphics with a list of points for display.
  - 8. Furnish PICS for each BACnet compliant device.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.

D. As Built Control Drawings:

1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
3. Furnish one (1) set of 3.5 inch floppy disk(s) (1) CD-ROM and (5) in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.

E. Operation and Maintenance (O/M) Manuals):

1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01010, GENERAL REQUIREMENTS.
2. Include the following documentation:
  - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
  - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
  - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
  - d. Complete troubleshooting procedures and guidelines for all systems.
  - e. Complete operating instructions for all systems.
  - f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
  - g. Licenses, guaranty, and other pertaining documents for all equipment and systems.
  - h. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify

any or all of the course outline and training material.

**1.8 INSTRUCTIONS/TRAINING:**

- A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01010, GENERAL REQUIREMENTS, and as noted below:
  - 1. First Phase: Formal instructions to the VA facilities personnel for a total of 48 hours, conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
  - 2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 48 hours of instructions ( six 8 hour periods) to the VA facilities personnel.
  - 3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.
  - 4. Training by independent or franchised dealers who are not direct employees of the controls supplier will not be acceptable.

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

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 65 to 90 degrees F at a relative humidity of 20 to 80 percent non-condensing.
- B. The CUs and associated equipment used in controlled environment shall be mounted in NEMA 1 enclosures for operation at 32 to 122 degrees F at a relative humidity of 10 to 90 percent non-condensing.
- C. The CUs and other control devices used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 150 degrees F. The cabinet shall protect all devices from dust, liquids or accidental blow.
- D. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- E. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

#### 1.10 APPLICABLE PUBLICATIONS:

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 135-95 . . . . . ACnet Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):
  - B16.18-84 (R-94) . . . Cast Copper Alloy Solder Joint Pressure Fittings.
  - B16.22-95 . . . . . Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. American Society of Testing Materials (ASTM):
  - B32-96 . . . . . Specification for Solder Metal
  - B88-96 . . . . . Specifications for Seamless Copper Tube
  - B88M-96 . . . . . Specification for Seamless Copper Tube (Metric)
  - B280-95a . . . . . Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
  - D2737-96a . . . . . Specification for Polyethylene Tube
- E. Federal Communication Commission (FCC):
  - Rules and Regulations Volume II-July, Part A Radio Frequency Devices.
- F. Institute of Electrical and Electronic Engineers (IEEE):
  - 802.3-96 . . . . . Information Technology-Telecommunications and Information Exchange between Systems-Local and Metropolitan Area Networks-Specific Requirements-Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
- G. Instrument Society Of America (ISA):
  - S7.0.01-96 . . . . . Quality Standard for Instrument Air
- H. National Fire Protection Association (NFPA):
  - 70-99 . . . . . National Electric Code

90A-99 . . . . . Standard for Installation of Air-  
Conditioning and Ventilation Systems

I. Underwriter Laboratories Inc.:

94-00 . . . . . Test for Flammability of Parts and Devices  
and Appliances

294-98 . . . . . Access Control System Units

486A-00 . . . . . Wire Connectors and Soldering Lugs for Use  
with Copper Conductors

486B-00 . . . . . Wire Connectors for use with Aluminum  
Conductors

555S-99 . . . . . Leakage Ratings for Dampers for Use in  
Smoke Control Systems

916-98 . . . . . Energy Management

1076-98 . . . . . Proprietary Burglar Alarm Units and  
Systems

**PART 2 - PRODUCTS**

**2.1 DIRECT DIGITAL CONTROLLERS**

A. Remote Control units (RCUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware, software, and communications interfaces, power supplies, and input/output modular devices. RCUs shall have access to data within the network as needed in order to accomplish required global control strategies.

1. All RCUs shall be provided with face mounted LED type annunciation to continually display its operational mode, power and communications.
2. The controllers shall reside on the BACnet Ethernet (ISO 8802-3) local area network and provide Read (Initiate) and Write (Execute) services as defined in Clauses 15.5 and 15.8, respectively of ASHRAE Standard 135, to communicate BACnet objects. Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.
3. All RCUs shall have sufficient memory to support its operating system, database, and program requirements, including the following:
  - a. Device and network management.
  - b. Data sharing.

- c. Alarm and event management including custom alarm messages for each level alarm for the points noted in the I/O Schedule.
  - d. Energy management.
  - e. Historical trend data for points specified.
  - f. Maintenance support.
  - g. Scheduling.
  - h. Dial up communications.
  - i. Manual overriding monitoring.
- 4. Each RCU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented I/O functions on the panel, but in no case shall there be less than one spare point of each implemented I/O type.
- 5. Each RCU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
- 6. Each RCU shall monitor the status of all overrides and inform the operator that automatic control has inhibited, and allow the operator to manually override automatic or centrally executed command.
- 7. In the event of normal power loss, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. Non-volatile memory shall be incorporated for all critical configuration data and battery backup shall be provided to support the real time clock and all volatile memory for a minimum of 72 hours.
- B. Auxiliary Control Units (ACUs) shall be stand-alone, multi-tasking, multi-user, real time digital processor complete with all hardware, software and communication interfaces, power supplies, and input/output modular devices.
  - 1. ACUs shall either reside on the LonTalk FTT-10a network, and provide data using LonMark standard network variable types and configuration properties, or BACnet interworking using ARCNET or MS/TP physical data link layer protocol.
  - 2. All ACUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  - 3. Each ACU shall have sufficient memory to support its operating system, database including the following:

- a. Data sharing.
  - b. Device and network management.
  - c. Alarm and event management.
  - d. Scheduling.
  - e. Energy Management.
- 4. Each ACU shall support firmware upgrades without the need to replace hardware and shall have a minimum of 15 percent spare capacity of I/O functions. The type of spares shall be in the same proportion as the implemented functions on the controller, but in no case there shall be less than one point of each implemented I/O type.
- 5. Each ACU shall continuously perform self-diagnostics, communication diagnosis, and provide both local and remote annunciation of any detected component failures, low battery condition; and upon failure shall assume the predetermined failure mode.
- 6. In the event of normal power loss, there shall be orderly shut down of the controllers to prevent the loss of database or software programming. Non-volatile memory shall be incorporated for all critical configuration data and battery backup shall be provided to support the real time clock and all volatile memory for a minimum of 72 hours.
- C. Unitary Control Units (UCUs) shall be capable of stand-alone, microprocessor-based and shall continue to provide control functions.
  - 1. Unitary Control Units shall either reside on the LonTalk FTT-10a network, and provide data using LonMark standard network variable types and configuration properties, or BACnet interworking using ARCNET or MS/TP physical data link layer protocol.
  - 2. Each UCU shall have sufficient memory to support its own operating system, including data sharing.
  - 3. All UCUs shall be provided with LED type annunciation to continually display its operational mode, power and communications.
  - 4. In the event of normal power loss, non-volatile memory shall be incorporated for all critical configuration data and battery backup shall be provided to support the real time clock and all volatile memory for a minimum of 72 hours.
- D. Provide I/O module that connects sensors and actuators onto the field bus network for use by the direct digital controllers. I/O devices shall support the communication technology specified for each controller.

1. Analog input shall allow the monitoring of low voltage (0-10 VDC), current (4-20 ma), or resistance signals (thermistor, RTD). Analog input shall be compatible with, and field configurable to commonly available sensing devices. Analog output shall provide a modulating signal for these control devices.
2. Binary inputs shall allow the monitoring of on/off signals from remote devices. Binary inputs shall provide a wetting current of at least 12 ma to be compatible with commonly available control devices. Binary outputs shall provide on/off operation, or a pulsed low voltage signal for pulse width modulation control. Outputs shall be selectable for either normally open or normally closed operation.
3. Binary outputs on remote and auxiliary controllers shall have 3-position (on/off/auto) override switches and status lights. Analog outputs on remote and auxiliary controllers shall have status lights and a 2-position (auto/manual) switch and manually adjustable potentiometer for manual override.
4. Each output point shall be provided with a light emitting diode (LED) to indicate status of outputs.

E. Communication Ports:

1. RCUs controllers in the DDC systems shall be connected in a system local area network using protocol defined by ASHRAE Standard 135, BACnet protocol.
2. The control supplier shall provide connectors, repeaters, hubs, and routers necessary for inter-network communication.
3. Minimum baud rate between the peer-to-peer controllers in the system LAN shall be maintained at the rate of 10 Mbps. Minimum baud for the low level controllers between UCUs and ACUs, ACUs and RCUs shall be maintained at the rate of 76 Kbps.
4. Provide RS-232 port with DB-9 or RJ-11 connector for communication with each controller that will allow direct connection of standard printers, operator terminals, modems, and portable laptop operator's terminal. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
5. All database, such as points, status information, reports, system software, custom programs of any one controller shall be readable by any other controller on the network. A controller shall automatically perform this value passing when a reference point name not located in this controller is entered into its database.



- F. Electric Outlet: Provide a single phase, 120 VAC electrical receptacle inside or within 6 feet of the RCU and ACU enclosures for use with test equipment.
- G. Spare Equipment:
  - 1. Provide spare digital controller (CU) boards and spare I/O boards as required. It shall be possible for trained hospital personnel to replace CU boards and load software via the PPT and the ECC.
  - 2. Provide a minimum of one spare digital controller board of each type and associated parts including batteries to make at least one complete set of DDC control equipment spares.
  - 3. If I/O boards are separate from the CU boards, provide two spare I/O boards for each spare CU board provided above.

## **2.2 DIRECT DIGITAL CONTROLLER SOFTWARE:**

- A. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.
- B. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the operator workstation.
- C. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
- D. All CU's shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC workstation. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
- E. All DDC control loops shall be able to utilize any of the following control modes:
  - 1. Two position (on-off, slow-fast) control.
  - 2. Proportional control.
  - 3. Proportional plus integral (PI) control.
  - 4. Proportional plus integral plus derivative (PID) control.

- a. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
- 5. Automatic tuning of control loops.
- F. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
- G. Application Software: The CUs shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the operator workstation.
  - 1. Night Setback/Morning Warm Up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.
  - 2. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall operate on both outside weather conditions as well as inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. Space temperature input is to be the highest value of zones served in the cooling mode and the lowest of zones served in the heating mode. It shall be possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via operator's workstation.
  - 3. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
    - a. Time, day.

- b. Commands such as on, off, auto.
  - c. Time delays between successive commands.
  - d. Manual overriding of each schedule.
  - e. Allow operator intervention.
- 4. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.
  - 5. Remote Communications: The system shall have the ability to dial out in the event of an alarm to workstations and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.
  - 6. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.
  - 7. Fire Emergency Programming

H. Sensors:

- 1. Electronic Sensors: Provide all remote sensors as required for the systems. All sensors shall be vibration and corrosion resistant for wall, immersion, and/or duct mounting.
  - a. Temperature Sensors: Thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter for all other sensors.
    - 1) Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.

- 2) Immersion sensors shall be provided with a separable well made of stainless steel or bronze or monel materials. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
  - 3) Space sensors shall be equipped with set-point adjustment, override switch, display, and/or communication port as shown on the drawings. Match room thermostats, locking cover.
  - 4) Outdoor air temperature sensors shall have watertight inlet fittings and shielded from direct sunlight.
  - 5) Room security sensors shall have stainless steel cover plate with insulated back and security screws.
  - 6) Wire: Twisted, shielded-pair cable.
  - 7) Output Signal: 4-20 ma.
- b. Humidity Sensors: Bulk polymer sensing element type.
- 1) Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability.
  - 2) Duct and outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - 3) 4-20 ma continuous output signal.
- c. Static Pressure Sensors: Non-directional, temperature compensated.
- 1) 4-20 ma output signal.
  - 2) 0 to 5 inches wg for duct static pressure range.
  - 3) 0 to 0.25 inch wg for Building static pressure range.

## 2. Water Flow Sensors:

- a. Sensor shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minus 0.05 inch; wetted parts shall be constructed of

stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.

b. Performance characteristics:

- 1) Ambient conditions: -10 to 110 degrees F, 5 to 100 percent humidity.
- 2) Operating conditions: 125 psig, 30 to 250 degrees F, 0.5 to 40 feet per second velocity.
- 3) Nominal range (turn down ratio): 10 to 1.
- 4) Overall accuracy plus or minus one percent of reading.
- 5) Repeatability: plus or minus 0.25 percent of reading.
- 6) Preamplifier mounted on meter shall provide a 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 6,000 feet. Preamplifier for bi-directional flow measurement shall provide a directional contact closure from a relay mounted in the preamplifier.
- 7) Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 4 inches.
- 8) Ambient temperature effects, less than 0.005 percent calibrated span per degree F temperature change.
- 9) RFI effect - flow meter shall not be affected by RFI.
- 10) Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.

3. Differential pressure sensors:

- a. The entire assembly shall be constructed to shock, vibration and pressure surges of 25 psi above scale will neither harm the gauge nor affect its accuracy.
- b. Sensors shall have the following features:
  1. Software adjustable high and low limits.
  2. Suitability for operation in an ambient temperature range of 30 to 140 degrees F.

- c. Flow status of fans and pumps, 1/2 hp and larger, shall be proven by differential pressure switches. Provide software resident time delays to prevent false alarms during starting/stopping including printout and application programs.

### **2.3 CONTROL CABLES:**

- A. As specified in Division 16.

### **2.4 THERMOSTATS AND HUMIDISTATS:**

- A. Room thermostats controlling heating and cooling devices shall have three modes of operation (heating - null or dead band - cooling). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats shall have polished or brushed aluminum finish, setpoint and temperature display and external adjustment:
  - 1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.
    - a. Public Space Thermostat: Public space thermostat shall be a platinum sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.
    - b. Patient Room Thermostats:
      - 1. Platinum sensor with set point adjustment and an indicator.
    - c. Battery replacement without program loss.
- B. Strap-on thermostat shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- C. Freezestat shall have a minimum of one linear foot of sensing element for each one square foot of coil area. A freezing condition at any increment of one foot anywhere along the sensing element shall be sufficient to operate the thermostatic element.
- D. Room Humidistats: Provide fully proportioning humidistats with adjustable throttling range for accuracy of settings and conservation. The humidistats shall have set point scales shown in percent of relative humidity located on the instrument. Systems showing moist/dry or high/low are not acceptable.

### **2.5 SPECIAL CONTROLLERS:**

- A. Room Differential Pressure Controller: The differential pressure in isolation rooms shall be maintained by controlling the quantity of air exhausted from or supplied to the room. A sensor-controller shall measure and control the velocity of air flowing into or out of the room through a sampling tube installed in the wall separating the room from the adjacent space. The controller shall

have an operating range that will maintain a differential pressure at any set point between 0.003 inches W.G. and 0.03 inches W.G.

## **2.6 FINAL CONTROL ELEMENTS AND OPERATORS:**

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, smoke or fire protection.
- B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
  - 1. Leakage: maximum leakage in closed position shall not exceed 15 CFMs differential pressure for outside air and exhaust dampers and 40 CFM/sq. ft. at 2 inches differential pressure for other dampers.
  - 2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
  - 3. Blades shall be galvanized steel or aluminum, 8 inch maximum width, with edges sealed as required.
  - 4. Bearing shall be nylon, bronze sleeve or ball type.
  - 5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
- D. Smoke Dampers and Combination Fire/Smoke Dampers: These dampers shall be classified as a Class II/III leakage rated damper for use in smoke control systems under the latest version of UL 555S, and shall bear a UL Label attesting to same. Smoke dampers shall be suitable for 250 degrees F.
- E. Operators shall be electric type required for proper operation.
  - 1. Dampers that requires manual reset or link replacement after actuation shall not be acceptable. See drawings for required control operation.
  - 2. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel.
  - 3. Maximum air velocity and pressure drop through free area the dampers:
    - a. Smoke damper in air handling unit; 700 fpm.
    - b. Duct mounted damper; 2000 fpm.

c. Maximum static pressure loss, 0.20 inches water gage.

F. Control Valves:

1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 125 psi.
2. Valves 2 inches and smaller shall be bronze body with threaded or flare connections.
3. Valves 2 1/2 inches and larger shall be bronze or iron body with flanged connections.
4. Brass or bronze seats except for valves controlling media above 210 degrees F, which shall have stainless steel seats.
5. Flow characteristics:
  - a. Three way valves shall have a linear relation or equal percentage relation of flow versus valve position.
  - b. Two-way valves position versus flow relation shall be linear for steam and equal percentage for water flow control.
6. Maximum pressure drop:
  - a. Two position steam control, 20 percent of inlet gauge pressure.
  - b. Modulating Steam Control, 80 percent of inlet gauge pressure (acoustic velocity limitation).
  - c. Modulating water flow control, greater of 10 feet of water or the pressure drop through the apparatus.
  - d. Two position water valves shall be line size.

G. Damper and Valve Operators and Relays:

1. Electric damper operator shall provide full modulating control of dampers. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design.
2. Electronic damper operators: VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.



3. Relays shall be of the following type:
  - a. Pneumatic: Diverting, selector, proportional, sequencing, ratio, positive positioning, biasing, repeating.
  - b. Electrical Interlocking Relays: Electric-pneumatic (EP) or pneumatic-electric (PE) types.
  - c. Electrical pilot duty of contactor types. Provide inductive rated contacts for circuits with coils, motors or other inductive devices.

## **2.7 AIR FLOW CONTROL:**

- A. Constant Volume Control: Systems shall consist of a differential pressure transmitter along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its primary total pressure and static pressure signal from the flow measuring station and shall have a span not exceeding three times this differential pressure at the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 0.008 inch velocity pressure as measured by the flow station.
- B. Airflow Synchronization:
  1. Systems shall consist of a differential pressure transmitter for each supply and return duct, the CU and such relays as required to provide a complete functional system that will maintain a constant difference between supply and return air volumes to meet the accuracy specified below. In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representative of total flow.
  2. The total flow signals from supply and return shall be the input signals to the CU. This CU shall operate the return air fan capacity control device to maintain return air flow rate control device to maintain return air flow rate at a constant difference between supply and return flow to maintain the theoretical return air flow rate plus or minus 4.0 percent of design maximum supply flow rate under all conditions.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION:**

#### **A. General:**

1. Examine project plans for control devices and equipment locations. Report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
2. Work Coordination: Section 01001, GENERAL CONDITIONS.
3. Install equipment, piping, wiring/conduit parallel to or at right angles to building lines.
4. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
5. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.
6. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
7. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
8. Install equipment level and plum.

#### **B. Piping Installation:**

1. All piping associated with smoke control shall be hard drawn copper.
2. Tubing passing through or buried in concrete shall be installed in rigid steel conduit of sufficient strength to prevent damage to tubing.
3. Install polyethylene tubing in metallic raceway or electrical conduit. Electrical conduits installations are specified in Division 16.
4. Welding shall be performed in accordance with specification Section 15705.
5. Label and identify control air piping in accordance with specification Section 15050, BASIC METHODS AND REQUIREMENTS (MECHANICAL).

#### **C. Electrical Wiring Installation:**

1. Install conduits and wiring in accordance with Specification Section 16111, CONDUIT SYSTEMS.

2. Install signal and communication cables in accordance with Specification Section 16126, CABLES, HIGH VOLTAGE (ABOVE 600 VOLTS).
  3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings. All wiring shall be installed in conduits unless otherwise noted.
  4. Install all system components in accordance with local Building Code and National Electric Code.
    - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
    - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 12 inches long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.
    - c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
    - d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
  5. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
  6. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
  7. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.
- D. Install Sensors and Controls:
1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.

- c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
- d. Install room sensors permanently supported on wall frame. They shall be mounted at 5.0 feet above the finished floor.
- e. Mount sensors rigidly and adequately for the environment within which the sensor operates.
- f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
- g. All pipe mounted temperature sensors shall be installed in wells.
- h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
- i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.

2. Pressure Sensors:

- a. Install duct static pressure sensor tips facing directly downstream of airflow.
- b. Install high-pressure side of the differential switch between pump discharge and check valve.
- c. Install snubbers and isolation valves on steam pressure sensing devices.

3. Actuators:

- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
- b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
- c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.

4. Flow Switches:

- a. Install flow switch according to manufacturer's written instructions.

- b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 2 feet whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.
- E. Installation of Network:
  - 1. Ethernet:
    - a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.
    - b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 10 Base 2 (ThinNet RG-58 A/U Coaxial cabling with BNC connectors), 10 Base T (Twisted-Pair RJ-45 terminated UTP cabling).
  - 2. Echelon:
    - a. The ECC shall employ LonTalk communications FTT-10.
    - b. Echelon LAN (Flat LON): The ECC shall employ a LON LAN that will connect through an Echelon Communication card directly to all controllers on the FTT-10 LAN.
- F. Installation of Digital Controllers and Programming:
  - 1. Provide a separate digital controller for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
  - 2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
  - 3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
  - 4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
  - 5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, terminal unit, boiler, pumping unit etc.

These graphics shall show all points dynamically as specified in the point list.

G. Field Test and Inspection:

1. General:

- a. Engage a factory-authorized representative and furnish personnel, instrumentation, and equipment necessary to perform complete testing of the installed HVAC systems, including piping and electrical connections. Field test will demonstrate proper calibration of input and output devices, and the operation of specific equipment.
- b. Calibrate electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
- c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
- d. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
- e. Contractor shall schedule the performance verification test with the Resident Engineer.
- f. During and after completion of the field tests, contractor shall determine causes, calibrate, repair, or replace equipment that fails to meet contract requirements, and subsequently deliver a written report to the VA.

2. Field Performance Tests:

- a. Perform tests in accordance with Articles-Quality Assurance and Performance.
- b. Test and adjust controls and safeties.
- c. Pressure test control air piping at 150 psig or 1.25 times the design pressure. Pressure shall be applied in several stages, allowing time for the system to reach equilibrium. The test pressure shall not exceed the pneumatic test pressure for any pump, valve, or other component in the system under test.
- d. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
- e. Demonstrate the software ability to edit the control program off-line.

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

3. Performance Verification Test and Certification:

- a. The contractor shall verify the performance of the control systems by running a continuous test, after the system has been completely tested and debugged, for 160 hours and submit the report to the VA. The system shall be completely compatible with the existing Johnson Controls DDC system and perform per sequences shown on drawings.

H. Guarantee Period Services: Guarantee period for mechanical systems shall be for a period of (2) years or as otherwise noted in the individual specifications sections starting with the final day of acceptance. The detailed guarantee period service requirements for individual systems have been described in the individual specifications sections.

- 1. Qualifications: All service technicians assigned to perform work under this contract shall be qualified and factory trained by the Original Equipment Manufacturer (O.E.M.). Each technician shall have at least three years experience of working on comparable systems and shall be a full time employee of the contractor. The contractor shall furnish, for the Department of Veterans Affairs (VA) review and approval, resumes of all service technicians scheduled to service the equipment and systems. The resume shall include details of experience, training, and educational qualifications and performance evaluations.

2. Replacement Parts: The contractor shall be equipped with all replacement parts of all equipment and systems to be serviced and the manufacturer's standard service and repair procedures. All replacement parts shall be brand new and of current design. The replacement parts shall be O.E.M. items. Obsolete or refurbished parts are unacceptable. "Approved Equal" parts must have prior approval of the Contracting Officer. Contractor shall furnish evidence of guaranteed supply of parts for the life of the system.
3. Service Supplies: The services shall include, without any additional cost to the government, all replacement parts, special tools and equipment, and consumable materials, that is, lubrication oil, grease, and cleaning materials, as required. The requirement of UL listing, where applicable, shall not be voided by any replacement parts, components, software, or modifications provided by the contractor.
4. Scheduled and Emergency Call Service: The service shall include a scheduled same day two hour response time for equipment and/or systems on a 7 day, 24 hours call back service for emergency service. The emergency service is defined as a situation created by a breakdown or malfunction of any equipment or system warranting urgent attention. A qualified service representative shall respond to the VA request for emergency service within two hours and assess the problem either by telephone or remote diagnostic capability. If the emergency situation cannot be rectified by the VA personnel, on site emergency service shall be provided by sending a qualified service representative within 24 hours. For the rural locations of the VA medical centers, situated over 200 miles from the contractor's established service depot, the maximum response time of 48 hours shall be acceptable. The emergency service shall be limited to adjustments and repairs specifically required to protect the safety of the equipment for which the emergency service was required to be performed.

- - - END - - -



**SECTION 15980**  
**TESTING, ADJUSTING, AND BALANCING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:
  - 1. Planning systematic TAB procedures.
  - 2. Inspecting equipment and installations for conformance with design.
  - 3. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
  - 4. Recording and reporting results.
- B. Definitions:
  - 1. Basic TAB used in this Section: Chapter 34, "Testing, Adjusting and Balancing" of ASHRAE Handbook, "HVAC Applications".
  - 2. TAB: Testing, Adjusting and Balancing. The process of checking and adjusting HVAC systems to meet design objectives.
  - 3. AABC: Associated Air Balance Council.
  - 4. NEBB: National Environmental Balancing Bureau.
  - 5. Hydronic Systems: Includes chilled water, condenser water, secondary water, heating hot water and glycol-water systems.
  - 6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
  - 7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.
  - 8. Steam systems.

**1.2 RELATED WORK**

- A. Section 15050, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).
- B. Section 15200, NOISE AND VIBRATION CONTROL.
- C. Section 15250, INSULATION.
- D. Section 15740, TERMINAL UNITS.
- E. Section 15840, DUCTWORK AND ACCESSORIES

F. Section 15902, CONTROLS AND INSTRUMENTATION.

### 1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).
- B. TAB Agency Qualification: Current membership in AABC or certification by NEBB.
- C. Test Equipment Criteria: The basic instrumentation requirements and accuracy/calibration required by AABC, National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.
- D. Tab Criteria:
  - 1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 34, shall be the basis for planning, procedures, and reports.
  - 2. Flow rate tolerance: Values are based on discussion in ASHRAE Handbook "HVAC Applications", Chapter 34. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 80 percent of final values for prefilters and after filters.
    - a. Air handling unit cubic feet per minute: Minus 0 percent to plus 10 percent.
    - b. All other fans: Minus 0 percent to plus 10 percent.
    - c. Air terminal units (Max): Minus 5 percent to plus 10 percent.
    - d. Exhaust hoods/cabinets: Minus 0 percent to plus 10 percent.
    - e. Minimum outside air: Minus 0 percent to plus 10 percent.
    - f. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 5 percent.
    - g. Secondary water and heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
    - h. Chilled water and condenser water pumps: Minus 0 percent to plus 10 percent.
    - i. Chilled water coils: Minus 5 percent to plus 5 percent.

3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.
  - b. During each partial final inspection and the final inspection for the project if requested by VA.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. TAB Agency qualifications: Submit names and qualifications of company officers and job supervisor. Submit information on three recently completed projects. Submit list of proposed test equipment.
- C. For use by the resident engineer staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. TAB Reports to be Submitted for Review:
  1. Inspection reports covering equipment and systems installation. These reports are to be submitted during early stages of the project in order to allow timely correction of deficiencies.
  2. TAB reports covering flow balance and adjustments, performance tests, vibration tests, and sound tests. These reports shall be submitted prior to or at the time of requesting final inspection, or partial final inspections of contract work.
  3. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.

#### **1.5 APPLICABLE PUBLICATIONS**

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the initials of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):
  - ASHRAE Handbook, 1995 HVAC Applications, Chapter 34, Testing, Adjusting, and Balancing; Chapter 43, Sound and Vibration Control.

- C. Associated Air Balance Council (AABC):
  - AABC National Standards MN-1, 5th Edition, 1989.
- D. National Environmental Balancing Bureau (NEBB):
  - Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems, 5th Edition, September 1991.
  - Procedural Standards for the Measurement and Assessment of Sound and Vibration, 1994 Edition.
- E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
  - HVAC SYSTEMS-Testing, Adjusting and Balancing, 2<sup>nd</sup> Edition, 1993.

## **PART 2 - PRODUCTS**

### **2.1 PLUGS**

Provide plastic plugs to seal holes drilled in ductwork for test purposes.

### **2.2 INSULATION REPAIR MATERIAL**

Section, INSULATION. Provide for repair of insulation removed or damaged for TAB work.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract and as-built documents and copies of approved submittals for HVAC equipment and automatic control systems.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial final inspections and for final phase inspection.
- D. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial final inspections and for final phase.
- E. Prior to demolition and construction, test and issue report on all existing grilles, registers, diffusers, and DDVAV boxes within the construction boundary areas which are to be closed. After construction, re-open grilles, registers, and diffusers and rebalance.

### **3.2 INSPECTING EQUIPMENT AND INSTALLATIONS FOR CONFORMANCE WITH DESIGN**

- A. GENERAL: The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- B. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including flexible duct sizes and routing.

### **3.3 TAB PROCEDURES**

- A. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work. Measure and report motor voltage and amps for all phases.
- B. Air Balance and Equipment Test: Include air handling units, fans, fan coils, terminal units, and room diffusers/outlets/inlets, and laboratory hoods and cabinets.
  - 1. Artificially load air filters by partial blanking to produce air pressure drop of at least 80 percent of the design final pressure drop.
  - 2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL).
  - 3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
  - 4. Variable air volume (VAV) systems and Dual Duct VAV Systems:
    - a. Coordinate TAB, including system volumetric controls, with Section 15902, CONTROLS AND INSTRUMENTATION (DDC).
    - b. Section 15740, TERMINAL UNITS, specifies that maximum and minimum flow rates for Air Terminal Units (ATU) be factory set. Within contract area, check, recalibrate and adjust all ATU flow rates in the field. Balance air distribution from ATU on full cooling maximum scheduled cubic feet per minute. Reset room thermostats and check ATU operation from maximum to

minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode.

5. Record final measurements for air handling equipment performance data sheets.
- C. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers.
1. Conduct chilled water/heating water flow balancing.
  2. Adjust flow rates for equipment, coils and evaporator for instance, to values on equipment submittals if different from values on contract drawings.
  3. Primary-secondary and variable volume systems: Coordinate TAB with Section 15902, CONTROLS AND INSTRUMENTATION. Balance systems at design flow then verify that variable flow controls function properly.
  4. Record final measurements for hydronic equipment performance data sheets. Include entering and leaving water temperatures for reheat coils, heating and cooling coils, heat recovery coils, and for convertors. Include entering and leaving flow rates and air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time, and record entering and leaving temperatures and flow rates. Record steam pressure at inlet and outlet of steam control valves 100% open at full load.

### **3.4 VIBRATION TESTING**

- A. Furnish instruments and perform vibration measurements as specified in Section, NOISE AND VIBRATION CONTROL. Field vibration balancing is specified in Section, BASIC MATERIALS AND REQUIREMENTS (MECHANICAL). Provide measurements for all rotating HVAC equipment 1/2 horsepower and larger, including pumps, fans and motors.
- B. Record initial and final measurements for each unit of equipment on test forms. Where vibration readings exceed the allowable tolerance and efforts to make corrections have proved unsuccessful, forward a separate report to the Resident Engineer.

### **3.5 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 15200, NOISE AND VIBRATION CONTROL.
  1. Take readings in rooms, approximately fifteen (15) percent of the total rooms. VA shall designate the specific rooms to be tested.

- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.
- C. Sound reference levels, formulae and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:
  - 1. When sound pressure levels are specified, including the NC Criteria in Section 15200, NOISE AND VIBRATION CONTROL:
    - a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
    - b. Measure octave bank sound pressure levels with specified equipment "off".
    - c. Measure octave band pressure levels with specified equipment "on".
    - d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 TO 9	10 OR MORE
FACTOR:	10	7	4	3	2	1	0

Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.

- e. Plot octave banks of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
- 2. When sound power levels are specified:
  - a. Perform steps 1.a thru 1.d, as above.
  - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determine sound level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
  - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 30 feet for sound level location.
- 3. Where sound pressure levels are specified in terms of dB(A), measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.

- E. Where measure sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.

### **3.6 DUCT AIR LEAKAGE TESTING:**

- 1. Verify that all new ducts are Seal Class A; therefore no leakage testing is required. Contractor to reseal ducts which indicate leakage.

- - - E N D - - -



**SECTION 15991**  
**DEMONSTRATIONS AND TESTS**

**PART 1 - GENERAL**

**1.1 REQUIREMENTS INCLUDED**

Procedures for on-site demonstration and testing of equipment and systems including temporary facilities. Instruction of Government operating personnel. Plumbing and emergency power systems are not included.

**1.2 DEFINITIONS**

- A. Start-Up: Initial inspection, cleaning, lubrication, adjustment, and operation of equipment and systems by the contractor with the assistance of the representatives of the equipment manufacturers.
- B. Pre-Tests: The final stage of the start-up procedure. This occurs after all adjustments have been made except for minor fine tuning which can be done during the pre-test. Serves as a verification that the systems are ready for the final test. Witnessing of pre-test by Resident Engineer is not required.
- C. Final Tests: Tests, witnessed by the Resident Engineer or his representative, which demonstrate that all equipment and systems are in compliance with requirements. At VA expense, VA may utilize the services of an independent testing organization or consultant to witness the tests.

**1.3 RELATED REQUIREMENTS**

- A. Operating and maintenance manuals: Section 15051, BASIC REQUIREMENTS AND METHODS.
- B. Demonstration, instructions and testing of temporary equipment: Section 15051, BASIC REQUIREMENTS AND METHODS.
- C. Sound and vibration levels; sound tests and vibration testing of rotating equipment: Section 15200, NOISE AND VIBRATION CONTROL.
- D. Demonstration and testing of instrumentation, controls and computer work station: Section 15902, CONTROLS AND INSTRUMENTATION (DDC).

**1.4 QUALITY ASSURANCE**

- A. Experienced, trained engineering service personnel who are representatives of the equipment manufacturers shall demonstrate, provide instructions, pre-test and final test, as specified, the following equipment:
  - 1. Instrumentation panel and peripheral equipment
- B. Experienced technicians shall demonstrate and provide instructions on the following equipment:

1. Ventilation and heating systems
  2. Controls and safety
- C. The person responsible for programming the computer work station shall demonstrate and provide instructions on hardware, software and programming.
  - D. The VA, upon request, will provide a list of personnel to receive instructions and will coordinate their attendance at agreed-upon times.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01340, SAMPLES AND SHOP DRAWINGS.
- B. Names and qualifications of personnel performing demonstrations, instructions and tests.
- C. Preliminary schedule of all demonstrations, instructions and final tests two weeks prior to proposed dates.
- D. Provide reports within three weeks after satisfactory completion of demonstrations, instructions, and tests. List date, type of work, persons participating, amount of time, test results, calculations of test results, test data.

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

#### **PART 3 - EXECUTION**

##### **3.1 PREPARATION FOR FINAL TESTS, DEMONSTRATIONS, AND INSTRUCTIONS**

- A. Verify that equipment and systems are fully operational. Complete all start-up and pre-test activities for all equipment and systems. Complete all construction and finish work.
- B. Arrange for all test personnel for all equipment to be continuously present during one period of time so that all equipment and systems can be tested in their interrelated functions.
- C. Complete and deliver all maintenance and operating manuals four weeks prior to instruction period.
- D. Furnish all special tools.

### **3.2 FINAL TESTS**

- A. Demonstrate proper operation of each equipment and system.
- B. Provide tests on equipment as specified in the individual specification sections.

### **3.3 DEMONSTRATION AND INSTRUCTION**

- A. Demonstrate operation and maintenance of equipment and systems to Government personnel no more than four weeks prior to scheduled opening.
- B. Use operation and maintenance manuals as basis of instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance.
- C. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shut-down of each item of equipment. Allow Government personnel to practice operating the equipment under supervision of instructors.
- D. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

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

- A. At least 8 total instructor manhours to include computer work station and programs.
- B. Do not exceed three trainees per session, one-four hour session, per day, per trainee.

- - - E N D - - -

**SECTION 16050**  
**BASIC METHODS AND REQUIREMENTS (ELECTRICAL)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section, Basic Methods and Requirements (Electrical) applies to all sections of Division 16.
- B. Furnish and install all required labor, materials, tools, equipment, instrumentation and services including but not necessarily limited to electrical wiring systems, conduit systems, equipment and accessories , transformers, panels, transient voltage surge suppressors, patient wall systems, motor starters, disconnect means and all final connections for a complete installation certified in writing ready for operation in all respects.
- C. Wiring ampacities specified or shown on the drawings are based on copper conductors, with the conduit and raceways accordingly sized. Aluminum conductors or copper clad aluminum are prohibited.

**1.2 MINIMUM REQUIREMENTS**

- A. References to the 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 or device of a kind mentioned which:
    - a. Is published by a nationally recognized laboratory which makes periodic inspection of production of such equipment.

- b. States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.
- 2. Labeled; equipment or device is when:
  - a. It embodies a valid label, symbol, or other identifying mark of a nationally recognized testing laboratory such as Underwriters Laboratories, Inc.
  - b. The laboratory makes periodic inspections of the production of such equipment.
  - c. The labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.
- 3. Certified; equipment or product is 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 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. All integral factory wiring shall be installed in a raceway system. Loose wiring not installed in wireway troughs or channels, raceways or the like is not acceptable.
- 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 reinspection is required, the contractor shall be liable for all additional expenses, including expenses of the Government.

## **1.6 EQUIPMENT REQUIREMENTS**

Where variations from the contract requirements are requested in accordance with Section 01001, GENERAL CONDITIONS and Section 01340, SAMPLES AND SHOP DRAWINGS, 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.

## **1.7 EQUIPMENT PROTECTION**

Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.

- A. 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.
- B. 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.
- C. Painted surfaces shall be protected with factory installed removable heavy kraft paper, sheet vinyl or equal.
- D. 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.

## **1.8 WORK PERFORMANCE**

- A. All electrical work shall 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 shall 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 Director of the Medical Center.

- 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 01010, GENERAL REQUIREMENTS.
- E. 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 01010, GENERAL REQUIREMENTS.
- F. Coordinate location of equipment and conduit with other trades to minimize interferences. See Section 01001, GENERAL CONDITIONS.

#### **1.9 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 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.

#### **1.10 EQUIPMENT IDENTIFICATION**

- A. In addition to the requirements of the NEC, provide engraved nameplates for all panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers, transformers controllers in switchboards, and motor control assemblies, control devices and other significant 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.
- C. Each receptacle and toggle switch coverplate shall be provided with an engraved nameplate indicating panel designation and circuit number.



### 1.11 SUBMITTALS

- A. Submit in accordance with section 01340, SAMPLES AND SHOP DRAWINGS.
- 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 01010, 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. Lubrication schedule including type, grade, temperature range, and frequency.
    - j. 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.
    - k. 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 coupling, bushing and termination fitting.
  3. Conduit hangers, clamps and supports.
  4. Duct sealing compound.
  5. Each type of receptacle, toggle switch, outlet box, manual motor starter, device plate, engraved nameplate, wire and cable splicing and terminating material and single pole molded case circuit breaker.
- 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.

#### **1.12 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.

#### **1.13 JOB CONDITIONS**

- A. Existing systems shown are based on visual inspection and existing drawings, but they may not reflect the actual electrical characteristics on conditions in every case or all details.
- B. Inspect the site and examine the work before submitting the bid proposal. Note the location of existing systems, the extent of the work, and interface of new systems with existing ones. Any discrepancies should be documented with the contracting officer prior to bids.
1. Certify, before executing a contract, that the above described site inspection has been performed. No extra charges shall be accepted by the Government for work that has to be performed due to the Contractor's negligence to verify the existing conditions.
  2. Plan the sequence of demolition and construction so that the entire project is carried out with minimum power and communication systems interruptions. Submit prior written notice to the Resident Engineer as stated herein. The work shall not start without the Resident Engineer's approval.
  3. Work that is required to be performed in occupied areas, below, above or adjacent to the project space such as power, lighting, communications, etc., such work shall be performed

during off building hours that meet the Resident Engineer's prior approval. Include premium overtime costs in bid proposal.

- C. The project encompasses demolition of walls and replacement of existing electrical equipment, feeders, branch wiring, signal cables, etc. with new work. Remove, reinstall or relocate that portion of the existing equipment, system, wiring, fixtures and device(s) which are a part of or which applies to the electrical trade.
  - 1. In areas where new ceilings, partition walls or doors are added and existing systems, such as fixtures, power, communication and miscellaneous feeders and devices are designated to remain, relocate and rework the existing circuitry, provide additional materials, and extend same as necessary to insure proper operation.
  - 2. Provide new lighting switch(es) so each existing area lighting affected by new work is switched locally.
  - 3. Maintain and restore when interrupted, all conduits, wiring, signal cables, etc. passing through remodeled areas and serving areas outside the scope of work.
  - 4. Perform all cutting, coring and patching.
- D. Equipment and devices removed and not relocated, such as lighting fixtures, switches, receptacles, wiremold, breakers, wire, etc. shall be grouped, turned over to the Resident Engineer and stored or legally disposed of, as directed by the Resident Engineer.
- E. All conduit that is abandoned shall have all wiring removed from source, and stubs shall be plugged flush with floor or ceiling slabs. All exposed conduit, including above dropped ceiling, that rendered obsolete shall be removed and legally disposed of off the VA site.
- F. Schedule shutdowns, disconnections and re-connections with the Resident Engineer. Such work shall take place at the convenience of the VA. Arrange work so as not to interrupt power, telephone, fire, communications and other systems during normal building hours.
  - 1. Where core drilling and cutting of floors or walls is required X-Ray areas to determine and avoid interference with existing concealed feeders and pipes.
  - 2. Use temporary cables and electrical apparatus as required. Contractor shall be held responsible for the use of great diligence and care in disconnecting various systems. Reconnect systems that serve adjacent areas or floor above if such systems have been disrupted during excavation and demolition work.
- G. Fire protection and fire alarm systems shall not be disconnected or otherwise rendered unserviceable without first notifying the

Resident Engineer and Fire Department. Comply with the Fire Department's requirements.

1. Provide fire seals to all conduits and pipes running through fire rated walls.
- H. New systems such as fire alarm and Nurses Call systems, are to be extended and interfaced with existing systems. All equipment and work shall be covered in the bids. Arrange for the on-site inspection and guidance of the respective manufacturer's representative during the execution of the work. Provide all materials, devices and components as required so that the existing and new systems are properly interfaced and function as one system.

#### **1.14 TRAINING**

- A. Training shall be provided in accordance with Article, INSTRUCTIONS, of Section 01010, 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.

#### **1.15 CONNECTIONS TO EQUIPMENT**

- A. Verify all rough-in connections for all equipment prior to doing any work. All connections shall be made in conformance to shop drawings, instructions, and wiring diagrams provided by the manufacturer of the equipment. Provide all final connections for equipment specified by the manufacturer's shop drawings, wiring diagrams, and instructions even though not specifically mentioned in the contract documents. All equipment shall be connected complete in place, ready for operation, including all power and control wiring and all final connections, at no additional cost to the contract.

#### **1.16 MISCELLANEOUS HANGERS AND STEEL**

- A. Provide all hangers, angles, channels, rods, welding, and other structural steel supports required by field conditions to install or platform mount any electrical equipment. Equipment platforms shall be supported from structural members only. Perforated strap is not acceptable.
- B. Ductwork, piping, suspended ceilings, or materials used to support suspended ceilings, piping and ductwork shall not be used for supporting conduits or electrical equipment.

#### **1.17 FLOOR OPENINGS**

- A. Provide complete in place conduit fire stop sealing fittings for all electrical conduits, and telephone cables penetrating fire rated floors and walls.

- B. Openings through floors and walls in which cable or conduit pass shall be sealed by fire stop fittings with elastomeric rings to seal off cold, smoke and toxic fumes. Additionally, these fittings shall have heat activated intumescent material which expands to fill the voids left by destroyed cable insulation. These fire stop fittings shall have an hourly fire-rating equal to or higher than the fire rating of the floor or wall through which the cable or conduit pass.
- C. Refer to Section 07270 - Firestopping System

#### **1.18 WARNING SIGNS AND LABELS**

- A. Provide all warning signs and labels in all rooms and areas where work is in progress.

#### **1.19 WORKMANSHIP**

- A. Where holes or recesses must be cut in walls, floors, ceilings or any part of the building to admit apparatus, conduit or other work of this section, a competent mechanic shall do this in a neat and workmanlike manner. The portions cut must be restored to their original condition under this section. Provide for all cutting and patching of this work.

#### **1.20 HOLES IN STRUCTURAL MEMBERS**

- A. No holes for conduit or equipment shall be permitted through any structural member.

#### **1.21 MAINTENANCE OF THE ELECTRICAL SYSTEM**

- A. Maintain the complete electrical system until all electrical installations and general appearance of the work are satisfactorily completed and accepted. The contractor will also be responsible for any vandalism, knockdown or breakage to any part of the system during the maintenance period.

#### **1.22 CLEARANCE AT ACCESS DOORS AND PANELS**

- A. Do not install any conduits, hangers, equipment or fixtures that will obstruct or interfere with the use of any access doors or removable access panels, louvers, dampers whether on equipment, in walls, or in the ceiling.
- B. Comply with this requirement, if necessary, by re-routing conduit at no extra cost to the contract.

#### **1.23 GENERAL**

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with all the following requirements.
  - 1. Coordinate electrical systems, equipment, and materials installation with all other building components.

2. Verify all dimensions by field measurements.

#### **1.24 PHASE SEQUENCE AND ROTATION:**

- A. All transformers, feeders, power sub-feeds to motor, etc., shall be completely phased out as to sequence and rotation. Phase sequence shall be A-B-C as follows:
  1. Front to rear, left to right, or top to bottom when facing equipment.

#### **1.25 CUTTING, CORING AND PATCHING**

- A. General: The following requirements apply in addition to all other requirements specified in the Contract Documents.
  1. Perform cutting, coring, fitting, and patching of electrical equipment and materials required to:
    - a. Remove and replace defective work.
    - b. Remove and replace work not conforming to requirements of the contract documents.
    - c. Install equipment and materials in existing structures.
  2. Perform all cutting, coring, and patching required to complete the work. Perform all demolition and removal of debris resulting therefrom as shown and required to complete the work.
  3. Employ the services of tradesmen skilled in the type of work required.
  4. Protect the structure, furnishings, finished and adjacent materials not indicated or scheduled to be removed.
  5. Protection of installed work: During coring, cutting and patching operations, protect adjacent installations.
  6. Patch existing finished surfaces and building components using new materials matching existing materials and texture using experienced installers.
  7. Provide all cutting, coring, fitting, and patching necessary for the running and securing of conduits and other equipment, and provide all supports necessary for same and all bracing and anchorage of work.
  8. Provide all demolition and removal of debris resulting from cutting, coring, and patching. Remove and legally dispose of all debris off the site.
  9. Provide all cutting, coring, and patching of existing concrete floor slabs, walls, ceilings as required for installing electrical materials.

10. No cutting of any structural member or fire-proofing shall be permitted.
11. Provide all cutting, coring, and patching of existing concrete floor slabs, walls, ceilings as required for installing electrical materials.
12. Provide protective HVAC duct barriers in the immediate areas of cutting and coring in order to prevent dust from getting into air stream, ducts, adjacent rooms, and corridors.
13. X-Ray floor/wall for feeders, piping, obstruction prior to coring or cutting, drilling.

#### **1.26 DRAWINGS AND SPECIFICATIONS**

- A. The drawings accompanying this specification cover the design and scope of the various systems. However, the exact disposition of the equipment is subject to the requirements and construction of the building. Changes required by job conditions shall be made without extra cost.
- B. All work shall be executed according to the true meaning and intent of the drawings and specifications which are intended to include everything requisite and necessary for the proper and entire finishing of the work, notwithstanding that each and every item necessarily involved in this work is not specifically mentioned and the work when compared, shall be delivered in perfect and undamaged condition without exception.
- C. The drawings and specifications are intended to be cooperative and the work or materials called for by the drawings and not mentioned in the specifications or vice-versa shall be furnished and performed in as faithful and thorough a manner as though treated by both.
- D. At the completion of the job and before final payment is made, a complete set of "Project Record" drawings shall be submitted, including revised drawings that may be issued, which shall show the location of all conduit, circuiting and equipment, etc., as finally installed.
- E. Carefully examine the Architectural, Fire Protection, Structural, and Mechanical, Plumbing drawings and specifications before submitting the bid. Bid shall include the cost of any or all work shown or called for therein that may affect or be a part of this work.
- F. Contractor shall refer to Architectural drawings for details, reflected ceiling plans, large scale drawings.
- G. The drawings and specifications are not intended to show all details and the Engineer will not be responsible for the absence of any detail which the contractor shall require or any special construction which may be found necessary as the work progresses.



- H. No extras will be allowed for any work or material unless it can be clearly shown to be an addition beyond the intent and contemplation of the drawings and specifications.
- I. Contractor shall review and carefully examine the plans and specifications in order to familiarize himself with all conditions and to fully understand the nature and scope of work under this Contract as well as the difficulties attending its execution.
- J. Contractor shall prepare and submit for review such additional electrical drawings and diagrams as are required by the applicable code authorities.
- K. Drawings: The small scale of the drawings does not permit duplication of all panels, feeders, and other electrical equipment on all drawings. This contractor shall exercise special care in the installation of his work to include all materials and fittings necessary for a complete installation. Exact dimensions and locations of all outlets shall be verified on the job.
- L. Diagrams: Certain drawings are diagrammatic. Only the outlets are shown. This contractor shall furnish and install all conduit and wiring required and leave these outlets in operating condition.
- M. Missing Pages and Articles:
  - 1. This contractor shall check this copy of the specifications for missing pages by comparing the articles, etc. in the Table of Contents at the front of this specification against all of the article titles in the main body of the specifications.
  - 2. This contractor shall be fully responsible for obtaining all missing pages. No extras will be allowed for items covered on pages missing from this copy of the specifications.
- N. Where there is a conflict between the drawings and specifications, bid shall be based on that item which is greater in quantity or quality. Verify which item shall take precedence prior to the installation of this item.

**1.27 COMPLETE SYSTEMS:**

- A. Furnish all materials and all equipment for a complete and ready-to-operate electrical system. Any item of material and/or equipment not shown on drawings or specified, but required for satisfactory operating systems, shall be furnished and installed as though completely specified and shown on the drawings.

**1.28 SYMBOLS AND OUTLETS LOCATIONS:**

- A. Symbols appearing on the drawings show approximate locations only, and care shall be used to locate all fixture outlets on center of spaces designated and in accordance with fixture plans. All switch outlets shall be on lock side of doors except as noted otherwise.

- B. In partitions dividing finished spaces, outlet boxes for receptacle and wall switches shall not be mounted back to back, but separated by a minimum 24" with wall stud in between wiring devices or as noted on drawings, whichever is greater.
- C. It shall be understood that any outlet may be relocated a distance not to exceed 10' from the location prior to rough-in shown when so directed by the Engineer at no increase in Contract price.

**1.29 HOISTING RIGGING, TRANSPORTATION AND SCAFFOLDING**

- A. The contractor shall provide all scaffolding, staging, cribbing, tackle, hoists and rigging necessary for placing all of his materials and equipment in their proper places in the project. All temporary work shall be removed from the premises when its use is no longer required on the job.
- B. Pay all costs of transportation of materials and equipment to the job site and include such costs in proposal. Scaffolding and hoisting equipment shall comply with requirements of all pertinent Federal, State and jurisdictional law and codes.

**1.30 SAMPLES:**

- A. The contractor shall submit samples of any equipment and materials, when requested for selection of quality, colors, etc. and to obtain the Architect's review before it is ordered.

**1.31 STORING ELECTRICAL EQUIPMENT AND MATERIALS:**

- A. Contractor shall store all electrical materials and equipment in a dry location so that corrosion and damage due to moisture will not affect same.
- B. All equipment furnished under other sections shall be placed in first class operating condition. The contractor will be responsible for its safety. Make all final connections.

**1.32 MAINTENANCE OF THE ELECTRICAL SYSTEM:**

- A. The Contractor will maintain the complete electrical system until all electrical installations and general appearance of the work are satisfactorily completed in accordance with plan and specifications, and accepted. The Contractor will also be responsible for any vandalism, knockdown or breakage to any part of the system during the maintenance period.

**1.33 CABLE SUPPORTS**

- A. Vertical cable in conduit risers shall be provided with cable supports in conformance with all applicable local, state and national electrical codes.

**1.34 REMOVAL OF RUBBISH:**

- A. Contractor shall remove all his rubbish as fast as it accumulates, keep the building and premises clean during progress of the work

and leave the premises at completion in perfect condition as far as his work is concerned.

**1.35 MAINTAINING MAXIMUM HEADROOM:**

- A. Maintain maximum headroom in all spaces when installing conduits. Study all drawings and plan the installation of work to provide the maximum headroom under all conduits or equipment in all spaces.
- B. Take into account the varying ceiling heights, beams, etc. and offset conduits up or down as required in order to maintain maximum headroom in all spaces even if such offsets are not shown on the drawings.
- C. Failure on the part of the Contractor to preserve maximum headroom will require him to raise his conduits and/or equipment without any additional cost to the Contract.

**1.36 SPACE:**

- A. All conduits, pull-boxes, and equipment shall fit into the designated locations and spaces shown on the drawings. Pull-boxes or equipment shall not be installed above inaccessible suspended ceilings.

**1.37 FIELD QUALITY CONTROL**

- A. Testing:
  - 1. After wires are in place and connected to devices and equipment, the system shall be tested for shorts and grounds.
  - 2. All hot wires, if shorted or grounded, shall be removed and replaced.
  - 3. A voltage test shall be made at the last outlet on each conduit. If drop in potential is excessive, Contractor will be required to correct the condition by locating partly grounded conductor or high resistance splice.
  - 4. All grounds, shorts and high resistance splices shall be rectified.
  - 5. Any wiring device, electrical apparatus or lighting fixture furnished under this Contract, if grounded or shorted on any integral "live" part, shall be removed and the trouble rectified by replacing all defective parts or materials as directed.
  - 6. All motors shall be tested under load with ammeter readings taken in each phase, and the RPM of motors and ampere draw recorded at the time. Coordinate solid state relay settings with each motor nameplate. All motors shall be tested for correct rotation. Rotation shall be corrected at motor terminals only. Contractor shall be responsible for test

running of all motors and shall verify that proper overload devices have been installed.

7. All meters, instruments, cable connections, equipment or apparatus necessary for making all tests, shall be furnished by this Contractor at his own expense.
8. Submit test results.
9. Provide polarity testing for all receptacles. Submit typewritten test reports.

#### **1.38 CLEANING:**

- A. Cleaning Equipment, Completed Work and Premises: After the completion of all installations, each system shall be thoroughly cleaned to remove all paint, oil and other foreign material. Clean all foreign paint, grease, oil, dirt, labels and stickers, etc., from all fixtures, equipment, etc. Remove all rubbish, debris, etc., accumulated from his operations from the premises.
- B. The Contractor shall be responsible for protecting all equipment and systems against harmful exposures to, or accumulations of dust and moisture, flooding, corrosion or other forms of damage and shall clean and restore damaged finishes as may be required to place installations in a "like new" conditions before final acceptance.
- C. All finished metal surfaces shall be cleaned and polished. All exposed materials, equipment and apparatus shall be thoroughly cleaned of dirt, rust, cement, plaster, etc., all cracks and corners scrapped out clean and all surfaces carefully cleaned of grease and oil spots and left smooth and clean, with all unfinished surfaces ready for painting.
- D. Clean all grease, oil, dust, and other spots caused by the work of this Contract, and from floors, walls, ceilings, fixtures, or other parts of the building and leave the premises clean and free from all debris and unused construction materials.
- E. All power panels, lighting panels, switchboards and the like shall be thoroughly cleaned prior to final acceptance of the project.

#### **1.39 SLEEVES AND INSERTS:**

- A. Provide all sleeves and inserts.
- B. Sleeves shall be galvanized or black enameled rigid steel heavy wall conduit or Schedule 40 black steel pipe. The space between conduit and sleeves shall be sealed with approved non-combustible packing material to prevent passage of air liquid exceeding fire resistance of the construction being penetrated. Aluminum conduit is not acceptable.
- C. All openings around conduits shall be sealed with fire seals and fire stops in a manner as approved by applicable codes.

- D. Sleeves through floor slabs for conduit risers shall be securely fastened in position. Sleeves shall be set with top and bottom 4" above and below floor slab. Sleeves shall be 2" larger than the outside diameter of the conduit specified.
- E. All raceways and electrical equipment that penetrates fire rated walls and floors shall be sealed at the wall or floor surface to prevent the passage of fire and smoke.

**1.40 AIR PLENUMS:**

- A. All materials and equipment installed in air plenum shall be approved for the purpose by Underwriter's Laboratories and shall be in conformance to all applicable codes.
- B. All materials and equipment shall be protected at all times. Pipe openings shall be closed with plugs or caps during installation. All fixtures and equipment shall be covered and protected against dirt, water chemical, and mechanical injury.

**1.41 DAMAGE TO OTHER WORK:**

- A. The Contractor shall be held responsible for any damage caused to work of other Division and/or existing installations not pertinent to the Contract. The cost of repairs to such damaged work shall be charged against the Contractor.
- B. All materials and equipment shall be protected at all times. Pipe openings shall be closed with plugs or caps during installation. All fixtures and equipment shall be covered and protected against dirt, water chemical, and mechanical injury.

**1.42 SYMBOLS AND OUTLETS LOCATIONS:**

- A. Symbols appearing on drawings show approximate locations only, and care shall be used to locate all fixture outlets on center of spaces designed and in accordance with fixture plans. All switch outlets shall be on lock side of doors except as noted otherwise.
- B. In partitions dividing offices and other finished spaces, outlet boxes for receptacles and wall switches shall not be mounted back to back, but separated by at least 24 inches with wall stud between wiring devices or as noted on drawings, whichever is greater.

**1.43 PLASTIC SIGNAGE**

- A. Provide self-adhesive or pressure sensitive, pre-printed flexible vinyl signs for operational instructions or warnings. Provide signage for applicable areas and adequate for visibility. Signage shall be white background; red block lettering.

**1.44 EXISTING CONDITIONS - DEMOLITION**

- A. It is not the intent of these specifications to describe in detail each and every step for demolition, but rather to present a performance specification with express requirements that the

contractor shall fulfill to the satisfaction of the contract documents and the requirements of VA Hines.

- B. Verify existing conditions and locations in field prior to submitting proposal. Failure to do so shall not relieve this contractor from performing the work required under this contract.
- C. Make necessary modifications and adjustments to all electrical items and equipment, both new and existing, as may be required by these alterations and additions.
- D. Disconnect at source and remove existing electrical materials and equipment, including but not limited to lighting fixtures, wiring devices, signal equipment, conduit and wires, and all other electrical items which are rendered obsolete by building renovations, alterations, additions, and removal of existing wall partitions. These are the property of VA Hines and shall either be removed from the site or returned to the VA Hines stock at the discretion of VA Hines. Provide cartage for all materials and equipment retained by VA Hines. Materials and equipment not to be retained by VA Hines becomes the property of the contractor and shall be lawfully disposed of off the site.
- E. Provide all required labor, materials, tools, equipment, and services, for disconnecting, relocating, reinstalling, and rewiring existing electrical equipment, materials, facilities that interfere or are interfered with, obstruct or are obstructed by demolition, renovations, alterations and additions. Permanently install such items in new locations. Provide junction boxes, new outlets, conduits, wiring, etc. as required to extend service to new locations. Electrical materials equipment, facilities include but not necessarily limited to the following:
  - 1. Power panels, distribution panels, panelboards. Provide all labor, materials, tools, equipment and services for removing, relocating, re-installing, rewiring existing panels obstructed by new construction and removal of existing walls including but not necessarily limited to junction boxes, splices, extending existing feeders and branch circuits, conduits, cable, wire, maintain continuity of existing services, all miscellaneous and individual hardware and all final connections for a complete relocated installation ready for operation. Provide a free standing structure to support relocated panels to columns, and structural members including channels, angle irons, bracelets, hardware, welding and miscellaneous hardware. Provide all final connections.
  - 2. Transformers - Provide all labor, materials, tools, equipment and services for removing, relocating, re-installing, rewiring existing transformers obstructed by new construction and removal of existing walls including but not necessarily limited to junction boxes, extending existing feeder, reuse existing disconnect means, all primary and secondary wiring, grounding, maintaining continuity of service, all miscellaneous and incidental hardware, and all final connections for a complete relocated installation

ready for operation. Relocated transformers shall be trapeze mounted. Provide all final connections.

3. Lighting Fixtures.
  4. Wiring Devices.
  5. Signal Equipment.
  6. Conduits, pullboxes, junction boxes, backboxes, wiring, hangers.
  7. Fire Alarm Devices.
  8. Exit Signs.
  9. Emergency lighting.
  10. Medical equipment.
  11. Remove wiring back to overcurrent devices.
  12. Upgrade existing panelboard directories with new typewritten directory. Include spare breakers in panel directory.
- F. Any equipment which is to be relocated and reconnected shall be carefully examined for any defects and tested for electrical continuity prior to relocation. After equipment has been certified to be in good electro/mechanical condition, the equipment may be relocated and thoroughly cleaned and retested for electrical continuity. Contractor shall bear all expenses for any equipment and shall replace with new equipment or properly repair any damaged equipment.
- G. It shall be this contractor's responsibility to maintain the existing building in operation at all times including but not limited to electrical, fire alarm, telephone, DATA, miscellaneous systems, etc. during the entire construction period. If it is absolutely necessary to shut down any service, any circuit, any feeder, switchboard, distribution panel, power panel, appliance panel at any time, this contractor shall consult with the Contracting Officer's Technical Representative to make arrangements to do so on Sundays or off-hour periods at the owner's convenience. Prior written notice shall be given to the Contracting Officer's Technical Representative four (4) weeks in advance of the desired shut-down time. Any premium or overtime costs necessary to accomplish the above shall be included in bid proposal.
1. Maintain electrical continuity of all existing power and distribution, lighting receptacles, feeders, branch circuits to remain at all times during the construction period.
  2. Maintain continuity of all existing systems for all systems at all times, including but not necessarily limited to electrical, life safety systems, security, HVAC systems, public address, telephone, lighting controls, data process

equipment, plumbing systems, fire alarm systems, pump systems, during the entire construction period.

- H. Coordinate electrical work with all applicable trades to avoid conflicts and delays.
- I. Provide all cutting, coring, and patching as required.
- J. Provide fire seals for any conduit penetrations where conduits have been removed from walls or floors.
- K. Where existing conduits have been rendered obsolete by these alterations and additions and it is impractical to remove same, this contractor shall:
  - 1. Pull out all wire and cable back to overcurrent devices.
  - 2. Cut conduit off at slab or wall line and seal.
  - 3. Blank-up all obsolete conduit entries into existing junction boxes, panelboards, pull boxes, cut-out boxes, wireways, outlet boxes, etc.
- L. All openings shall be fire sealed.
- M. All existing conduits and equipment shall be protected.
- N. Where the continuity of circuits or conduits serving any existing electrical equipment in areas of the existing building is interfered with by demolition, and rendered obsolete. Disconnect, remove, provide cartage and legally dispose of off the site including but not limited to the following:
  - 1. Lighting Fixtures: Remove lighting fixtures, lamps, pendant accessories, junction boxes, conduits, wiring, ballasts.
  - 2. Floor Outlets: Remove floor outlets, service fittings and wiring. Provide new blank cover fittings. Where continuity of the circuit is interrupted by floor outlet removal, connect existing floor outlets to remain to the nearest active floor or wall receptacle. Make all final electrical connections. Fill floor opening with concrete.
  - 3. Wall Receptacles: Remove receptacles, backboxes, coverplates, wiring, conduits, where continuity of the circuit is interrupted by receptacle removal, rewire existing receptacles to the nearest active receptacle. Make all final electrical connections.
  - 4. HVAC, Plumbing, Humidifiers, Motors: Remove existing motors, motor starters, push buttons, disconnect means, wiring, fittings, junction boxes, etc. Remove all wiring back to overcurrent devices.
  - 5. Panelboards: Remove, relocate, re-install, rewire, splices, junction boxes, panelboards, including all conduits, feeder wiring and branch circuit wiring back to overcurrent device.



6. Maintain electrical continuity of all existing lighting, wiring devices, voice data, receptacles, feeder wiring, branch circuit wiring, and floor outlets that are to remain.
  7. Remove all exposed conduits, hangers, wiring, wiremold, etc., rendered obsolete by these renovations and remodeling.
  8. Remove lighting fixtures, hangers, conduits, wiring, battery lights, exit signs, switches, receptacles, floor outlets, fire alarm devices, miscellaneous devices, wireways, and miscellaneous wiring devices rendered obsolete.
  9. Remove all existing lighting fixtures where new ceiling and lighting are shown and specified. Maintain continuity of existing lighting to remain.
  10. Remove all existing wiring devices in existing wall partitions shown to be removed. Maintain continuity of existing wiring devices to remain by rewiring to nearest active like wiring device or rewire back to panelboard.
  11. Provide all required labor, materials, tools, equipment, and services for removing exit signs; wiring devices; motorized door operators, complete with all controls; conduits, junction boxes, hangers, supports, wiring back to nearest active device to remain or to overcurrent device as applicable.
- O. Maintain continuity of existing emergency lighting circuits for exit direction signs and emergency lighting for means of egress. Provide temporary wiring for removing, relocating, re-installing, rewiring existing exit signs and light fixtures as required to maintain exit directional signage and emergency lighting during the entire construction period.
- P. Remove, relocate, re-route existing conduits installed on or within existing walls to be removed. Provide all required junction boxes, conduits, wiring, splices in order to maintain continuity of existing circuits and feeders to remain, but obstructed by removal of existing walls. Provide all final connections.
- Q. Fire Alarm System - Provide all labor, materials, tools, equipment, and services for maintaining existing fire alarm system and subsequently removing fire alarm devices and wiring rendered obsolete. Maintain continuity of existing fire alarm system during the entire construction period. Temporarily rewire existing fire alarm devices at temporary locations to existing fire alarm control panel. Maintain continuity of existing fire alarm and detection system wherever the removal of a device interrupts the continuity of fire alarm wiring. Provide all required re-wiring of the existing fire alarm system complete with all final connections as required to maintain continuity of fire alarm and detection until the new fire alarm system is operational with the existing fire alarm system. Provide all required temporary support apparatus in order to support existing fire alarm devices and conduits during construction. After the new

fire alarm modifications are complete in place, certified ready for operation, the existing fire alarm devices and existing fire alarm wiring, temporary supports and the like shall be removed.

1. Existing Fire Alarm Equipment: Existing fire alarm equipment shall be maintained fully operational until the new equipment has been tested and accepted by the Government. As new equipment is installed, it shall be labeled "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted it shall be placed in service. All new equipment shall have tags removed and the existing equipment shall be tagged "NOT IN SERVICE" until removed from the building.
  2. Equipment Removal: After acceptance of the new system by the Government, all existing equipment not connected to the new system shall be removed and all damaged wall, ceiling, floor surfaces shall be restored. The material shall be removed from the site and legally disposed of by the Contractor.
- R. Nurse call system. Provide all labor, materials, tools, equipment, and services for maintaining continuity of existing Building 200 nurse call systems not rendered obsolete to existing nurse call systems. Provide conduits for wiring provided by nurse call sub-contractor.
- S. Provide all labor, materials, tools, equipment and services for the complete removal and lawful disposal of existing equipment, and associated miscellaneous hangers, cable, conduits, electrical equipment rendered obsolete and lawfully dispose of all equipment, cables, conduits, wiring, devices, removal of appurtenant equipment and materials, in conformance to the rules and regulations of all applicable Federal and State Law, Standards, Codes of any Agencies.
- T. PROTECTION
1. Perform removal of all electrical equipment conduits, conduits, wiring, junction boxes and all allied and related equipment in such a manner as to eliminate hazards to persons and property; to minimize interference with use of adjacent areas, utilities, process areas, and structures or interruption of use of such utilities; and to provide free passage to and from such adjacent areas of structures.
  2. Provide safeguards, including warning signs, barricades, temporary fences, warning lights, and other similar items that are required for protection of all personnel
  3. Maintain electrical continuity of all existing power and distribution, lighting, receptacles, feeders, branch circuits to remain at all times during the construction period.
- U. Provide all required labor, materials, tools, equipment and services for rerouting existing overhead and existing in-slab

conduits with existing circuit to remain from existing panels scheduled for demolition to new panels.

V. Re-route existing overhead branch circuit conduits to new panels.

1. At existing panel location, intercept existing overhead homerun conduits with new junction boxes.
2. Re-route overhead circuits in new conduits to new path.
3. Match existing branch circuit wire sizes.
4. Make all final connections in junction boxes and in new panels.
5. Where new above ceiling junction boxes are located above inaccessible ceilings, provide ceiling access in panels.

W. Re-route existing branch circuit conduits with existing circuits to remain in floor slabs:

1. Existing conduits in floor slabs rendered obsolete shall be cut off at the floor line and filled with concrete.
2. Provide new junction boxes above ceilings to intercept existing homerun conduits within rooms or areas where receptacles or lighting is affected by the loss of the in slab homerun.
3. From new junction boxes provide overhead homerun conduits to new panel.
4. From above ceiling new junction boxes fish down flexible conduit in drywall to first receptacle on the circuit or homerun box. All flexible conduits shall be equipped with a grounding conductor.
5. Where masonry walls are encountered, provide surface mounted wiremold with grounding conductor from new above ceiling junction box to the first receptacle on the circuit or homerun box. Provide wiremold extension box to existing wall box.
6. Match branch circuit wire sizes.
7. Make all final connections in junction boxes and in new panels.
8. Where new above ceiling junction boxes are located above inaccessible ceilings, provide ceiling access panels.

**1.45 EXISTING BUILDING 200**

- A. Visit and inspect the existing building, become familiar with actual job conditions before signing contracts. No extras will be allowed for work which might have been reasonably foreseen by an inspection of the premises.

- B. While the size and location of new work and equipment in the existing building has been indicated on the drawings as accurately as possible, contractor shall adjust his work as required to avoid existing ducts, pipes and beams not shown on the drawings. Contractor shall adapt his work to meet all actual conditions on the existing premises without any further cost to the contract.

#### **1.46 REMODELING**

- A. Remove all conduit, wire, panels, lighting fixtures, switches, convenience outlets, etc., rendered obsolete in all areas to be remodeled in the existing building. Inspect all areas scheduled for remodeling to determine the portions of the existing installation to be demolished and removed.

#### **1.47 MAINTAIN CONTINUITY OF SERVICES**

- A. All work shall be phased and coordinated by an approved predetermined detailed schedule.
- B. It is not the intent of these specifications to describe in detail each and every step of maintaining continuity of services for all systems; installation and maintaining temporary, normal, and life safety services; installation of new temporary and permanent feeders and circuits; installation of temporary and permanent fire alarm, trouble, supervisory alarms zoned to existing and new fire alarm control panels; maintain continuity of existing fire alarm devices in construction areas; removal of existing fire alarm devices after new fire alarm devices are operational; demolition of existing wiring devices; wiring, but rather to present a performance specification with express requirements that the Contractor shall fulfill to the satisfaction of the contract documents and the requirements of VA Hines, Maywood, Illinois.
- C. Long lead time equipment shall be ordered by the contractor within 10 days after contracts are signed.
- D. Provide caution and warning signs on all live equipment and cubicles and at all door entries to rooms under construction, construction areas, and existing electrical and mechanical rooms where work is being performed during the entire construction period. Provide barricades with flashing lights for all areas under excavation, backfilling, etc. during the entire construction period.
- E. Desired off hour time periods for downtime and cutover periods shall be conveyed to the Contracting Officer's Technical Representative in writing a minimum of three weeks in advance of downtime period. Time periods for downtime and cutovers shall be strictly at the convenience of VA Hines Medical Center.
- F. Existing building services shall be maintained at all times for all systems during the entire construction period including but not necessarily limited to life safety systems, electrical systems, nurse call systems, essential electrical systems, HVAC systems, telephone, fire alarm, life safety, data signal, communications and all miscellaneous electrical/electronic systems

by employing the use of existing and new feeders, temporary distribution panels, panelboards, temporary feeders, permanent switchboards, mobile generators, and distribution panels; all required low voltage wiring, temporary wiring for all miscellaneous systems.

- G. Provide temporary feeders, low voltage branch circuits, junction boxes and pull boxes complete with overcurrent protection for all temporary wiring and circuits to maintain continuity of services as required during the entire construction period.
- H. Any exterior lighting or exterior circuits affected during the construction period shall be energized by the close of each day's work, but not later than dusk.
- I. Provide temporary wiring for lighting and GFI receptacles as required for all areas of construction.
- J. Test, correct and retest all temporary and permanent wiring for rotation, polarity, shorts, grounds, insulation resistance, ground resistance, and torque all connections to manufacturer's instructions and recommendations and, verify all final connections prior to energizing any equipment.
- K. Provide all required temporary feeders, distribution panels, panelboards, mobile generators, equipment, wiring, overcurrent protection, cables, grounding conductors and all final connections in order to maintain continuity of all services during all phases of construction with minimum downtime and to maintain continuity of all services at all times.
- L. Provide all required temporary equipment, including but not limited to junction boxes, 600 volt class feeders spliced to existing feeders, panels, transformers, switches, mobile generators, 120/208V 3Ø 4W and 277/480V 3Ø 4W panels and distribution panels, in order to maintain continuity of service at all times, for all systems during the entire construction period.
- M. All building systems shall be maintained for continuity during the entire construction period including but not limited to electrical, fire alarm, telephone, intercom, closed circuit T.V., security, HVAC systems, life safety systems, essential electrical system, normal electrical system, nurses call system, medical gas system, medical data systems, temperature control wiring, and all miscellaneous systems.
- N. Temporary 600 volt wiring shall essentially consist of type THWN/THHN cable and wire in conduit system.
- O. All premium time, overtime, labor, material, travel, lodging, and equipment costs required to accomplish the above shall be included in the Contractor's bid proposal.
- P. Maintain complete continuity of fire alarm system at all times during entire construction period. Provide all required temporary fire alarm devices including but not limited to pull stations, horns, strobes, fire alarm control panels, power supplies, zone

modules, all instrumentation and devices, city tie, and all miscellaneous equipment and instrumentation to maintain 100 percent fire alarm and detection system continuity throughout the entire construction period.

- Q. Contractor shall not leave the premises at any time when any feeder or circuits remain(s) unconnected or de-energized.
- R. All electric rooms and closets shall be locked when left unattended.
- S. Provide all labor, materials, tools, equipment and services to maintain continuity of services for all facilities with minimum downtime including but not limited to all temporary and permanent distribution panels, mobile generators, panelboards and wiring, temporary and permanent electrical equipment and junction boxes, disconnecting and reconnecting of electrical equipment and switchboards, and all related equipment, all temporary equipment required, all overcurrent devices, all splices and terminations, coordination with VA Hines Resident Engineer and all temporary and permanent cutovers, and all temporary and permanent final connections, testing, correcting and retesting.
- T. Provide all required temporary panelboards, distribution panels, mobile generators, transformers, wiring, equipment, and conduits for all feeders, relays, controls, in order to maintain continuity of services. Wiring above grade shall be copper conductors with grounding conductors in conduits. Provide protection for all cables from mechanical injury. All temporary conduits, wiring panels shall be in place, ready for cutover operations prior to shutdown period.
- U. Maintain complete continuity of services for all miscellaneous systems during the entire construction period including but not limited to nurse call; public address; closed circuit TV; patient monitoring system; computer systems; voice systems; data systems; security systems; exterior lighting control systems; door control systems.
- V. Downtime for cutovers, disconnecting or reconnecting switchboards, panels, feeders, transformers or any related equipment shall be kept to a minimum time on a pre-approved schedule approved by the Contracting Officer's Technical Representative.
- W. Provide 1000V minimum safety insulated mat for all panels, with front mat, trim, covers removed, energized or de-energized. This includes without exception any distribution panel, panelboard, pullboxes and junction boxes, disconnect switches, with exposed energized or de-energized elements including but not limited to circuit breakers, cable lugs, buswork, wiring of any rating, any voltage classification, exposed switches, breaker cable lugs, and any equipment or wiring, without the benefit of approved coverplates, panel covers, mats, trims and the like. Provide danger safety warning signs at all panels, and junction boxes, switches, etc. and on all door entries to electric rooms and electric closets without exception.

- X. All premium time, overtime, labor, material, tools, instrumentation, services, travel, lodging, and equipment costs required to maintain continuity of services shall be included in the Contractor's bid proposal.
- Y. Contractor shall submit a construction schedule for review to the Contracting Officer within 30 days after contracts are signed. Construction schedules shall include equipment cutovers, time periods, coordination meetings with VA personnel.
- Z. Contractor shall indicate in schedule form all project procedures that can be anticipated to be of a noise level above those normally acceptable in a hospital environment. These procedures will be reviewed by the Contracting Officers for time scheduling and coordination.
- AA. Downtime for cutovers, shall be at off-hour periods from 4 p.m. to 5 a.m. Monday through Friday or weekend periods as predetermined by the Contracting Officer and at the time/date and convenience of The Government. All services; all low voltage feeders; and all related equipment shall be maintained at all times with Building 5 generator in standby, and Building 226 generators in standby, and all other on-site generators in standby, temporary mobile generators and temporary mobile generator feeders and all required temporary and permanent electrical equipment complete in place, ready for cutovers and electrical operation. Include all premium overtime in Bid Proposal.
- BB. All downtime time periods shall be at the convenience of the Veterans Affairs Medical Center and approved by the Contracting Officer. Contractor shall give a minimum of four weeks prior written notice to the Contracting Officer in advance of any desired shutdown. Prior written notice shall include a schedule for downtime, work to be performed, complete with detailed shop drawings indicating all temporary wiring and equipment. All downtime periods shall be on weekends or off hours with exact time period approved in advance in writing by the Contracting Officer. Provide all required temporary distribution panels, panelboards, feeders, temporary and permanent wiring, overcurrent devices, cables, conduits, junction boxes, raceways and all connections, ready for cutover and all required temporary and permanent wiring for miscellaneous systems.
- CC. Existing feeders, panels, transformers, distribution panels, scheduled for cutovers, modifications, replacement, retrofit, shall have temporary and permanent feeders from new panels, temporary panels, and existing panels, switchgear, temporary and permanent panelboards and distribution panels, to automatic transfer switches complete in place ready for cutovers for minimum down time. Existing feeders and panels, shall be de-energized during cutover periods. Provide all required permanent and temporary wiring, conduits, splices, overcurrent devices complete in place ready for cutovers. Remove existing cable and conduits rendered obsolete. Remove all temporary wiring after cutovers are complete.

#### **1.48 FIELD FABRICATED SUPPORTS:**

- A. Provide free-standing structural supports for supporting electrical equipment. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat, workmanlike appearance.
- B. Use hexagon head bolts with spring lock washers under all nuts.
- C. Provide unistrut channels for supporting light fixtures. Channel not less than #12GA 1 5/8" x 1 5/8".

#### **1.49 EQUIPMENT AND DEVICE IDENTIFICATION**

- A. Provide identification for all equipment including but not limited to transformers, disconnect switches, lighting and power panels, starters, push buttons, etc., as to their function and/or the apparatus they control by means of a bakelite engraved nameplate white letters on a black background.
- B. The Contractor shall affix an engraved "Micarta" nameplate to each of the switchgear, power and lighting distribution panels. The terminology shall be as approved by the Engineer.
- C. All wiring devices shall be identified indicating panel and circuit number. Provide identification using engraved nameplates for each wiring device. Engraved nameplates for wiring devices connected to the critical or life safety branch shall be red background with white lettering. Engraved nameplates for wiring devices connected to the normal system shall be white background with black lettering. Each and every wiring device shall be provided with an engraved panel/circuit identification nameplate without exception.
- D. Engraved plastic-laminate signs:
  - 1. Provide engraving stock, melamine plastic laminate face color as specified and white core plies (letter color).
  - 2. Provide minimum 1/16" thickness for signs up to 20 square inches or 8" length and 1/8" thickness for larger units.
  - 3. Provide 1/4" high lettering with lines of information as specified.
  - 4. Provide 1/4" black border around outside edge of sign.
  - 5. Punch label for mechanical fastening and provide self-tapping stainless screws, except where screws cannot or should not penetrate substrate.

#### **1.50 CEILING ACCESS PANELS**

- A. Provide ceiling access panel for any existing junction box to remain for any system installed above a new inaccessible ceiling. New junction boxes shall be installed above accessible ceilings only.



#### 1.51 CEILING TILES

- A. In all areas outside the limits of the primary construction area contractor shall remove existing ceiling tiles for providing conduits above existing accessible ceilings designated closets, riser shafts, or areas. Re-install all ceiling tiles. Coordinate with the Contracting Officer's Technical Representative prior to doing any work. Include in bid five new tile replacement for ceiling tiles damaged by contractor. Include any required premium overtime cost in Bid proposal.

- - - E N D - - -

**SECTION 16111**  
**CONDUIT 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.
- 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. Sealing around penetrations to maintain the integrity of time rated construction: Section 07270, FIRESTOPPING SYSTEMS.
- B. Fabrications for the deflection of water away from the building envelope at penetrations: Section 07600, FLASHING AND SHEET METAL.
- C. Sealing around conduit penetrations through the building envelope to prevent moisture migration into the building: Section 07920, SEALANTS AND CAULKING.
- D. Identification and painting of conduit and other devices: Section 09900, PAINTING.
- E. General electrical requirements and items that are common to more than one section of DIVISION 16: Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- F. Section 16685, PATIENT WALL SYSTEMS.
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 16450, GROUNDING.

**1.3 SUBMITTALS**

In accordance with Section 01340, SAMPLES AND SHOP DRAWINGS, furnish the following:

- A. Shop Drawings:
  - 1. Size and location of main feeders. Size and location of panels and pull boxes.
  - 2. The specific item proposed and its area of application shall be marked on the catalog cuts.
- B. Certification: Prior to final inspection, deliver to the Resident Engineer four copies of written 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):
  - 70-99 . . . . . National Electrical Code (NEC)
- C. Underwriters Laboratories, Inc. (UL):
  - 1-93 . . . . . Flexible Metal Conduit
  - 5-96 . . . . . Surface Metal Raceway and Fittings
  - 6-97 . . . . . Rigid Metal Conduit
  - 50-95 . . . . . Enclosures for Electrical Equipment
  - 467-93 . . . . . Grounding and Bonding Equipment
  - 514A-96 . . . . . Metallic Outlet Boxes
  - 514B-97 . . . . . Fittings for Cable and Conduit
  - 797-93 . . . . . Electrical Metallic Tubing
  - 1242-96 . . . . . Intermediate Metal Conduit

## PART 2 - PRODUCTS

### 2.1 MATERIAL

- A. Conduit Size: In accordance with the NEC, but not less than 3/4 inch. Where permitted by the NEC, 1/2 inch flexible conduit may be used for tap connections to recessed lighting fixtures. Flexible conduit shall be at least 4 feet in length, but shall not be more than six feet in lineal length.
- B. Conduit:
  - 1. Rigid steel: UL 6.
  - 2. Rigid intermediate steel conduit (IMC): UL 1242.
  - 3. Electrical metallic tubing (EMT): U.L. 797. Maximum size 5 inch. Permitted only with cable rated 600 volts or less.
  - 4. Flexible steel conduit (commercial greenfield): UL 1.
  - 5. Liquid-tight flexible metal conduit: Flexible galvanized steel tubing covered with extruded liquid-tight jacket of polyvinyl chloride (PVC). Provide conduit with a continuous

copper bonding conductor wound spirally between the convolutions.

6. Surface metal raceway: UL 5.

C. Conduit Fittings:

1. Rigid steel and IMC conduit fittings:

- a. Standard threaded couplings, locknuts, bushings, and elbows: Only steel or malleable iron materials are acceptable. Integral retractable type IMC couplings are acceptable also.
- 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 coverplates having the same finishes as that of other electrical plates in the room.

2. Electrical metallic tubing fittings:

- a. Only steel or malleable iron material are acceptable.
- b. 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.
- c. Indent type connectors or couplings are prohibited.
- d. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.

3. Flexible steel conduit (greenfield) fittings:
    - a. UL 5. Only steel or malleable iron materials are acceptable.
    - b. Clamp type, with insulated throat.
  4. Liquid-tight flexible metal conduit fittings:
    - a. Only steel or malleable iron materials are acceptable.
    - b. Fittings must incorporate a threaded grounding cone, a steel or plastic compression ring, and a gland for tightening. Connectors shall have insulated throats.
  5. Surface metal raceway fittings: As recommended by the raceway manufacturer.
  6. Expansion and deflection couplings:
    - a. 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. Boxes shall be 12 gauge or heavier steel, sheared or galvanized to prevent rusting and shall have readily removable knockouts.
5. Pull boxes and pull fittings shall be accessible with removable knockouts.
6. Branch circuit junction boxes shall be a minimum 4" square or octagon, not less than 2-1/8" deep; all junction boxes shall be equipped with threaded green grounding screw; junction boxes shall be deeper and/or larger physical sizes where required by the number of wires or construction, or as required by miscellaneous systems including but not limited to nurses call system, monitors, fire alarm systems, voice/data systems, controls with appropriate covers and plastic rings. Provide with 3/8" stud where lighting fixture is suspended from box.
7. All switches and receptacles shall be provided with minimum 4" square box, minimum 2-1/8 inches deep. Gang boxes shall be provided where groups of wall switches occur. All boxes shall be equipped with plaster ring properly raised covers. The approximate location of outlet boxes is shown on the Drawings, but care shall be taken to install all outlets with proper relation to equipment or material to be installed by other trades. Special outlets shall have proper boxes to accommodate special equipment. Outlet boxes for masonry shall be of proper depth to allow conduit to be installed without cutting out shell of blocks, etc.
8. Boxes for all exterior conduit shall be cast iron boxes, type "FS" or "FD" boxes provided with gasketed watertight covers. Fittings shall be pull type with gasketed covers.
9. Outlet boxes and junction boxes installed in plenum ceiling spaces shall be approved for plenum use in conformance to the applicable codes.
10. Outlet boxes shall be securely fastened. All fixture outlet boxes shall be set flush with ceiling. There shall be no more knockouts opened in any outlet boxes than are actually required.
11. All conduits shall be rigidly supported independently of outlet boxes at not over 8 ft. intervals. Outlet boxes shall have individual supports from adjacent structures or framework.
12. All light fixtures shall have suitable individual supports. Provide all supports and drill and tap holes and furnish all necessary bolts, washers, etc., for mounting of equipment.

- 13. Provide single or multi-gang plaster rings as required for single or multi-gang boxes.
  - 14. Provide common coverplates for all multigang boxes.
  - 15. Provide special boxes as required for nurses call, fire alarm system, door access stations, medical gases, etc.
  - 16. Single gang switch boxes not acceptable except where ganged together for (3) or more wiring devices.
- F. Wireways: Equip with hinged covers, except where removable covers are shown.

## **2.2 CONDUIT VOICE/DATA**

- A. Provide, furnish and install conduit system for all telecommunications wiring in a separate conduit system. Furnish all required conduits, outlet boxes, covers, jacks, wiring.
- B. Minimum size of conduit shall be 3/4 inch. Provide pull line in empty conduits. Tag each end of pull line.
- C. An outlet shall consist of 4" square box, 2 1/2 inches minimum depth. Provide one gang or two gang plaster ring as required.
- D. Provide nylon pull rope minimum 1/8" diameter in all empty conduits smaller than 1-1/2". Provide pre-lube 1500 in conduits 1-1/2" diameter.

## **PART 3 - EXECUTION**

### **3.1 PENETRATIONS**

- A. Cutting, coring, notching any structural members is strictly prohibited without exception.
- B. Fire Stop: Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, provide fire stops with ratings that meet or exceed fire ratings and are effective barriers against the spread of smoke and gases as specified in Section, FIRESTOPPING SYSTEMS, 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: Coordinate with applicable trades to seal roof penetrations at floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight by using an approved conduit sealing bushing.

### **3.2 CONDUIT SYSTEMS INSTALLATION, GENERAL**

- A. Installation: In accordance with UL, NEC, as shown, and as hereinafter specified.

- B. Wiring systems for equipment systems, critical branch, normal system, life safety branch shall be installed in separate and independent conduit systems.
- C. Conduit installation:
  - 1. Provide complete conduit installation prior to pulling in cables or wiring.
  - 2. Flattened, dented, or deformed conduit is not acceptable. 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. Conduit installation shall be mechanically and electrically continuous.
  - 6. Independently support conduit. Do not support conduits from suspended ceilings, suspended ceiling supporting members, lighting fixtures, mechanical piping, or mechanical ducts.
  - 7. Support conduits within 1 foot of changes of direction, and within 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 the conduits.
  - 9. Conduit installations under fume and vent hoods are prohibited.
  - 10. Secure conduits to panels, 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, FLASHING AND SHEET METAL.
  - 12. All conduits shall include an equipment grounding conductor installed into the same conduits with feeder and branch circuit conductors.
  - 13. Do not install conduits across pipe shafts, duct shafts, vent duct openings, hatchways, and other openings. Install conduit to avoid conflicts with mechanical ductwork and piping.
  - 14. Where conduits pass from a hot to a cold location, such as through roofs or exterior walls, provide an approved watertight conduit sealing bushing.



15. Ends of all conduits shall be capped during and after construction to exclude all foreign material. Prior to installation wiring, all conduits shall be swabbed clean of all debris.
16. Install conduit with a minimum of 12" of free air space between conduits and steam or hot water pipes and a minimum of 3" of free air space from all other mechanical piping. Conduit shall not be supported from pipe, hangers, or extension of installation of other building trades.
17. All ends of conduits shall be provided with an insulated bushing, except at couplings of threaded type outlets. All insulated bushings shall have metal body with molded phenolic insulation. All connections between conduits and steel boxes shall be made with double locknuts.
18. Double lock nuts and one bushing shall be used wherever a conduit terminates in a junction or outlet boxes, switch, circuit breakers, etc.
19. Malleable or insulation bushing shall be used on conduits 1" and smaller. Insulating bushing shall be used on conduit 1-1/4" and larger.
20. It is intended that complete metal raceways or enclosures be provided for all circuiting and miscellaneous systems throughout the extent of all the systems.
21. All conduit runs shall be run neat, in an accurate manner and shall emerge from the floors and ceilings at right angles thereto.
22. Provide conduits below the floor slab of the floor above and above the ceilings of the floor below for floor slabs and above poke through boxes, and for any conduit entries to floor mounted equipment requiring a bottom entrance. Provide fire rated floor penetration fittings exceeding the fire rating of the floor. Verify fire rating of floors, walls with the Architect, prior to doing any work.
23. All wiring shall be run in conduit. Conduits shall be reamed to remove all burrs and obstructions. Conduit shall be run with long bends and not more than three-quarter bends shall be used on any one run. Conduit is to be fastened securely to the building structure. Provide necessary pull boxes to facilitate the pulling in of wires. No conduits smaller than 3/4" shall be used.
24. EMT galvanized conduit shall be used in dry locations only.
25. All conduits in all finished spaces shall be concealed. This includes all work in masonry walls and poured concrete walls and columns.

26. Hot dipped rigid galvanized steel conduits with threaded fittings shall be used but not necessarily limited to the following:
  - a. All conduits exposed to the weather. All conduits shall be painted as per section 09900. Provide weatherproof NEMA 4X junction boxes and weather-proof fittings.
  - b. Exterior walls.
  - c. Wet locations.
27. Furnish and set all sleeves for Conduit.
28. All conduit shall be sizes as required by applicable code as a minimum.
29. It is intended that complete metal raceways or enclosures be provided for all circuiting and miscellaneous systems throughout the extent of all the systems.
30. Thin-wall may be used for extension of circuits in dry areas above floor slabs and suspended ceilings and dry-wall construction.
31. All conduit runs shall be run neat, in an accurate manner and shall emerge from the floors and ceilings at right angles thereto.
32. Exposed conduit shall be run parallel to the building construction and shall be fastened in place by means of the correct size of one hole galvanized pipe clamps, two hole galvanized pipe straps, mineral conduit hangers. All exposed conduits shall be installed along structural members. Conduit system shall be independently supported. No conduits shall be supported from ductwork, piping, or from suspended ceiling members. Any conduits supported from ductwork, piping or from suspended ceiling members shall be removed, re-routed, re-installed with proper supports from the building structure at no additional cost to the government.
33. Double locks nuts and one bushing shall be used wherever a conduit terminates in a junction or outlet box, switch, circuit breakers, etc.
34. Ends of all conduits shall be capped during and after construction to exclude all foreign material. Prior to installing wiring, all conduits shall be swabbed clean of all debris.
35. Final connections to motors shall be made through flexible sealtight conduits, no more than 3 feet long. Provide bonding jumpers for all flexible conduits.

36. Fasteners, in general, shall be substantial in construction, not subject to breakage, and shall be complete with screws, or other means by which they are affixed, of the same material as the conduit, or of such nature that there will be no tendency toward electrolytic corrosion in the presence of moisture because of contact between the dissimilar metals.
37. All conduit fittings shall be hot-dipped galvanized, suited to the type of conduit with which used. Fittings shall conform to and meet all requirements of the Underwriters' Laboratories, Inc. and conform to the requirements and recommendations of codes. Die cast fittings not acceptable.
38. Furnish and install a conduit expansion fitting wherever conduits cross an expansion joint in the structure. The expansion joint in the structure. The expansion fitting shall be complete with grounding or bonding jumper. The length of bonding jumpers shall be three times (minimum) the nominal width of the joint.
39. Each straight uninterrupted run of surface mounted conduit in excess of 100 feet shall be provided with an appropriate expansion fitting and the distance between fittings so installed shall not exceed 100 linear feet.
40. Perforated strap hangers are not acceptable for supporting conduits, boxes, junction boxes and the like.
41. All conduit risers shall be rigidly supported by the building structure, using appropriate cable supports only.
42. Conduit shall be continuous from outlet and from outlet to panels, junction or pull boxes. Termination of all conduits shall be furnished with locknuts and bushings. Plug the ends of each conduit with an approved cap or disc during construction. Conduit system shall be complete before conductors are drawn in.

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. No more than three 90 degree bends shall be used between pull points.
4. Bending of conduits with a pipe tee or vise is prohibited.

E. Layout and Homeruns:

1. Install conduit with wiring, including homeruns.
2. Deviations: Make only where necessary to avoid interferences and only after drawings showing the proposed deviations have

been submitted to and have been approved by the Resident Engineer.

### **3.3 CONCEALED WORK INSTALLATION**

- A. Above Furred or Suspended Ceilings and in Walls:
  - 1. Conduit for conductors above 600 volts:
    - a. Rigid steel locations.
  - 2. Conduit for conductors 600 volts and below:
    - a. Rigid steel, IMC, or EMT. Types 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 four feet but not longer than six feet of flexible metal conduit extending from a junction box to the fixture.
  - 5. Tightening set screws with pliers is prohibited.
  - 6. Contractor shall remove existing ceiling tiles in all areas outside the limits of the area of construction for providing conduits above existing ceilings to designated closets, riser shafts, or other areas within the Building. Safeguard all ceiling tiles removed. Reinstall all ceiling tiles, coordinate with the Contracting Officer's Technical Representative prior to doing any work. Include in bid proposal 5 percent new tile replacement for ceiling tiles damaged by contractor.

### **3.4 EXPOSED WORK INSTALLATION**

- A. Conduit for Conductors 600 volts and below:
  - 1. Rigid steel, IMC, or EMT. Types mixed 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.
- D. Support horizontal or vertical runs at not over 2400 mm (eight foot) intervals.
- E. Surface metal raceways: Use only where shown.
- F. Painting:
  - 1. Paint all exposed conduit as specified in Section, PAINTING.

2. Paint all conduits containing cables rated over 600 volts safety orange. Refer to Section, 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 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 explosive proof lighting fixtures, switches, and receptacles, as required by the NEC.

### **3.6 WET OR DAMP LOCATIONS**

- A. Conduits shall be rigid steel or IMC.
- B. Provide watertight conduit sealing bushings 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 feet of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Conduit shall include an outer factory coating of 20 mil bonded PVC or field coat with asphaltum before installation. After installation, completely coat damaged areas of coating.

### **3.7 MOTORS AND VIBRATING EQUIPMENT**

Use flexible metal conduit for connections to motors and other electrical equipment subject to movement, vibration, misalignment, cramped quarters, or noise transmission. Provide liquid-tight flexible metal conduit for installation in exterior locations, moisture or humidity laden atmosphere, corrosive atmosphere, water or spray wash-down operations, inside (air stream) of HVAC units, and locations subject to seepage or dripping of oil, grease or water. Provide a green ground wire within flexible metal conduit.

### **3.8 EXPANSION JOINTS**

- A. Conduits 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 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 5 inch vertical drop midway between the end. 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 15 inches and larger conduits are acceptable.

- C. Install expansion and deflection couplings.

### **3.9 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.
- 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 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 1/4 inch bolt size and not less than 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. Bolts supported only by plaster are not acceptable.
- G. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.
- H. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.
- I. Chain, wire, or perforated strap shall not be used to support or fasten conduit.

- J. Spring steel type supports or fasteners are prohibited for all uses except: Horizontal and vertical supports/fasteners within walls.
- K. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

### **3.10 BOX INSTALLATION**

- A. Boxes for Concealed Conduits:
  - 1. Mount flush.
  - 2. Provide raised covers for boxes to suit the wall or ceiling, construction and finish.
- B. Provide additional junction 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.
- E. Through the wall boxes for mounting wiring devices back to back are prohibited.
- F. Minimum size of outlet boxes for ground fault interrupter (GFI) receptacles is 4 inches square by 2-1/8 inches deep, with device covers for the wall material and thickness involved.
- G. Provide phenolic nameplates on covers of boxes. For example "SIG-FA JB No. 1".

### **3.11 VOICE/DATA CONDUIT**

- A. Install the voice/data raceway system from each jack to designated voice closet and data closet or to above ceiling cable tray as applicable and as specified.
- B. Minimum conduit size of 3/4 inch, but not less than the conduit sizes shown on the drawings.
- C. All conduit ends shall be equipped with insulated bushings.
- D. All two inch, three inch, four inch conduits shall be provided with pull boxes sized per the NEC. To limit total bends and elbows to 270 degrees.
- E. Vertical conduits/sleeves through closets floors shall terminate not less than 3 inches below the floor and not less than 3 inches below the ceiling of the floor below.

- F. Terminate conduit runs to/from a telephone backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits shall enter telephone closets next to the wall and be flush with the backboard.
- G. Core drilling for vertical conduits. Locate holes so as not to affect structural sections such as ribs or beams. X-Ray scan concrete floors and walls prior to core drilling for existing conduit and piping.
- H. All conduits terminating in telephone closets or on telephone backboards shall be bushed. Fire seal all conduit penetrations through voice/data and electrical rooms and closets.
- I. Conduit runs less than two inches shall contain no more than three quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of telephone 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. Bush each end of conduits in voice closets and data closets. Fire seal all conduits penetrating voice closets and data closets each end after telephone cables are installed by VA Hines communications sub-contractor. Fire seal around conduit sleeves.
- K. Furnish and install 3/4 inch thick fire retardant plywood specified in Section, ROUGH CARPENTRY on the wall of voice and telephone closets. Size plywood 2400 mm (eight feet) high by the width of the closet. Mount the plywood with the bottom edge 300 mm (one foot) above the finished floor.
- L. Furnish and install pull wire in all empty conduits.

### **3.12 PULL AND JUNCTION BOXES**

- A. Standard or special pull or junction boxes shall be installed to accommodate runs that have a maximum of three (3) 90 degree bends except as noted. All boxes shall be accessible, shall have screw covers and shall be code gauge galvanized steel.



### **3.13 PREPARATION:**

- A. Field Management: The drawings are generally indicative of the work, but due to their small scale, it is not possible to indicate offsets, and apparatus required nor the minor structural obstructions that may be encountered.
- B. Roughing-in dimensions of electrically operated equipment shall be furnished by the Trades responsible for such equipment. Set conduit and boxes only after receiving approved shop drawings coordinated with the applicable Trades involved.
- C. Layout electrical work to suit actual field measurements and according to accepted Trade standard practices. However, electrical installations shall conform to all applicable codes.

### **3.14 METHODS OF WIRING**

- 1. Conduit and raceway systems shall be installed in conformance to the National Electric Code and as specified herein as a minimum.
- 2. Cut conduits and raceways square and deburr cuts to the same degree as cuts made by the material manufacturer. Ream cuts of conduits per code requirements with openings not restricted more than cuts made by the material manufacturer.
- 3. Avoid bending conduits as much as possible and practical, but when same are made use an approved conduit bending tool or machine. Do not install crushed or deformed conduits, and remove same from the site.
- 4. Attach wall mounted conduit and raceway runs tight to interior walls, following contour of walls and securely attach anchors into walls.
- 5. Do not attach conduit or raceway systems to exterior walls; suspended ceiling members; or to the suspending mediums, ductwork piping and the like.
- 6. Make connections to motors and controls with a junction box located as close as possible to motor. Make final connections from metal conduit to motors with neat, flexible, liquid-tight conduit in lengths not to exceed 3'-0". Provide grounding conductor in all flexible conduits.
- 7. Wiring below 250 volts phase to phase and 480 volts phase to phase shall be installed in separate and independent conduit systems.
- 8. Concealed Work: Make conduit and raceway runs in concealed work grouped as much as practical to avoid congesting the concealed spaces. The quality of workmanship in electrical work in such spaces shall not be less than that exercised in exposed work.

9. Install flexible steel conduit in dry locations for equipment connections and for connections recessed to lighting fixtures. Lengths shall be not less than four feet and shall not to exceed 6'-0". Provide grounding conductors in all flexible conduits.
10. Provide equipment connections using liquid-tight, flexible steel conduit for the following conditions (provide a grounding conductor in all flexible conduits):
  - a. Wet or damp locations.
  - b. Where subject to water, oil, or other liquids.
  - c. Mechanical rooms.
  - d. Transformers.
  - e. Motors.
11. All flexible conduits shall include a grounding conductor installed with circuit conductors.
12. All conduits (except service entrance) shall include a grounding conductor installed with circuit conductors and feeder conductors throughout without exception.

### **3.15 EMPTY CONDUITS:**

- A. Provide pull line in all empty conduits.
- B. Provide nylon pulling rope, minimum 1/8 inch diameter in all conduits smaller than 1-1/2". Provide Pre-Lube 1500 in all conduits 1-1/2" and larger in all empty conduits. Provide three feet of slack, in addition to rope, the length of each conduit.
- C. Seal spare and empty conduits with a conduit cap or plug to which the pulling rope is attached.
- D. Provide conduit identification at each end indicating miscellaneous system.

### **3.16 IDENTIFICATION**

- A. Provide conduit markers for the emergency system with "Emergency" lettering at a 10' spacing. White background, red lettering.
- B. Provide conduit markers for the fire alarm and detection system with "Fire Alarm" lettering at a 10' spacing and on every box. Red background, white lettering.
- C. Provide conduit markers for normal system with "Normal" lettering on 10'-0" spacing. White background, black lettering.
- D. Provide conduit markers for nurse call system with "Nurse Call" lettering at 10'-0" spacing. Yellow background, white lettering.

- E. Provide conduit markers for voice conduits white background; black lettering - 10 feet spacing.
- F. Provide conduit markers for data conduits white background; blue lettering - 10 feet spacing.
- G. Provide conduit markers for M-TV as specified.
- H. Provide conduit markers for TV as specified.
- I. Provide conduit markers for Panic alarm as specified.
- J. Provide conduit markers for future waiting room sound system as specified.
- K. Provide conduit markers for security TV as specified.
- L. Conduits shall be identified every 10 feet on center.

**3.17 CLEARANCE AT ACCESS DOORS AND PANELS:**

- A. Do not install any conduits, hangers, equipment or fixtures that will obstruct or interfere with the use of any access doors or removable access panels whether on equipment, in walls, or in the ceiling.
- B. Comply with this requirement, if necessary, by re-routing conduit at no extra cost to the contract.

**3.18 INSTALLATION-SUPPORTING DEVICES:**

- A. Use clamps for mating attachments to structural steel for installation purposes wherever possible. Patch up any field applied fire proofing damaged during supports installation. Welding will only be permitted for structural load requirements and if approved by the architect.
- B. Do not fasten supports to piping, ductwork, mechanical equipment, conduit or roof deck.
- C. Do not notch, cut, bore or drill into building structural steel members.

**3.19 PROTECTION:**

- A. All conduit openings shall be closed by means of plugs or caps to prevent the entrance of foreign matter, and cover all fixtures, equipment and apparatus as required to protect them against dirt, water, chemical or mechanical damage both before and after installation.

**3.20 TESTING:**

- A. Provide conduit ground continuity testing and resistance to ground.

### **3.21 BUILDING 200 - SUB-BASEMENT MECHANICAL ROOM AND PIPE BASEMENT**

- A. All new conduits shall be installed as high as possible to maintain maximum head room. Any new conduits installed lower than any conduits or piping in the same room or area such as electric rooms, mechanical rooms, fan rooms, HVAC rooms; or above ceilings as determined in the opinion of the VA Resident Engineer shall be removed, re-routed, re-installed as high as possible at no additional cost to the Government.

- - - END - - -

**SECTION 16127**  
**CABLES, LOW VOLTAGE (600 VOLTS AND BELOW)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Sealing around penetrations to maintain the integrity of time rated construction: Section 07270, FIRESTOPPING SYSTEMS.
- B. General electrical requirements that are common to more than one section in Division 16: Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- C. Conduits for cables and wiring: Section 16111, CONDUIT SYSTEMS.
- D. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 16450, GROUNDING.
- E. Patient Wall Systems: Section 16685

**1.3 SUBMITTALS**

In accordance with Section 01340, SAMPLES AND SHOP DRAWINGS, furnish the following:

- A. Manufacturer's Literature and Data: Showing each cable type and rating.
- B. Certificates: Two weeks prior to final inspection, deliver to the Resident Engineer four copies of written certification that the material is in accordance with the drawings and specifications and has been properly installed and tested.

**1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are reference in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
- |              |       |  |
|--------------|-------|--|
| J-C-30B-89   | . . . | Cable and Wire, Electrical   |
| HH-I-595C-76 | . .   | Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic  |
| W-F-406E-93  | . . . | Fittings for Cable, Power, Electrical And Conduit, Metal, Flexible |

- C. National Fire Protection Association (NFPA):
  - 70-99 . . . . . National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 44-99 . . . . . Thermoset-Insulated Wires and Cables
  - 83-98 . . . . . Thermoplastic-Insulated Wires and Cables
  - 467-93 . . . . . Electrical Grounding and Bonding Equipment
  - 486A-97 . . . . . Wire Connectors and Soldering Lugs for Use with Copper Conductors
  - 486C-97 . . . . . Splicing Wire Connectors
  - 486D-97 . . . . . Insulated Wire Connector Systems for Underground Use or in Damp or Wet Locations
  - 486E-94 . . . . . Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
  - 493-95 . . . . . Thermoplastic-Insulated Underground Feeder and Branch Circuit Cable
  - 514B-97 . . . . . Fittings for Cable and Conduit
  - 1479-94 . . . . . Fire Tests of Through-Penetration Fire Stops

## 1.5 GUARANTEE

- A. Provide written guarantee for all wiring, terminations, splices, wiring connections. Guarantee shall be for two years from date of final acceptance.

## PART 2 - PRODUCTS

### 2.1 CABLE AND WIRE (POWER AND LIGHTING)

- A. Cable and Wire shall be in accordance with Fed. Spec. J-C-30B, except as hereinafter specified.
- B. Single Conductor:
  - 1. Annealed copper.
  - 2. Shall be stranded for sizes No. 8 AWG and larger, solid for sizes No. 10 AWG and smaller except as noted.
  - 3. Shall be minimum size No. 12 AWG.
- C. Insulation:
  - 1. All branch circuit wiring shall be VW-1, XHHW-2 jacket, FR-XLPE insulation 600 volts. Insulation shall maintain a dielectric constant of 3.5 or less for low leakage current,

stranded copper connector, flame retardant, heat resistant. Do not use wire pulling compound for pulling wiring in conduit systems.

2. Feeder wiring shall be dual rated THWN - 75EC wet locations/90E C dry locations pvc insulation, nylon jacket 600 volts, stranded copper.

D. Color Code:

1. All 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.		

2. Grounding conductor shall be green insulation for 120/208V 3 phase, 4 wire systems; for 277/480V 3 phase, 4 wire systems provide green insulation with yellow tracer.
3. Provide manufactured insulation and cable jackets of solid color compound or solid color coating for No. 12 AWG and No. 10 AWG branch circuit phase conductors, neutral conductors and equipment grounding conductors.
4. Phase conductors, neutral conductors and equipment grounding conductors, No. 8 and larger may be solid color compound or solid color coating or may be color coded using one of the following methods:
  - a. Stripes, bands, or hash marks of color specified above.
  - b. Color as specified using one inch wide tape. Apply tape in half overlapping turns for a minimum of 75 mm (three inches) for terminal points, and in junction boxes, pull boxes, troughs, manholes, and handholes. 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.
5. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.
6. Color code for isolated power system wiring shall be in accordance with the NEC.

7. Panel main lugs only, sub-feed lugs overcurrent device cable lugs shall be UL approved for 75 degree centigrade and shall be copper only. AL/CU lugs not acceptable.

## **2.2 SPLICES AND JOINTS**

- A. In accordance with UL 486A, C, D, E and NEC.
- B. Branch circuits (No. 10 AWG and smaller):
  1. Connectors: Solderless, screw-on, reusable pressure cable type, 600 volt, 105 degree C with integral insulation, approved for copper only.
  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 manufacturers packaging shall be strictly complied with.
- C. Feeder Circuits:
  1. Connectors shall be indent, hex screw, or bolt clamp-type of high conductivity and corrosion-resistant material.
  2. Field installed compression connectors for cable sizes 250 kcmil and larger shall have not less than two clamping elements or compression indents per cable.
  3. The non-shielded cable inline splice shall be capable of continuous operation at 1000 V and 90EC, with an emergency overload temperature rating of 130EC. The splice shall consist of an EPDM rubber tube which has been factory stretched onto a spiral core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as coverings or adhesive. It shall be designed for use with inline compression type connectors, for indoor, outdoor, overhead direct burial or submerged locations. The splice must conform to the requirements of ANSI C119.1 and Western Underground Cable 2.5, and must have REA acceptance for submersible and aerial applications.
  4. All connectors shall be of the compression type. For cables 250 MCM and larger shall have not less than two clamping elements or compression indents per cable. Installation shall be compression type, using tools that shall develop forty tons of pressure. Smaller cables shall utilize hand compression tools. In either case, the proper size compression die shall be used to match the size of wire and connector. Cable connectors shall be copper. Copper/aluminum connectors are not acceptable.



### **2.3 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.

### **2.4 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.

### **2.5 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 VW-XHHW-2 jacket FR-XLPE wire specified herein.

### **2.6 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 arcproof 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.

### **2.7 CABLE/CONDUCTOR IDENTIFICATION BANDS:**

- A. Provide vinyl-clock, self-adhesive marker band of wrap-around tape, pre-numbered plastic type, with clear plastic self-adhesive cover flap.

## 2.8 PLASTIC TAPE:

- A. Provide self-adhesive vinyl tape not less than three mils thick by ½" wide with color as specified.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERALLY

- 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. All boxes shall be accessible.
- D. 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.
- E. For panelboards, cabinets, wireways, switches, and equipment assemblies, neatly form, train, and tie the cables in individual circuits.
- F. Seal cable and wire entering a building from underground with conduit sealing bushings.
- G. 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.
  - 5. **Do not use cable pulling compound for type VW-1, XHH-2, FR-XLPE low leakage branch circuits to patient care areas.**
- H. Installation of Wires and Cables:
  - 1. All wires and cables shall be pulled into conduits in a manner which will not injure the insulation or place undue strain on the conductors.
  - 2. The sizes of conduits shall be listed in the latest applicable codes specified herein applying to this work, for the number of wires in each run. Not more than nine conductors shall be installed in any conduit run.

3. **Wire pulling lubricant shall not be used for pulling branch circuit wiring VW-1, XHH2, FR-XLPE low leakage to patient care areas, headwall systems, wiring devices, lighting, etc.**
4. Wire pulling lubricant shall only be used for wire pulling in non-patient care areas. Pulling lubricant shall be chemically neutral, containing no oils or greases, and shall be used where necessary to facilitate pulling. The lubricant shall be of a type especially intended for wire pulling, such as "EX" Wire Pull, which will not harm the insulation or braid.
5. All wires and cable shall be legibly tagged to indicate circuits designation at the panelboard ends. The tags shall be securely fastened to the conductors at the time the wires are pulled in and tested.
6. All wires and cable shall be legibly tagged to indicate circuit designation at each patient head wall system and at each wiring device.
7. At least 6" loops or ends shall be left at outlets, when pulling wires, to permit connections to devices. Leave longer lengths where necessary.
8. Provide cable supports for all vertical risers in accordance with applicable codes.
9. No splices will be permitted in conduit, but must be made in outlet or junction boxes, after being made mechanically and electrically secure.
10. Installation of wires and cables shall include furnishing and installation of all racks, cable cleats, insulated bushings and supports that may be necessary to make a neat and substantial wiring installation. Tag each feeder cable in each pull box with proper feeder symbol, and where 2 or more feeders enter a panel, switchboard or load center, tag each cable.
11. Provide cable supports for all vertical risers.
12. All cable shall be pulled through conduits by means of cable grips and other devices in such a manner as not to damage the cable.
13. Conduits ends shall be capped during construction to prevent the entrance of foreign matter from entering the conduit system.
14. Swab conduits clean prior to cable installation.
15. Pull wire and cable simultaneously where more than one is being installed in the same raceway.

16. Feeders. Use pulling compound or lubricant as required to comply with cable manufacturer's maximum allowable pulling tensions.
17. Feeders. Use pulling compounds recommended by the cable manufacturer for the cable type being installed. Do not use petroleum-based lubricants and lubricants which may damage cable. Do not use pulling compounds for branch circuit wiring to patient care areas.
18. Use pulling methods that will not damage cables or raceways. If damage does occur, remove and replace damaged cable section.

### **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.
- C. All splices shall be installed in accessible junction boxes.
- D. Number of conductor splices shall be kept to a minimum.
- E. Install splices that maintain or exceed the mechanical strength and electrical insulation ratings of the wire and cable.
- F. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values or, when manufacturer does not indicate torquing requirements, per UL 486A.

### **3.3 CONTROL, COMMUNICATION AND SIGNAL WIRING INSTALLATION**

- A. Unless otherwise specified in other sections of these specifications, install wiring and connect to perform the functions shown and specified in other sections of these specifications.
- 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 power supply circuits are not shown for systems, connect them 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 lock on device 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 not exceed 120 volts and shall be lower voltages where shown on the drawings or 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.

### **3.5 FEEDER IDENTIFICATION**

- A. In each interior, pullbox and junction box, install metal tags on each circuit cables and wires to clearly designate their circuit identification and voltage.

### **3.6 WIRE CIRCUIT NUMBER IDENTIFICATION**

- A. Install a permanent wire marker indicating circuit number on each wire at each termination, including receptacles, switches, head wall units.
- B. Wire markers shall retain their markings after cleaning.

### **3.7 FIELD TESTING**

- A. Feeders and branch circuits shall have their insulation tested after installation and before connection to utilization devices such as fixtures, motors, or appliances, patient wall systems.
- B. Tests shall be performed by megger and conductors shall test free from short-circuits and grounds.
- C. Test conductors phase-to-phase and phase-to-ground.
- D. The Contractor shall furnish the instruments, materials, and labor for these tests.
- E. Provide typewritten certification notarized, signed by the contractor and all applicable sub-contractors stating that all wiring has been tested; provided in conformance with all applicable codes and the contract documents.

- - - E N D - - -

**SECTION 16140**  
**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 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL): General electrical requirements that are common to more than one section of Division 16.
- B. Section 16111, CONDUIT SYSTEMS: Conduits and outlets boxes.
- C. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 16450, GROUNDING: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 16685, PATIENT WALL SYSTEM

**1.3 SUBMITTALS**

- A. In accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL), 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.
- E. Submit samples of engraved panel/circuit nameplates.

#### 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 basic designation only.
- B. National Fire Protection Association (NFPA):
  - 70-02 . . . . . National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):
  - WD 1-99 . . . . . General Color Requirements for Wiring Devices
  - WD 6-02 . . . . . Wiring Devices - Dimensional Requirements
- D. Underwriter's Laboratories, Inc. (UL):
  - 5-96 . . . . . Surface Metal Raceways and Fittings
  - 20-00 . . . . . General-Use Snap Switches
  - 231-98 . . . . . Power Outlets
  - 467-93 . . . . . Grounding and Bonding Equipment
  - 498-01 . . . . . Attachment Plugs and Receptacles
  - 943-03 . . . . . Ground-Fault Circuit-Interrupters

#### 1.5 GUARANTEE

- A. Provide written guarantee for all wiring devices and associated wiring shall be guaranteed for two years from date of final acceptance. Guarantee shall be submitted after polarity testing.

### PART 2 - PRODUCTS

#### 2.1 RECEPTACLES

- A. General: All receptacles shall be listed by Underwriters Laboratories, Inc., as hospital grade with 100,000 hour power status indicator LED behind a permanent green dot indicator lens - shall meet UL 498 and conform to NEMA WD 1. (EXCEPTION - Receptacle types which have no listing as hospital grade but are listed by UL in their respective categories or receptacles indicated on the drawings as "not hospital grade").
  - 1. Mounting straps shall be one piece brass strap, with break-off plaster ears and shall include integral self-grounding feature. Terminal screws shall be brass, brass plated or a copper alloy metal.
  - 2. Receptacles shall have provisions for back and side wiring with separate metal clamp type terminals (four min.) and side wiring from four captively held binding screws.

3. Provide integral equipment grounding wire termination slotted screw-green in color for each receptacle.
- B. Duplex receptacles shall be 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. All wiring devices connected to the normal system shall be white in color with 100,000 hour power status indicator LED behind permanent green dot indicator lens.
  2. All wiring devices connected to the Emergency System shall be red in color with 100,000 hour power status indicator LED behind a permanent green dot indicator lens.
  3. All receptacles shall be back and side wired; slotted screws; hospital grade with metallic coverplates.
  4. Ground Fault Interrupter Duplex Receptacles: Shall be an integral unit suitable for mounting in a minimum 4" x 4" x 2 1/8" D box with single gang plaster ring.
    - a. Ground fault interrupter shall be hospital grade and consist of a differential current transformer, solid state sensing circuitry and a circuit interrupter switch. It shall be rated for operation on a 60 Hz, 120 volt, 20-ampere branch circuit. 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. Devices shall meet UL 943. Feed through GFI receptacles not acceptable.
  5. Safety Type Duplex Receptacles:
    - a. Bodies shall be gray in color.
    - b. Shall be hospital grade, as above with the following additional requirements.
      - 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 tamper proof type.
    - c. Shall be installed in the following locations:
      - 1) Housekeeping quarters, buildings, waiting areas and lobbies where children might be present.



6. Duplex Receptacles in electric rooms, telephone rooms, storage rooms, linen rooms, non-patient care areas (not hospital grade): shall be the same as hospital grade duplex receptacles except for the "hospital grade" listing and as follows.
  - a. Receptacles shall be industrial grade. Bodies shall be brown phenolic compound supported by a brass 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 and shall be locking type. Provide type 302 stainless wall plates. Verify straight blade or locking type.
- D. Weatherproof Receptacles: Shall consist of a duplex receptacle, mounted in box with a gasketed, weatherproof, cast metal cover plate with raintight clear plastic cover approved for use when cord is connected. The cover shall be permanently attached to the cover plate by a spring-hinged flap. The weatherproof integrity shall not be affected when heavy duty specification or hospital grade attachment plug caps are inserted. Cover plates on outlet boxes mounted flush in the wall shall be gasketed to the wall in a watertight manner.

## **2.2 TOGGLE SWITCHES - GENERAL**

- A. Toggle switches shall be totally enclosed tumbler type with bodies of phenolic compound. Rocker type switches are 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, industrial grade, butt contact, quiet AC type, heavy-duty general-purpose use with an integral self grounding brass mounting strap with break-off plaster ears and provisions for back and side wiring.
  3. Shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meet the requirements of NEMA WD 1, Heavy-Duty and UL 20.
  4. Ratings:
    - a. 120 volt circuits: 20 amperes at 120-277 volts AC.
    - b. 277 volt circuits: 20 amperes at 120-277 volts AC.
  5. The switches shall be mounted on the striker plate side of doors.
  6. Incorporate barriers between switches with multi-gang outlet boxes.

7. All switches connected to the Emergency System shall be quiet type hospital grade, red in color with 100,000 hour power status indicator behind a permanent green dot indicator lens, heavy duty type, one piece brass mounting strap integral self grounding, back and side wired 20A 120/277V A.C. Switches shall be red toggle with red metallic coverplate with the work 'EMERGENCY' engraved in 1/4 inch white lettering.
8. All switches connected to the normal system shall be quiet type hospital grade, white in color with 100,000 hour power status indicator behind a permanent green dot indicator lens, heavy duty type, one piece brass mounting strap, integral self grounding, back and side wired, 20A-120/277V AC. Switches shall be white toggle with 302 stainless steel coverplate.
9. All toggle switches shall be of the same manufacturer.
10. Snap switches for lighting shall not be grouped or ganged in outlet boxes unless they can be so arranged that the voltage between exposed live metal parts of adjacent switches does not exceed 300 volts. Provide barriers where voltage does exceed 300 volts.
11. Provide integral equipment grounding wire termination slotted screw green in color for each toggle switch.
12. Shall be color coded for current rating, listed by Underwriters Laboratories, Inc., and meeting the requirements of NEMA WD1 Heavy-Duty.
13. Provide neutral conductor to pilot light switches.
14. Provide separate and independent boxes for switches connected to 120V circuits and switches connected to 277V circuits.

### 2.3 DIMMERS

- A. Fluorescent dimmers shall be single pole 277 volt rated at 8 amperes. Fluorescent dimmers shall be Lutron Nova "T" - NTF - 277V single pole series or approved equivalent by the A/E.  
**Provide separate neutrals from panelboard for each dimmer.**  
Fluorescent dimming devices as specified shall only be used with Lutron Hi-Lume FDB electronic dimming ballast for compatibility and one source of responsibility for proper dimming operation between dimmer and dimming ballast. Dimmers shall not be derated for up to three gang alignment. Fluorescent dimmers shall be THIN profile; no visible heat sink for improved appearance; heavy duty components for surge protection and long life. Multi-gang alignment shall not derate dimmer ampere rating. All wall mounted dimmers and the associated electronic dimming ballast shall be of the same manufacture without exception. Dimmers shall have adequate capacity for the load served and the environment in which the dimmer is installed. Dimmer connected to the emergency system shall be red with red metallic coverplates. Dimmers connected to

the normal system shall be white with 302 stainless steel coverplates.

#### **2.4 WALL PLATES**

- A. Wall plates for switches and receptacles connected to the normal system shall be type 302 stainless steel.
- B. Wall plates for switches and receptacles connected to the emergency system shall be metallic and shall be red with the word "Emergency" engraved with 1/4 inch white filled lettering.
- C. Standard NEMA design, compatible with different manufacturers for interchangeability. Dimensions for openings in wall plates shall be accordance with NEMA WD1.
- D. Wall plates for wall mounted data, voice or other communication outlets shall be type 302 stainless steel.
- E. In unfinished areas, plates shall be painted to match wall paint system.
- F. In toilet rooms and locker rooms, plates shall be type 302 stainless steel 302.
- G. Provide plate with separate spring type cover for each receptacle of weatherproof duplex receptacles mounted on FS or FD box. Provide plastic raintight weatherproof cover for each exterior receptacle whenever cord is connected to the receptacle.
- H. Provide wall plates for single and combination wiring devices, of types, sizes, ganging, and cut-outs as required for associated wiring devices.
- I. Provide plates that mate to the type of wiring device to which they attach.
- J. Provide plates with metal screws to match plate finish for securing plates to devices.
- K. Provide plates for flush, wall mounted devices with beveled, smooth rolled outer edge.
- L. Provide plates for surface mounted device boxes with beveled steel, pressure primed for smooth edge fit to box.
- M. Oversized wall plates are not acceptable.

#### **2.5 ENGRAVED IDENTIFICATION NAMEPLATES FOR ALL WIRING DEVICES**

- A. Provide engraved nameplate for each wiring device indicating panel and circuit number. Nameplates for wiring devices connected to the emergency system shall be red background - white lettering. Nameplates for wiring devices connected to the normal system - white background - black lettering. Submit sample of each normal and emergency type nameplate for review with shop drawing submittals.

## 2.6 POKE-THRU FEED DEVICES

- A. The poke-thru device provides the interface between power and communication cabling in an above grade concrete floor and the modular furniture workstation or activation location where power and/or communication services are required.
- B. Classification and Use:  
The poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and UL514C and tested to Canadian Standard C22.2, No. 18-902 and bear the cULus mark. **This poke-thru device shall also be UL Listed and UL Fire Classified to U.S. and Canadian safety standards for tile, terrazzo, and the future UL requirement under UL514A and UL514C for the scrub water exclusion test for carpet and wood floors. This future requirement takes effect in June, 2003.** This poke-thru device shall conform to the standards set in the National Electrical Code, Section 300-21. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. to Standard UL263 as to fire resistance and the fire classification mark. Devices shall be for use in 1-, 1 ½-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1 ½-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings, or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the poke-thru fittings).
- C. Materials:  
This assembly consists of an insert and an activation service head cover.
1. The insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one ½" conduit channel and one 1 1/4" conduit channel for power and communication cabling. The body will also consist of an intumescent fire stop material to maintain the fire rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain the fire rating of the unit and the floor slab. Insert shall have a spring steel-retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. Insert shall also accept conduit connectors to accommodate extensions for deeper concrete slab depths. Conduit extensions shall be available for both ½" and 1 1/4" conduits.
- D. Activation Service Head:  
The activation service head shall be manufactured of zinc die-cast alloy and consist of a trim flange and a hexagonal service head. The activation cover shall be capable of being power coated or plated. Finish shall be textured, two-stage epoxy paint available in a gray or black finish. A gasket is attached to the underside of the service heads to maintain scrub water tightness. Service heads shall have six openings to address both power and communication requirements. Five openings shall contain rubber grommet material for cable pass-through. The sixth opening shall

have a zinc die-cast threaded drop-in hub to accept a 3/4" conduit connector. Service head height shall be 2 5/32" high and 5 1/2" in diameter. The trim flange shall be 7" in diameter. Service head shall also provide conduit barrier to complete isolation of power and communication service throughout the poke-thru assembly. Service head is not to be used as a junction box. All power connections must be made in a junction box above an accessible ceiling of the floor below.

## **2.7 SURFACE MULTIPLE-OUTLET ASSEMBLIES**

- A. Assemblies shall conform to the requirements of NFPA 70 and UL 5.
- B. Shall have the following features:
  - 1. Enclosures:
    - A. Thickness of steel shall be not less than 1 mm (0.040 inch) steel for base and cover. Nominal dimension shall be 40 by 70 mm (1-1/2 by 2-3/4 inches) with inside cross sectional area not less than 2250 square mm (3.5 square inches). The enclosures shall be thoroughly cleaned, phosphatized and painted at the factory with primer and the manufacturer's standard baked enamel or lacquer finish.
  - 2. Receptacles shall be duplex, hospital grade. See paragraph 'RECEPTACLES' in this section. Device cover plates shall be the manufacturer's standard corrosion resistant finish and shall not exceed the dimensions of the enclosure.
  - 3. Unless otherwise shown on drawings, spacing of the receptacles along the strip shall be 600 mm (24 inches) on centers.
  - 4. Wires within the assemblies shall be not less than No. 12 AWG copper, with 600 volt ratings.
  - 5. Installation fittings shall be designed for the strips being installed including bends, offsets, device brackets, inside couplings, wire clips, and elbows.
  - 6. Bond the strips to the conduit systems for their branch supply circuits.

## **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 and light switch shall be bonded to the outlet box with an approved green bonding jumper, and also connected to the green equipment grounding conductor installed with circuit conductors.

- C. All wall switch outlets shall be installed on the lock side of the door immediately adjacent to door frame. Verify door switch location prior to rough-in work. Where glass partitions or other architectural features prevent such locations, switches shall be located for maximum accessibility.
- D. Ground Fault Interrupter Hospital grade (GFI) type receptacles 20A, 125 volt, white, shall be installed, within six (6') feet of any sink; for all exterior outlets; and damp or wet areas; on roof within 25 feet of heating, air conditioning and refrigeration equipment. Feed-through type GFI receptacles not acceptable.
- E. Full gang size, heavy-duty, polarized, duplex, parallel blade, U-grounding slot with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke.
- F. Provide duplex hospital grade receptacles 125 volt, 20A safety grounds receptacles, in all patient care areas.
- G. In all toilet rooms and bathrooms or within 6'-0" of a sink, provide white industrial grade receptacles with 20 amp - 125 volt ground fault circuit interrupter.
- H. When receptacles are exposed to the weather, provide weatherproof plastic hinged cover raintight when cord is connected to receptacle. Provide UL labeled clear covers for when receptacles are in use.
- I. Refer to Architectural drawings for mounting heights of wiring devices in Patient Rooms, nurses stations, isolation rooms, offices, staff rooms, and the like. Mounting heights for wiring devices not indicated on architectural drawings in the above areas shall be verified with the Architect.
- J. Receptacles and switches shall be installed in minimum 4 inch square pressed steel boxes 2 1/8 inches deep (minimum) with single gang or multiple gang plaster ring and common coverplates.
- K. Where more than one switch occurs in the same location, the switches shall be installed in gang type outlet boxes. Provide barriers between each switch without exception. Provide separate and independent backboxes for 120V switched circuits and 277V switched circuits.
- L. A separate pole shall be provided for equipment grounding conductor on all wiring devices.
- M. Install devices plumb and level.
- N. Install switches with OFF position down.
- O. Connect wiring devices by wrapping conductor around screw terminal.
- P. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings and on surface mounted outlets.

- Q. Match existing mounting heights where new receptacles and toggle switches are installed in rooms with existing receptacles and toggle switches.
- R. All wiring devices shall be identified indicating panel- and circuit number. Provide identification using engraved nameplate indicating panel and circuit number shall be on all coverplates.
- S. In finished areas: Do not install wiring devices back-to-back. Install metal studs between devices, move 24" minimum apart to stop sound transmission between rooms. Provide sound insulation between boxes and within boxes.
- T. All outlets shall be centered with regard to beams, furrings, trim, etc., and the contractor shall consult with the architect with regard to furred and paneled walls, other ornamental features, etc., before fixing the location of outlets.
- U. Contractor shall check all door swings and the required mounting heights of all wall outlets with the architect prior to the installation of outlets and wall switches.
- V. Any outlet that is improperly located on account of failure to take account of the above conditions shall be relocated at the expense of the contractor.
- W. Provide plaster rings for all flush mounted boxes. Provide one gang, two gang, or multi-gang as required.

### **3.2 POKE-THRU DEVICES**

#### **A. Installation**

1. Unit shall mount in a cored hole. Use is defined by the UL Fire Resistance Directory as a minimum spacing of "2 ft. on center and not more than one device per each 65 sq. ft. of floor area in each span." This poke-thru device is UL Classified to U.S. and Canadian safety standards for total allowable number of copper conductors for both power and communication:
2. Floor coverings: The poke-thru device is fire rated for carpet covered floors, tile floor coverings up to 3/4" maximum thickness, and linoleum floor coverings up to a maximum of 1/8" thickness. For other floor coverings not listed above, consult manufacturer.

Installation shall be completed by pushing unit down into the cored hole. Prior to and during installation, refer to system layout and/or approved drawings. Contractor shall comply with detailed manufacturer's instruction sheet included with each device. Units shall be UL Listed to U.S. standards for use on tile, terrazzo, carpet, and wood floors.

### 3.3 TESTING

- A. Provide polarity testing and ground fault indication testing for each receptacle. Submit typewritten report.

- - - E N D - - -



**SECTION 16150**  
**MOTORS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies motors.

**1.2 RELATED WORK:**

- A. General electrical requirements and items that are common to more than one Section of Division 16: Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- B. Other sections specifying motor driven equipment in Divisions 14 and 15.
- C. CABLES LOW VOLTAGE (600 VOLTS AND BELOW), Section 16127
- D. For multiple motor control assemblies, which include motor starters: Section 16155, MOTOR STARTERS.
- E. DISCONNECT SWITCHES, Section 16170

**1.3 SUBMITTALS:**

Submit in accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL):

- A. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting, material, horsepower, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- B. Manuals:
  - 1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and application data.
- C. 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:**

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. National Electrical Manufacturers Association (NEMA):

MG1-98/Rev.1-00 . . . . Motors and Generators

MG2-89 . . . . . Safety Standard for Construction and Guide  
for Selection, Installation and Use

B. National Fire Protection Association (NFPA):

70-99 . . . . . National Electrical Code (NEC)

#### **1.5 WARRANTIES**

All motors shall be warranted for all labor, materials, tools, equipment, and services at the jobsite for two years from date of final acceptance.

### **PART 2 - PRODUCTS**

#### **2.1 MOTORS:**

A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG1 and MG2 shall apply.

B. Voltage ratings shall be as follows:

1. Single phase:

1. Motors connected to 120 volt systems: 115 volts.

2. Motors connected to 208 volt systems: 200 volts.

3. 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.

- 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 motors shall be high efficiency. All permanently wired polyphase motors of 746 W or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W or more with open, dripproof or totally enclosed fan cooled enclosures shall be high 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 Efficiency Motor				Minimum Efficiency Motor			
Open Drip-Proof				Totally Enclosed Fan-Cooled			
Rating	1200	1800	3600	Rating	1200	1800	3600
kW (HP)	RPM	RPM	RPM	kW (HP)	RPM	RPM	RPM
0.746 (1)	82.5%	85.5%	80.0%	0.746 (1)	82.5%	85.5%	78.5%
1.12 (1.5)	86.5%	86.5%	85.5%	1.12 (1.5)	87.5%	86.5%	85.5%
1.49 (2)	87.5%	86.5%	86.5%	1.49 (2)	88.5%	86.5%	86.5%
2.24 (3)	89.5%	89.5%	86.5%	2.24 (3)	89.5%	89.5%	88.5%
3.73 (5)	89.5%	89.5%	89.5%	3.73 (5)	89.5%	89.5%	89.5%
5.60 (7.5)	91.7%	91.0%	89.5%	5.60 (7.5)	91.7%	91.7%	91.0%
7.46 (10)	91.7%	91.7%	90.2%	7.46 (10)	91.7%	91.7%	91.7%
11.2 (15)	92.4%	93.0%	91.0%	11.2 (15)	92.4%	92.4%	91.7%
14.9 (20)	92.4%	93.0%	92.4%	14.9 (20)	92.4%	93.0%	92.4%
18.7 (25)	93.0%	93.6%	93.0%	18.7 (25)	93.0%	93.6%	93.0%
22.4 (30)	93.6%	94.1%	93.0%	22.4 (30)	93.6%	93.6%	93.0
							%
29.8 (40)	94.1%	94.1%	93.6%	29.8 (40)	94.1%	94.1%	93.6%
37.3 (50)	94.1%	94.5%	93.6%	37.3 (50)	94.1%	94.5%	94.1%
44.8 (60)	95.0%	95.0%	94.1%	44.8 (60)	94.5%	95.0%	94.1%
56.9 (75)	95.0%	95.0%	94.5%	56.9 (75)	95.0%	95.4%	94.5%
74.6 (100)	95.0%	95.4%	94.5%	74.6 (100)	95.4%	95.4%	95.0%
93.3 (125)	95.4%	95.4%	95.0%	93.3 (125)	95.4%	95.4%	95.4%
112 (150)	95.8%	95.8%	95.4%	112 (150)	95.8%	95.8%	95.4%
149.2 (200)	95.4%	95.8%	95.4%	149.2 (200)	95.8%	96.2%	95.8%

- I. Minimum Power Factor at Full Load and Rated Voltage: 85 percent at 1200 RPM, 1800 RPM and 3600 RPM.
- J. Minimum efficiency motors shall be used when usage of motors is 500 or more hours per year.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION:

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

#### 3.2 FIELD TESTS

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

- - - E N D - - -

**SECTION 16155**  
**MOTOR STARTERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This specification section is applicable to all types of motor controllers including but not necessarily limited to across the line non-reversing motor starters; reduced voltage motor starters; variable frequency drive controllers and manual motor control starters.
- B. This specification section is applicable to all types of motor controllers and variable frequency drives specified in Division 15 specifications.

**1.2 RELATED WORK**

- A. Other sections that specify motor driven equipment, except elevator motor controllers.
- B. General electrical requirements and items that are common to more than one Section of Division 16: Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- C. Section 16111, CONDUIT SYSTEMS.
- D. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW)
- E. Section 16150, MOTORS
- F. Section 16170, DISCONNECT SWITCHES (MOTOR AND CIRCUIT)
- G. Requirements for personnel safety and to provide a low impedance path for possible ground fault currents: Section 16450, GROUNDING.

**1.3 SUBMITTALS**

Submit in accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL):

- A. 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, branch circuit, overcurrent protection, wiring diagrams, starting characteristics, interlocking and accessories.

B. 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. (Update manual to include any information necessitated by shop drawing approval).

C. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certifications to the Resident Engineer:

1. Certification by the manufacturer that the motor controllers have passed the factory 24 hour operational test. (This certification must be furnished to the Resident Engineer prior to shipping the controller to the job site.)
2. Certification by the manufacturer that motor controllers conforms to the requirements of the drawings and specifications. (This certification must be furnished to the Resident Engineer prior to shipping the controller to the job site.).
3. Certification that the equipment has been properly installed, adjusted, and tested, in conformance to all applicable codes, manufacturer's instructions, wiring diagrams, operation and maintenance manuals, complete in place, ready for operation in all respects. Certifications shall be notarized, signed and dated by the contractor and all applicable sub-contractors.

**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 basic designation only.

- B. Institute of Electrical and Electronic Engineers (IEEE):
  - 519-92 . . . . . Recommended Practices and Requirements  
for Harmonic Control in Electrical Power  
Systems
  - C37.90.1-89 . . . . . Standard Surge Withstand Capability  
(SWC) Tests for Protective Relays and  
Relay Systems
- C. National Electrical Manufacturers Association (NEMA):
  - ICS 1-93 . . . . . Industrial Control and Systems General  
Requirements
  - ICS 1.1-84 . . . . . Safety Guidelines for the Application,  
Installation and Maintenance of Solid  
State Control
  - ICS 2-93 . . . . . Industrial Control and Systems,  
Controllers, Contactors and Overload  
Relays Rated Not More Than 2000 Volts AC  
or 750 Volts DC
  - ICS 6-93 . . . . . Industrial Control and Systems  
Enclosures
  - ICS 7-93 . . . . . Industrial Control and Systems  
Adjustable-Speed Drives
  - ICS 7.1-95 . . . . . Safety Standards for Construction and  
Guide for Selection, Installation and  
Operation of Adjustable-Speed Drives
- D. National Fire Protection Association (NFPA):
  - 70-99 . . . . . National Electrical Code (NEC)
- E. Underwriters Laboratories Inc. (UL):
  - 508-99 . . . . . Industrial Control Equipment

## 1.5 WARRANTEES

- A. Provide two year typewritten warrantee from date of final acceptance when manufacturer's engineering services provides start-up and written certification stating that variable frequency drives and motor starters (as applicable) are installed and wired per applicable codes; manufacturer's operation and instruction manuals complete in place, ready for operation. Guarantee shall include all labor, materials, tools, equipment, services, lodging, meals, all miscellaneous and incidental expenses, guarantee Sunday through Monday.

#### **1.6 DELIVERY, STORAGE AND HANDLING**

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.
- B. Contractor shall completely inspect shipments for damage upon delivery.

#### **1.7 FACTORY TESTING - VARIABLE FREQUENCY DRIVES**

- A. The following standard factory tests shall be performed on variable frequency drives. All tests shall be in accordance with the latest version of UL and NEMA standards.
  - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
  - 2. All final assemblies shall be tested at full load with application of line-to-line and line-to-ground bolted faults. The Adjustable Frequency Drive shall trip electronically without device failure.
  - 3. After all tests have been performed, each AFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
  - 4. After the burn-in-cycle is complete, each AFD shall be put through a motor load test before inspection and shipping.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.

#### **1.8 FIELD MEASUREMENTS**

- A. Contractor shall verify equipment provided shall fit into the available space.

#### **1.9 FACTORY TESTING - MOTOR STARTERS (Except Variable Frequency Drives)**

- A. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- B. The manufacturer shall provide three (3) certified copies of factory test reports.
- C. The following standard factory tests shall be performed on soft start electronic starters. All tests shall be in accordance with the latest version of UL and NEMA standards.
  - 1. All printed circuit boards shall be functionally tested via fault finder bench equipment prior to unit installation.
  - 2. All final assemblies shall be load tested.



## **1.10 QUALIFICATIONS**

- A. The manufacturer of the equipment specified herein shall have produced similar electrical equipment for a minimum period of ten (10) years. When required by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

## **1.11 MANUFACTURER**

- A. Across the line non-reversing motor starters, variable frequency drives, reduced voltage motor starters shall be Cutler Hammer to match existing electrical equipment provided under Electrical Project 578-96-101, Phase I; Electrical Project 578-97-102 Phases II, V, VI; Electrical projects 578-313, 578-314, Phases III, IV.

## **PART 2 - PRODUCTS**

### **2.1 MOTOR STARTERS, GENERAL**

- A. Applicable to all types of motor controllers including but not limited to across the line motor starters; reduced motor starters; variable frequency drives.
- B. Applicable to motor controller types specified herein and shall be applicable to Division 15 specifications relative to all motors, motor starters, and variable frequency drives.
- C. Motor starters 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.
- D. Motor starters shall be combination type full voltage non-reversing with fusible or non-fusible disconnect means as indicated on the contract documents.
- E. All motor starters and variable frequency drives shall have the following features as a minimum:
  - 1. Separately enclosed unless part of another assembly.
  - 2. Disconnecting means 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 700VA minimum or higher rating to accommodate maximum temperature control HVAC requirements within each motor controller enclosure and to provide the control voltage for each motor operating over 120 volts. Verify KVA requirements with all applicable trades.
  - d. Incorporate over current protection for both primary and secondary windings of the control power transformers in accordance with the NEC.
4. Overload solid state 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 by contractor field survey for the associated motor's nameplate data.
  - e. Verify every motor controller and variable frequency drive after installation and verify that correct sizes and ratings of protective devices have been provided.
  - f. Deliver four copies of a summarized list to the Resident Engineer indicating and identifies each and every motor nameplate and each and every motor controller installed. Include the catalog numbers and ratings for the correct sizes of protective devices for the motor controllers. Include manufacturer's solid state relay rating schedule coordinated with motor HP rating.
5. Hand-Off-Automatic (H-O-A) switch is required for all motor starters. 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.
7. Eight sets normally open and eight normally closed auxiliary contacts, two pilot lights (red and green), pushbuttons and other devices and accessories specified herein.
8. Enclosures:
- a. Shall be the NEMA types specified herein.
  - b. Shall be the NEMA types suitable for the environmental conditions where the motor controllers are being installed.

- c. Doors mechanically interlocked to prevent opening unless the breaker or switch within the enclosure is open.
  - d. Enclosures shall be primed and finish coated at the factory with the manufacturer's prime coat and standard finish.
- F. Coordinate with applicable contractor furnishing motors to assure compatibility between motors and motor starters and between motors and variable frequency drives. Verify prior to shop drawing submittals.
- G. Motor controllers incorporated with equipment assemblies shall also be designed for the specific requirements of the assemblies.
- H. For motor controllers being installed in existing motor control centers or panelboards, coordinate with the manufacturer's representative of the existing centers or panelboards.
- I. Additional requirements for specific motor controllers, as indicated in other specification sections and drawings, shall also apply.
- J. Provide a disconnecting means near and within sight of each motor.
- K. Provide all required instrumentation and component equipment for phase unbalance and anti-single phasing for all three phase motor starters.
- L. Refer to paragraph, MOTOR CONTROL STATIONS, in this section for additional requirements.
- M. Provide 65,000 AIC symmetrical at 480V adjustable motor circuit protector or thermal magnetic circuit breaker as specified on the contract documents.
- N. Phase loss relays and phase unbalance relays with associated N.O. and N.C. contacts.

## **2.2 MANUAL MOTOR STARTERS**

- A. Shall be in accordance with applicable requirements of 2.1 and 2.7 above.
- B. Manual motor starters.
  - 1. Starters shall be AC, general-purpose Class A, manually operated type with full voltage controller for induction motors, rated in horsepower.
  - B. Units shall include overload protection, red pilot light and toggle operator.
- C. Fractional horsepower manual motor starters.

1. Starters shall be AC, 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 AC, 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 and toggle operator.

### **2.3 ACROSS THE LINE - NON-REVERSING MOTOR STARTERS - GENERAL**

- A. Shall be in accordance with applicable requirements of 2.1 and 2.7.
- B. Starters shall be AC, general-purpose, Class A controllers for induction motors rated in horsepower. Minimum size 1 starters.
- C. Provide combination motor starters. Combine starter with protective overcurrent devices or disconnect device in a common enclosure.
- D. Provide phase loss protection relay, and phase unbalance relays for each starter, with contacts to de-energize the starter upon loss of any phase.
- E. Motor controller types specified herein shall be applicable to all applicable Division 15 Specification Sections.

### **2.4 REDUCED VOLTAGE MOTOR CONTROLLERS - GENERAL**

- A. Shall be in accordance with applicable portions of 2.1 and 2.7.
- B. Shall be the motor controller type specified herein and shall be applicable to all Division 15 specification sections.
- C. Shall have closed circuit transition for the types which can incorporate such transition.
- D. Shall limit inrush currents to not more than 200 percent of motor full load running amperes.
- E. Provide phase loss protection relays, and phase unbalance relays for each starter, with contacts to de-energize the starter upon loss of any phase.

### **2.5 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Shall be in accordance with applicable portions of 2.1 and 2.7.

- 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. Shall be rated for input power as specified in the contract documents. 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. Each controller shall be factory tested at maximum watts (HP), rated full load current and at an ambient temperature of 40 degrees C for a period of not less than 24 hours. If a component fails, it shall be replaced and the test restarted for the full time period. A certified copy of the factory Test Report shall be furnished to the Resident Engineer prior to shipping the controller to the job site. Each controller shall be compatible with the applicable motor in all respects.
- E. Variable frequency drives shall have the following features as a minimum:
  - 1. Isolated power supply for control circuits.
  - 2. Manually re-settable motor overload protection for each phase.
  - 3. Adjustable current limiting circuitry to provide soft motor starting. Maximum starting current shall not exceed 200 percent of motor full load current.
  - 4. Independent acceleration and deceleration time adjustment, manually adjustable from 2 to 30 seconds. (Set timers to the equipment manufacture'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 the following electrical disturbances and shall automatically restart when the conditions are corrected:
    - 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 overcurrent 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. Phase unbalance.
  - i. Short duration power outages of 12 cycles or less (i.e., distribution line switching, generator testing, automatic transfer switch operations.)
8. Provide for automatic shutdown on receipt of a power transfer warning signal from existing automatic transfer switches serving power panels with subsequent variable frequency drives. Controller shall automatically restart motor after the power transfer. Provide all required accessories, relays, instrumentation in existing automatic transfer switches that directly or indirectly serve variable frequency drives. All accessories, relays, instrumentation shall be installed in existing ASCO transfer switches by ASCO certified factory trained engineers so as not to abort existing automatic transfer switch warranties. All control wiring shall be installed in a separate conduit system from automatic transfer switch to each variable frequency drive. Make all final connections. Applicable to all stand-alone variable frequency drives and all variable frequency drives specified in HVAC equipment contract documents.
- F. Minimum efficiency shall be 95 percent at 100 percent speed and 85percent at 50 percent speed.
- G. The displacement power factor of the controller shall not be less than 95 percent under any speed or load condition.
- H. Controllers shall include a door interlocked thermal magnetic circuit breaker switch which will disconnect all input power.
- I. Provide a by-pass motor starter assembly with circuitry to protect and isolate the variable speed controller. When the variable speed controller is in the by-pass mode, the solid-state components shall be isolated from the power supply on both the line and motor side.
- J. The following door mounted accessories shall be provided as a minimum:
- 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.
- K. Provide eight N.O. and eight N.C. dry contacts rated 120 volts, 10 amperes, 60 HZ for remote indication of the following:
1. System shutdown with auto restart.
  2. System shutdown without auto restart.
  3. System running.
- L. Incorporate into each control circuit a 120-volt, time delay relay (ON delay), adjustable from 0.3-10 minutes, with transient protection. Provide primary and secondary fused transformers for the control circuits.
- M. Controller shall not add any current or voltage transients to the input AC power distribution system nor shall the controller be affected by transients from other devices on the AC power distribution system. 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.
- N. The AFDs shall have a one (1) minute overload current rating of 150% and a two (2) second overload current rating of 250% for constant torque drives. The AFDs shall have a one (1) minute overload current rating of 110% for variable torque drives.
- O. The AFDs shall be capable of operating **any NEMA design B squirrel cage induction motor**, regardless of manufacturer, with a horsepower and current rating within the capacity of the AFD.
- P. The AFDs shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing standard 3% nominal impedance integral ac three-phase input line reactor.
- Q. Harmonic calculations shall be provided based on the KVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, and the total system load. The calculations shall be made with the point of common coupling being the point where

the utility feeds multiple customers. Submit harmonic calculations.

- R. Total harmonic distortion shall be calculated under worst case conditions in accordance with the procedure outlined in IEEE standard 519-1992. The contractor shall provide any needed information to the AFD supplier three (3) weeks prior to requiring harmonic calculations.
- S. The system containing the AFDs shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992. If the system cannot meet the harmonic levels with the AFDs provided with the standard input line reactor, the AFD manufacturer shall supply an eighteen pulse, multiple bridge rectifier ac to dc conversion section with phase shifting transformer for all drives above 75 Hp. This eighteen pulse rectifier converter shall result in a multiple pulse current waveform that will more nearly approximate a true sinewave to reduce voltage harmonic content on the utility line. The phase shifting transformer shall be of a single winding type to optimize its KVA rating and harmonic cancellation capability. Harmonic filters are not acceptable above 75 Hp.
- T. The AFDs shall be able to start into a spinning motor. The AFDs shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the AFDs shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
- U. Standard operating conditions shall be:
  - 1. Incoming Power: Three-phase, **480 VAC** (+10% to -15%) and 60 Hz (+/-5 Hz) power to a fixed potential DC bus level.
  - 2. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.
  - 3. Speed regulation of +/-0.5% of base speed.
  - 4. Load inertia dependant carryover (ridethrough) during utility loss.
  - 5. Insensitive to input line rotation.
  - 6. Humidity: 0 to 95% (non-condensing and non-corrosive).
  - 7. Altitude: 0 to 3,300 feet (1000 meters) above sea level.
  - 8. Ambient Temperature: -10 to 50EC (CT), -10 to 40EC (VT).
  - 9. Storage Temperature: -40 to 60EC.
- V. CONTROL FUNCTIONS
  - 1. Frequently accessed AFD programmable parameters shall be adjustable from a digital operator keypad located on the



front of the AFD. The AFDs shall have a 3 line alphanumeric programmable display with status indicators. Keypads shall utilize plain English words for parameters, status, and diagnostic messages. Keypads that are difficult to read or understand are not acceptable, and particularly those that use alphanumeric code and tables. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.

2. Standard advanced programming and trouble-shooting functions shall be available by using a personal computer's RS-232 port and Windows™ based software. In addition the software shall permit control and monitoring via the AFD's RS232 port. The manufacturer shall supply a diskette with the required software. An easily understood instruction manual and software help screens shall also be provided. The computer software shall be used for modifying the drive setup and reviewing diagnostic and trend information as outlined in this specification.
3. The operator shall be able to scroll through the keypad menu to choose between the following as a minimum:
  - A. Monitor
  - B. Operate
  - C. Parameter setup
  - D. Actual parameter values
  - E. Active faults
  - F. Fault history
  - G. LCD contrast adjustment
  - H. Information to indicate the standard software and optional features software loaded.
4. The following setups and adjustments, at a minimum shall be provided:
  - a. Start command from keypad, remote or communications port
  - b. Speed command from keypad, remote or communications port
  - c. Motor direction selection
  - d. Maximum and minimum speed limits
  - e. Acceleration and deceleration times, two settable ranges
  - f. Critical (skip) frequency avoidance
  - g. Torque limit
  - h. Multiple attempt restart function
  - i. Multiple preset speeds adjustment
  - j. Catch a spinning motor start or normal start selection
  - k. Programmable analog output
  - l. DC brake current magnitude and time
  - m. Proportional/Integral process controller

W. The AFDs shall have the following system interfaces as a minimum:

1. Inputs - A minimum of six (6) programmable digital inputs, two (2) analog inputs and serial communications interface shall be provided with the following as a minimum:
  - a. Remote manual/auto
  - b. Remote start/stop
  - c. Remote forward/reverse
  - d. Remote preset speeds
  - e. Remote external trip
  - f. Remote fault reset
  - g. Process control speed reference interface, 4-20mA dc
  - h. Potentiometer and 1-10Vdc speed reference interface
  - i. RS232 programming and operation interface port
  - j. Serial communications port
2. Outputs - A minimum of two (2) discrete programmable digital outputs, one (1) programmable open collector output, and one (1) programmable analog output shall be provided, with the following as a minimum:
  - a. Programmable relay outputs with one (1) set of Form C contacts for each, selectable with the following available as a minimum:
    1. Fault
    2. Run
    3. Ready
    4. Reversing
    5. Jogging
    6. At speed
    7. In torque limit
    8. Motor rotation direction opposite of commanded
    9. Overtemperature
  - b. Programmable open collector output with available 24Vdc power supply and selectable with the following available as a minimum:
    1. Fault
    2. Run
    3. Ready
    4. Reversing
    5. Jogging
    6. At speed
    7. In torque limit
    8. Motor rotation direction opposite of commanded
    9. Over temperature
  - c. Programmable analog output signal, selectable with the following available as a minimum:
    1. Output current
    2. Output frequency
    3. Motor speed
    4. Motor torque

- 5. Motor power
- 6. Motor voltage
- 7. DC link voltage

X. Monitoring and Displays

- 1. The AFD's display shall be a LCD type capable of displaying three (3) lines of text and the following thirteen (13) status indicators as a minimum:
  - a. Run
  - b. Forward
  - c. Reverse
  - d. Stop
  - e. Ready
  - f. Alarm
  - g. Fault
  - h. Local
  - i. Panel
  - j. Remote
  - k. Hand
  - l. Auto
  - m. Off
- 2. The AFD's keypad shall be capable of displaying the following monitoring functions as a minimum:
  - a. Output frequency
  - b. Output speed
  - c. Motor current
  - d. Motor torque
  - e. Motor power
  - f. Motor voltage
  - g. DC-link voltage
  - h. Heatsink temperature
  - i. Total operating days counter
  - j. Operating hours (resetable)
  - k. Total megawatt hours
  - l. Megawatt hours (resetable)
  - m. Voltage level of analog input
  - n. Current level of analog input
  - o. Digital inputs status
  - p. Digital and relay outputs status
  - q. Motor temperature rise, percentage of allowable.

Y. Protective Functions

- 1. The AFD shall include the following protective features as a minimum:
  - a. Overcurrent
  - b. Overvoltage
  - c. Inverter fault
  - d. Undervoltage
  - e. Phase loss
  - f. Output phase loss
  - g. Undertemperature

- h. Overtemperature
  - i. Motor stalled
  - j. Motor overtemperature
  - k. Motor underload
  - l. Logic voltage failure
  - m. Microprocessor failure
  - n. DC injection braking
2. The AFD shall provide ground fault protection during power-up, starting, and running. AFD's with no ground fault protection during running are not acceptable.
- Z. Diagnostic Features
1. Fault History.
- a. Record and log faults
  - b. Indicate the most recent first, and store up to 9 faults.
- AA. The following features shall be provided in each AFD as a minimum:
- 1. Thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the AFD door with the disconnect handle in the ON position. This shall be defeatable by maintenance personnel.
  - 2. AC input line current limiting fuses shall provide a means of disconnecting the AFD from the line under fault conditions.
  - 3. Three contactor bypass shall include a drive input disconnect, a fused control transformer, an AFD input isolation contactor, bypass contactor and an AFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor overcurrent relays. The complete bypass system Hand-Off-Auto with Inverter-Bypass selector switch(s), and inverter/bypass pilot lights shall be packaged with the AFD. The unit may be set up for Automatic bypass operation upon an AFD trip.
  - 4. AC output contactor to provide a means for positive disconnection of the drive output from the motor terminals.
  - 5. Fused space heaters with thermostat shall be provided to minimize condensation potential upon drive shutdown.
  - 6. Laminated plastic or steel nameplate engraved with user's identifying name or number for oversize enclosures.

7. 120 Vac control to allow AFD to interface with remote dry contacts.
8. Motor overcurrent relay to provide motor overcurrent sensing of a given level of load current.
9. Motor dv/dt filter for use on motor cable runs exceeding 100 feet for motors with a peak voltage insulation rating under 1600 Vac.
  - a. The dv/dt filter shall be located at the AFD and shall reduce the dv/dt clamp any voltage overshoots of the AFD output. It will return the energy in the voltage overshoots to the AFD's dc bus. A power dissipative resistance device is not acceptable.

OR

- b. Provide properly sized output filter to reduce transient voltage (dv/dt) levels and the resultant peak voltage overshoots at the motor terminals for motor HP specified within applicable feeder lineal footage.
10. Dynamic braking control circuitry shall be provided to decelerate the motor faster than the internal losses can absorb. Dynamic braking shall cause resistor bank, to be switched onto the dc link as required to absorb the regenerative energy. This shall allow the fastest controlled deceleration and/or stop without an overvoltage condition.
11. Communication card for interface with Modbus RTU, DeviceNet, Interbus-S, Profibus-DP, Lonworks control system.
12. Provide an input EMI/RFI filter to minimize conducted electrical noise to meet the requirements of IEC 61800-3.
13. Provide 8 channel 120V AC control interface with eight interposing relays.
14. Provide primary and secondary fused control transformer 120V secondary minimum 700VA. Verify and coordinate transformer rating with all applicable trades. Increase transformer rating as required.

BB. Enclosure

The AFD enclosure shall meet NEMA 1 except complete with filters and gasketing. The AFD shall have complete front accessibility with easily removable assemblies. AFD provided with roof mounted HVAC packaged unit shall be NEMA 12 with filters and gasketing. The overall enclosures for AFD/VFD shall have a thermostatically controlled, factory installed heater to protect the assembly from ambient temperature and maintain minimum 40°F at -10°F ambient.

- CC. Spare Parts  
The main logic board, keypad and power supply board shall be supplied as spares, one for each different part number supplied.
- DD. The AFD manufacturer shall maintain, as part of a national network, engineering service facilities within 250 miles of project to provide start-up service, emergency service calls, repair work, service contracts, maintenance and training of customer personnel.
- EE. Miscellaneous
1. Provide all required power and control wiring in separate conduit systems.
  2. Provide all required grounding per manufacturers recommendations and wiring diagrams, operation and installation manuals.
  3. Provide separate raceways for input power circuits, output motor wiring and control wiring.
  4. To reduce noise level from the total system, motor wiring shall be as short as possible.
  5. Terminal tightening torque shall be in conformance to manufacturer's instruction and O & M Manuals.
  6. Do not ground one adjustable frequency drive to another AFD by daisy chaining. (Daisy chain grounding not acceptable.)
  7. Provide separate and independent raceways for each entry to and each exit from adjustable frequency drives.
  8. Shall meet UL and NEC grounding and bonding requirements. Install metal grounding plate in all drives that have a plastic bottom. Install the grounding plate just above the plastic bottom. Ground the metal plate to the chassis and ground the grounding conductor and the conduit to the metal plate.
  9. Provide for cable strain relief for the conduit entries and conduit exits.
  10. Plenum Mounting - The drive shall be UL rated for plenum mounting. Where AFD is to be mounted in the plenum, allow sufficient access for servicing. All normal clearance, temperature and humidity limitations apply.
  11. Grounding Plate - 380 to 460 V drives with a NEMA 1 filtered and gasketed enclosure have a plastic bottom cover with provision for conduit entry. To meet UL requirements, the metal grounding plate must be in place above the plastic bottom cover. It must be grounded to the chassis, and the conduit ground to it. If the grounding plate is not factory installed, it must be installed in the drives that have a

plastic bottom panel to ensure proper grounding of the conduit to the enclosure. Connect the ground wire from the grounding plate to the grounding tab marked with the ground symbol.

12. All required instrumentation control devices, relays, wiring components and all final connections.
13. All required power and control wiring and all final connections.
14. Adjustable frequency drive testing, correcting, retesting, start-up as per manufacturer's operation, maintenance manuals.
15. Adjustable frequency drives shall be properly grounded in conformance to adjustable frequency drive manufacturer's maintenance manual.
16. The adjustable frequency drive shall be rated for air plenum mounting. Allow sufficient access for servicing.
17. Provide shielded power wiring to reduce radio frequency noise interference, between the drive and the motor. Provide shielded control wiring. The shield of the control wiring shall be grounded at the cable clamp at the bottom of the drive, but shall continue with the cable to the control card, but not connected to any terminal on the control card. The insulation around the shield shall only be removed where it is connected to the cable clamp. The insulation shall be left on the shield between the clamp and the terminals verify shield grounding in installation manual. All wiring shall be installed in flexible conduit.
18. Provide DC voltage to the drive motor for heating the motor when the motor is inactive.

## **2.6 COMBINATION SOLID-STATE ELECTRONIC SOFT START REDUCED VOLTAGE MOTOR STARTERS - DETAILS**

- A. Combination type Reduced Voltage Motor Starters shall be provided for all motors 20HP and above.
- B. Combination solidstate starters shall include, but shall not be limited to the following:
  1. The solid-state reduced voltage starter shall be UL, and CSA listed for solid state reduced voltage motor starters. The solid state reduced voltage starter shall be an integrated unit with power SCR's, heat sink, logic board, paralleling bypass contactor, and electronic overload relay enclosed in a single molded housing.
  2. The SCR based power section shall consist of six (6) back-to-back SCRs and shall be rated for a minimum peak inverse voltage of the driven motor. The starter shall be three-

phase, 60 Hz, and rated for the hp, current, and voltage as shown on the contract documents.

3. Units shall include an integrated fan controlled by thermal sensors on the heat sink. Fan shall automatically operate during the start ramp and if internal temperature on the heat sink exceeds 60 degree C.
4. Units using triacs or SCR/diode combinations shall not be acceptable.
5. Resistor/capacitor snubber networks shall be used to prevent false firing of SCRs due to dv/dt effects.
6. The logic board shall be identical for all ampere ratings and voltage classes and shall be conformally coated to protect environmental concerns.
7. The paralleling run bypass contactor shall energize when the motor reaches 90% of full speed and close/open under 1 times motor current.
8. Starter shall be provided with electronic overload protection as standard and shall be based on an inverse time-current algorithm. Overload protection shall be capable of being disabled during ramp start for long acceleration loads via a DIP switch setting on the device keypad. Provide flashing red LED with horn and silencer whenever overload protection is disabled.
9. Overload protection shall be adjusted via the device keypad and shall have a motor full load amp adjustment from 30 to 100% (3.2:1) of the max continuous ampere rating of the starter.
10. Starter shall have selectable overload class setting of 5, 10, 20 or 30 via a DIP switch setting on the device keypad.
11. Starter shall be capable of either an electronic or mechanical reset after a fault.
12. Units using bi-metal overload relays are not acceptable.
13. Overtemperature protection (on heat sink) shall be standard.
14. Starters shall provide protection against improper line side phase rotations as standard. Starter shall shut down if a line side phase rotation other than A-B-C exists. This feature can be disabled via a DIP switch on the device keypad. Provide flashing red LED with horn and silencer whenever phase loss feature is disabled.
15. Starters shall provide protection against a phase loss as standard. Starter will shut down if a 50% current differential between any two phases is encountered. This feature can be disabled via a DIP switch on the device



keypad. Provide flashing red LED with horn and silencer whenever phase loss is disabled.

16. Starter shall provide protection against a motor stall condition during the start ramp as standard. This feature can be disabled via a DIP switch on the device keypad. Provide flashing red LED with horn and silencer whenever motor stall feature is disabled.
17. Starter shall provide protection against a motor jam condition during run as standard. This feature can be disabled via a DIP switch on the device keypad. Provide flashing red LED with horn and silencer whenever motor jam condition feature is disabled.
18. Starter shall be provided with (8) form C normally open (NO), and (8) normally closed (NC) contacts that shall change state when a fault conditions exists. Contacts shall be rated 240V AC and 24V DC max, 3 amps as standard. In addition, an LED display on the device keypad shall indicate type of fault (Overtemp, Phase Loss, Jam, Stall, Phase Reversal, and Overload).
19. The following control function adjustments on the device keypad are required:
  - a. Selectable Torque Ramp Start or Current Limit Start
  - b. Adjustable Kick Start Time, 0-2 seconds
  - c. Adjustable Kick Start Torque, 0-85%
  - d. Adjustable Ramp Start Time; 0.5-180 second
  - e. Adjustable Initial Starting Ramp Torque; 0-85%
  - f. Adjustable Smooth Stop Ramp Time; 0-60 seconds.
20. Enclosed combination solid state starters shall include a adjustable/magnetic circuit breaker HMCP for short circuit protection and quick disconnect means. Starters and breakers are to be rated per UL508D for a withstand rating of not less than 65 kAIC rms.
21. Provide all required instrumentation for anti-single phase protection and phase reversal.
22. Units enclosed in motor control centers shall be of the same manufacturer as that of the circuit breaker and motor control center for coordination and design issues.
23. All solid state starter units shall be plug in for ease of maintenance. Bolt in units are not acceptable.
24. Solid state starter units shall be capable of maintaining proper operating temperature without the aid of door vents or external bypass contactors.
25. Soft starts that use external bypass contactor designs shall not be acceptable.

26. The manufacturer of the solid-state starter shall employ a field based factory service organization for the purpose of start up and repair of units. (Third party service contractors are not acceptable.)
27. Maximum continuous operation shall be at 100% of continuous ampere rating.
28. Control power shall be 24V DC as standard for safety and reliability.
29. Separate control terminals shall be provided for 24V DC power, logic level signals for permissive, start, jog forward, ramp start overload override and electric reset.
30. Control terminals shall be pull-apart for easy access and wiring.
31. External interface circuitry shall include 120-volt relay logic interface capability.
32. A removable Customer Interface Module (CIM) shall be provided that allows for full adjustment of control and protection functions thru the use of potentiometers and DIP switches.
33. Power terminations shall consist of pressure type terminals rated for 75 degree centigrade conductors.
34. Enclosure:
  - a. Provide NEMA 1 except gasketed with filtered enclosure.
  - b. The following shall be included as a minimum:
    - 1) The operating handle of the disconnect shall always remain connected to the breaker. The operating handle shall not be mounted on the door of the enclosure, but on the controller for safe "stand -aside" operation. The position of the operating handle shall indicate ON or OFF position of the circuit breaker and include provision for padlocking in the OFF position.
    - 2) Interlock provisions shall prevent unauthorized opening or closing of the starter door with the disconnect in the ON position.
35. Each starter shall be equipped with a primary and secondary fused minimum 700VA control power transformer, (coordinate VA rating with all applicable trades) one green and one red "Run" indicating transformer type pilot lights, Hand-Off-Automatic selector switch, one illuminated reset pushbutton with overload indication, and (8) NO/ (8) NC contacts.

Device panel to have space to accommodate six (6) oil-tight pilot-control devices.

- 37. Shall be in accordance with all applicable portions of subsection 2.1, 2.4, 2.7.
- 38. Provide phase unbalance relays with associated N.C. and N.O. contacts.

## **2.7 ALL TYPES OF MOTOR CONTROLLERS AND VARIABLE FREQUENCY DRIVES - DETAILS:**

- A. Include built-in-H-O-A selector switches, red and green pilot lights, fused control transformers, minimum 700VA (coordinate with all applicable trades) auxiliary contacts, disconnect means, circuit breakers, integral in to all three phase motor starters, and variable frequency drives.
- B. Motor starters and adjustable frequency drives shall be of a single manufacturer.
- C. Doors mechanically interlocked to prevent their opening unless the disconnect is opened. Incorporate "defeater" mechanisms for inspection by qualified personnel.
- D. External operating handles with lock-open padlocking provisions and ON and OFF position indicators.
- E. Combination starter units shall be full-voltage non-reversing; or combination type reduced voltage starters and shall utilize motor circuit protectors.
  - 1. Each combination unit shall be rated minimum of 65,000 AIC symmetrical at 480V. The motor circuit protectors shall provide adjustable magnetic protection and be provided with pin insert to stop magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the motor circuit protector. Motor circuit protectors shall include transient override feature for motor inrush current. Motor circuit protectors shall be instantaneous type breakers. Contractor shall set instantaneous circuit breaker trip rating based on field survey of each motor nameplate data. Each circuit breaker shall indicate trip rating.
  - 2. Provide engraved nameplates for all motor starters and variable frequency drives.
- F. Motor starters shall be operated, electrically held, three-pole assemblies with arc electrically extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight (8) NO or eight (8) NC auxiliary contacts. The overload protection shall consist of one (1) current sensor located in each phase monitored by the Microprocessor that yields a time current curve closely paralleling that of motor heating damage boundary, accurate to 2%.

Running overload protection shall be DIP switch selectable for the specific motor full load amperes within the starter range. Provide DIP switch selectable overload trip class of 10, 20 and 30. Contractor shall survey each motor nameplate data and select overload protection in conformance to manufacturer's instructions and in conformance to applicable codes.

1. Motor starters shall monitor current in each phase to provide phase loss and phase unbalance protection, such that if the unbalance on any of two phases is greater than 30% of the DIP switch selected trip rating, a phase loss/unbalance trip occurs. Provide phase loss/unbalance protection which requires no time delay for reset.
  2. Motor starters shall provide ground fault protection. Ground fault protection shall be set at 20% of maximum continuous ampere rating and have a start delay of 20 seconds, and a run delay of 1 second to prevent nuisance trip on starting.
  3. Microprocessor shall measure control circuit voltage and prevent closing of the coil on low-voltage (78 volts AC) and/or high-voltage (135 volts AC) conditions which are outside of the coil ratings.
  4. Microprocessor shall apply voltage to the coil such that a guaranteed maximum of two (2) milliseconds of main contact bounce occurs on contactor closure.
  5. Microprocessor shall continuously measure coil circuit voltage and current so as to maintain constant coil power at a level to maintain main contact closure and minimize coil power consumption.
  6. Each motor starter shall be equipped with a primary and secondary fused minimum 700VA control power transformer, one green and one red "Run" indicating transformer type pilot lights, Hand-Off-Automatic selector switch, one illuminated reset pushbutton with overload indication, and (8) NO/(8) NC contacts, unless otherwise scheduled on the drawings. Device panel to have space to accommodate six (6) oil-tight pilot-control devices.
  7. Motor starter shall monitor phase unbalance and phase loss. Provide required N.O. and N.C. contacts and all instrumentation.
- G. Identify each motor controller, circuit breaker and switch with a separate nameplate of laminated black phenolic resin with white core and engraved lettering not less than 1/4-inch high. Identify each motor by its number or other designation and indicate function fulfilled by the motor; also identify panel or MCC designation. Identify pilot light with ON and OFF designation.
- H. Overload ratings must be properly sized and coordinated for each motor starter unit.

- I. Coordinate control transformer KVA rating, quantity of normally open - normally closed auxiliary contacts, temperature control wiring termination points with applicable temperature control sub-contractor prior to shop drawing submittals.
- J. Interface all local and remote devices into the control wiring and operational systems for each load.
- K. 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 START - STOP pushbuttons or switches, which cause motors to restart automatically when the pushbuttons or switches are released, are not acceptable.
- L. Shall be in accordance with applicable portions of subsection 2.1.

## **2.8 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 system 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; also identify panel or MCC designation.
- 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.

## **2.9 SPARE PARTS**

- A. Provide the following as a minimum:
  1. Provide six spare sets of all fuse types.
  2. Provide two spare auxiliary relays.
  3. Provide ten sets of indicating light bulbs.
  4. Provide two cans of touch up paint.
  5. Provide one set of detailed manufacturers recommended spare parts which are in addition to those listed above.
  6. Provide spare fuse cabinet, wall mounted.
- B. The spare parts and quantities listed above are a minimum and are intended to provide the recommended maintenance on the equipment during the warranty period. Provide additional spare parts or greater quantities of parts at no additional cost to the Government, when recommended by the equipment manufacturer's standard published spare parts bulletin.

**2.10 All motor starters and variable frequency drives** shall be provided with engraved nameplates, identifying the motor controlled.

## **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. Install Variable Speed Motor Controllers in accordance with manufacturers recommendations, the NEC, and in accordance with NEMA ICS 7.1.C.
- C. Provide all final wiring connections to all motors with minimum 24-inch length of seal-tite flexible conduit.
- D. Provide, furnish and install all motor controllers with a minimum of downtime and in accordance with the NEC, and as per manufacturer's instructions, wiring diagrams and drawings.
- E. The equipment shall be certified in writing by manufacturer's engineering services that equipment has been provided and installed in conformance to all applicable codes and manufacturer's instructions, complete in place ready for operation in all respects. All motors, motor starters and variable frequency drives shall be listed on the certifications. Typewritten certifications shall be notarized, signed and dated by the contractor and all applicable sub-contractors.

F. Harmonic Measurements

1. The AFD manufacturer shall perform harmonic measurement at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE519-1992. A report of the voltage THD and current TDD shall be sent to the engineer. The contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

**3.2 MOTOR WIRING**

- A. Provide all power wiring and disconnect means for all motors including but not limited to heating, ventilating, air conditioning, and plumbing, fire protection motors.
- B. Set all loose motors complete in place ready for wiring and provide, furnish, install, wire all motor controls.
- C. Verify exact locations of all motors prior to rough-in.
- D. Furnish and install all necessary connections between motor starters and motors, in conduit, and leave motors ready to start. Change connections, if necessary, at motor starters to secure proper rotation of motors. The power supply wiring to the motors, from the motor starters, shall be of the same size as the power wiring indicated on the drawings. Furnish and install all fuses in all fusible combination starters and fusible disconnect switches.
- E. Provide fractional horsepower manual starters, surface and recessed types. Recessed types shall be installed in all finished spaces. All motor starters shall contain pilot lights. Contractor shall install and wire all motor starters complete in place ready for operation.
- F. Except as noted on drawings, all 120 volt, single phase motors 1/3 HP and larger are to be placed on separate circuits.
- G. Set instantaneous magnetic circuit breaker settings in conformance to manufacturers instructions for starters and motors. The contractor shall field survey each motor nameplate and shall be responsible for instantaneous overload setting, sized in accordance to motor nameplate data for motor, and in conformance with applicable codes. Submit typewritten certified report, in (6) three ring binders notarized, signed, dated by the manufacturer, the contractor, and all applicable sub-contractors listing each motor name plated data and associated magnetic circuit breaker setting. Include manufacturer's tables for proper magnetic circuit breaker coordination for each motor/voltage/HP rating.
- H. Verify the exact location of all motor locations and point of conduit entrance prior to rough-in.

- I. Provide complete in place ready for operation motor starters, for all motors as required.
- J. Provide non-fused heavy duty 600 volt disconnect means for each motor at each motor location. Provide disconnect means installed adjacent to the respective motor starter where non combination type motor starters are used. Provide fusible combination type motor starters when more than one starter is connected to a motor circuit. Provide non-fusible when only one starter is connected to a motor circuit.
- K. Provide non-fusible disconnect switches at each motor location for all three phase motors and single phase 120 volt disconnect means for all 120 volt single phase motors.
- L. Motor starters shall include the necessary instantaneous sensing elements of proper rating for each motor served-based on nameplate amperes, loading and duty cycle, and ambient temperature. Contractor shall field survey each motor nameplate and provide sensing elements accordingly. Submit typewritten certifications.
- M. Control circuits for starters shall operate at 120 volts and shall be grounded and wired such that a ground fault will neither cause false starting nor sustain operation. Such grounding connection shall be provided by the starter manufacturer.
- N. Provide fractional horsepower manual starters for all single phase motors not requiring interlocking with HVAC system. Where interlocking is required contractor shall furnish and install magnetic starter with hand-off auto and two (2) sets of convertible auxiliary contacts. Furnish and install disconnect switch horsepower rated for each single phase magnetic starter. The manual starters shall consist of a manually operated toggle switch equipped with melting alloy type thermal overload relay. Thermal unit shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed. Starters shall be equipped with pilot light. Starters for use in all finished areas shall be of the flush type. Starters in mechanical or electrical equipment rooms shall be of the surface mounted type.
- O. Install motor control equipment in conformance with manufacturer's instructions, wiring diagrams, and drawings.
- P. Install fuses in all fusible switches, and fusible starters.
- Q. Survey and record each motor nameplate data. Select sensing rating for all motor starters to match installed motor nameplate characteristics. Submit motor nameplate data for each motor with solid state sensing unit provided in a columnar format. Each motor shall be identified. Submit typewritten certification, notarized, signed, dated by the manufacturer, contractor and all applicable sub-contractors in (6) three ring binders.
- R. Motor data: provide engraved nameplate for each motor starter identifying motor served.



- S. For all motors provide all wiring, flexible conduits, junction boxes, pull boxes, overcurrent devices, overloads, motor starters, disconnect means, fuses and all final connections complete in place, ready for operation in all respects.

### **3.3 TECHNICAL SERVICES DURING INSTALLATION AND TESTING**

- A. Provide the services of competent, factory-trained engineering services employed by the manufacturers of the across the line motor starters, adjustable frequency drives, and reduced voltage starters for a minimum of one, six hour working day to technically supervise and assist the contractor and participate during all of the adjustments, setting overload sensors, setting circuit breaker instantaneous setting, and testing for the motor starters, wiring circuit breakers, and major auxiliaries. Adjustments and testing shall be made in the presence of the VA Resident Engineer. Provide not less than four weeks prior written notice to the Contracting Officer. Testing date and time shall be at the convenience of the VA.
- B. When the complete motor control system has been installed and prior to the final field observation, test and certify in writing that all motors and motor controllers have been installed and wired per manufacturers instructions, wiring diagrams, installation manuals and are ready for operation. This includes but not necessarily limited to all variable frequency drives, all motors, reduced voltage starters, manual starters, motor starters, and all components of the system have been acceptance tested in the presence of the VA Resident Engineer for proper operation of the individual components; and the complete system has been tested to eliminate electrical and mechanical faults and defects. Provide the services of manufacturer's engineering service group for acceptance testing and written certification. Provide typewritten certifications as specified herein.
- C. Prior to on-site testing, contractor shall submit a testing schedule. The testing schedule shall include but not be limited to the following:
  - 1. Manufacturer's Representatives on site. (Individuals name and company name.)
  - 2. Testing sequence for each major piece of equipment.
  - 3. Test all status and alarm and transmission.
- D. Provide acceptance testing and typewritten certifications as outlined per NETA Acceptance Testing Specifications for motor control centers, motors, motor starters, variable frequency drives and reduced voltage starters and associated overcurrent devices. When any defects are detected, make corrections and repeat all tests at no additional cost to the Government. All testing shall be certified in writing by the contractor and by the manufacturer's engineering services group that the equipment is ready for operation in all respects. All certifications shall be notarized, signed, dated by the contractor, manufacturer, and all applicable sub-contractors.

- E. The following minimum work shall be provided and performed by the Contractor under the technical direction of the manufacturer's service representative.
1. Connect all power wiring and control wiring and verify basic operation of each starter from control power source.
  2. Calibrate any solid-state metering or control relays for their intended purpose and make written notations of adjustments on record drawings. Perform startup of any solid-state starters and adjustable frequency drives.
  3. Inspection and final adjustments.
  4. Operational and functional checks of across the line starters and solid state soft start starters.
  5. Calibrate overload current sensors as per manufacturer's instructions and each motor nameplate data.
  6. The contractor shall provide six (6) typewritten certifications in (3) ring binders with tabs of the manufacturer's engineering services field startup report certifying each motor starter and each variable frequency drive including all connected motors and equipment, overcurrent protection, short circuit protection, overload protection, settings, has been tested, corrected, and retested and is certified ready for operation in all respects. All certifications shall be notarized, signed, dated, by the contractor, manufacturer, and all applicable sub-contractors.
- F. Thermograph all overcurrent devices and motor connections and all motor starters, and adjustable frequency drives, and all motor feeder wiring connections. Provide thermograph testing under load. Minimum loading during thermograph testing shall be a minimum of 50% of bus rating. Submit detailed typewritten report with front end analysis stating potential faults, heating, loose parts or the like. Contractor shall repair or replace any faulty equipment, devices, wiring, workmanship, connections, components, apparatus, at no extra cost to the government.
- G. Provide detailed and complete start-up report in typewritten format, personnel present, time/dates, detailing all aspects of start-up problems, how problems were solved, isometrics, wiring diagrams, detailed instructions, photographs, thermograph, detailed typewritten, photographic, for operation and maintenance. Provide detailed typewritten start-up report in three ring binders. Provide (5) three ring binders with tabs.

### **3.4 INSTRUCTIONS AND TRAINING**

- A. Provide the services of competent, factory-trained motor control engineers, variable frequency drives, programming, status and alarm systems, sensor settings, for one, 6-hour period for instruction personnel in operation and maintenance of the

equipment, on the dates and time requested by the Resident Engineer.

- B. The training classes shall be at on-site locations. The equipment manufacturer shall provide three ring binders detailing operation and maintenance for all systems and equipment provided by the contractor.
- C. Provide detailed operation and maintenance criteria for all equipment components.
- D. Review of each type of starter, components within, control, and power wiring.
- E. Review contactor coil replacement and contact replacement procedures.
- F. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
- G. Provide three-ring binders to participants complete with copies of drawings and other course material covered.
- H. The training shall include a complete working demonstration with simulation of all possible operations which may be encountered. Training shall include any documentation and hands-on exercise necessary to enable electrical operations personnel to assume full operating responsibility after completion of the training period.

### **3.5 CERTIFICATION**

- A. Provide contractor's and manufacturer's typewritten certification certifying that all motor control equipment are ready for operation in all respects including but not limited to overcurrent devices, overload sensing coordinated with each motor nameplate data, controls, resets, variable frequency drives, motor starters, local status and alarm.
- B. Qualified factory-trained manufacturer's engineering services shall certify in writing that all equipment has been installed, adjusted, and tested in accordance with the manufacturer's recommendations, instructions, wiring diagrams, and the contract documents.
- C. Provide six (6) copies of the manufacturer's engineer's certification and test reports before final payment is made.
- D. Certifications shall be provided prior to final observation.
- E. Certifications shall be notarized, signed, and dated by the contractor, manufacturer, and all applicable sub-contractors.

### **3.6 AS-LEFT DEVICE SETTINGS**

- A. Coordinate circuit breaker instantaneous setting, phase loss relays and time/current curves, ground fault time (current) settings and ground fault current pick up settings. Secure copy

of Project 578-313 Electrical Project Phase III Short Circuit and Coordination Study for reference.

- B. The desired settings shall be calibrated and set in the field by an authorized representative of the motor control manufacturer, coordinated with downstream motors and overcurrent devices.

### **3.7 MAINTAIN CONTINUITY OF SERVICE**

- A. Continuity of service shall be maintained for all Building 200 systems at all times during the entire construction period. Provide all required premium overtime in bid proposal. Provide all cutovers from existing equipment to temporary equipment and from temporary equipment to permanent wiring and equipment including but not necessarily limited to motor starters, wiring, panels, transformers, conduits, overcurrent devices during premium overtime, and all final connections for a complete existing to temporary; temporary to permanent electrical installation, ready for operation. All downtime cutover time/date shall be prescheduled with (3) weeks prior written notice.
- B. Maintain continuity of existing feeders from existing Building 226 generators to building essential distribution equipment at all times during the entire construction period. Provide all required temporary services and mobile generators during cutover periods including but not necessarily limited to premium labor time, wiring; conduits; temporary and permanent connections to panels; temporary distribution panels; existing motor control centers; motor starters; panelboards; temporary and permanent splices; and all final connections in order to maintain continuity of service at all times during the entire construction period.
- C. Provide all required temporary feeders and overcurrent protection to panels. Provide all required high compression splices; and make all final connections. All cutovers shall be in place prior to any shutdowns. Remove all temporary wiring and equipment after permanent equipment has been tested, corrected and retested.
- D. Provide all required premium overtime in bid proposal in order to maintain continuity of services at all times for all Building 200 systems during the entire construction period.

### **3.8 FIELD ADJUSTMENTS**

- A. All motor starter current sensors, ground fault, phase loss control, overcurrent devices, relays, overload sensors, circuit breakers shall be set in the field by a qualified representative of the motor control manufacturer. Current sensors shall be coordinated with each motor nameplate. Submit typewritten reports listing each motor nameplate with motor starter VFD, solid state overload current settings. Submit manufacturer's recommended coordination tables.

### **3.9 TESTING AND ADJUSTMENTS TRAINING**

- A. Provide all labor, materials, tools, equipment and services for all testing, adjustments, reports, training of VA personnel,

Operation and Maintenance manuals, test results. Manufacturer's technical engineering services shall perform all start-up testing and provide typewritten certifications stating motor starters and variable frequency drives are ready for operation.

### **3.10 TEMPORARY SERVICES**

- A. Provide all labor, materials, tools, equipment, services for maintaining continuity of services for all building systems by providing temporary feeders and branch circuits for temporary heating, lighting, cubicle heaters, receptacles, life safety devices, all required wiring, conduits, panelboards, motor starters, control devices, as required. Provide all required wiring, conduits, transformers, panelboards, overcurrent devices, motor starters, safety switches, support structures, barricades, warning lights, boxes, fittings and all final connections for a complete temporary service for maintaining continuity of services as required for all heating requirements, lighting, receptacles, tools, equipment and services.
- B. Maintain continuity of services for all building systems by providing temporary service or mobile generator. Temporary service may be obtained from the nearest available power source subject to the approval of the VA Resident Engineer and the Contracting Officer. Contractor shall provide all labor, materials, tools, equipment and services required. All temporary labor, equipment and material, and premium time costs shall be included in contractor's bid proposal.

### **3.11 MISCELLANEOUS WIRING:**

- A. Unless otherwise indicated on plans all 120 volt, single phase motors 1/3 HP and larger are to be placed on separate circuits.
- B. All interlock wiring and control wiring in connection with supply fans, pumps, etc., will be done under another Division of this specification.
- C. All vertical drops in open spaces shall be rigidly supported at top and bottom of drop. Where vertical drops are longer than 10 feet, they shall have at least one intermediate support.

### **3.12 MOTOR CONNECTIONS:**

- A. Furnish and install power wiring for all motors, fans, pumps, etc., and their associated control equipment furnished by other applicable subcontractors. Review plumbing, fire protection, mechanical HVAC contract documents for all motor locations. Final connections to all motors to be made with liquid-tight flexible metallic conduit with grounding conductor. Power wiring includes feeder from distribution panel to disconnect, from disconnect to motor starter and feeder from motor starter to disconnect and from disconnect to motor. Provide sufficient slack in final connections to allow for minor repositioning of motor mount.

### 3.13 IDENTIFICATION

- A. Provide engraved nameplate for each motor starter, variable frequency drive and each disconnect means.
- B. Provide circuit identification on the inside cover of each motor starter, variable frequency drive, and each disconnect means. Identification shall clearly indicate power source identification to each motor starter, variable frequency drive, and each disconnect means (i.e. from CMCC-PHB-#12). Identification shall be computer generated, typewritten sticker type 3" high x 4" wide white background with black lettering.

- - - END - - -

**SECTION 16160**  
**PANELBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of panelboards.

**1.2 RELATED WORK**

- A. Section 09900, PAINTING: Identification and painting of panelboards.
- B. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL): General electrical requirements and items that are common to more than one Section of Division 16.
- C. Section 16111, CONDUITS: Conduits and outlet boxes.
- D. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW): Cables and wiring.
- E. Section 16450, GROUNDING: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

**1.3 SUBMITTALS**

- A. Submit in accordance with section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- 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, wiring diagrams and accessories.
  - 3. Complete nameplate data including manufacturer's name and catalog number.
- C. Certification: Two weeks prior to final inspection, submit four copies of the following to the Resident Engineer:  
Certification that the material is in accordance with the drawings and specifications, has been properly installed, and that the loads are balanced. All certifications shall be notarized, signed, dated by the manufacturer, the contractor and applicable sub-contractors.

#### **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. Underwriters Laboratories, Inc. (UL):
  - No. 50-1995 . . . Enclosures for Electrical Equipment
  - No. 67-1993 . . . Panel boards
  - No. 489-1991 . . . Molded Case Circuit Breakers and Circuit Breaker enclosures
- C. National Fire Protection Association (NFPA):
  - No. 70-2002 . . . National Electrical Code (NEC)
- D. National Electrical Manufacturers Association (NEMA):
  - No. PB-1-2002 . . . Panelboards
  - No. AB-3-1996 . . . Molded Case Circuit Breakers and Their Application

#### **1.5 MANUFACTURER**

- A. Cutler Hammer to match existing electrical equipment provided under electrical phases I, II, III, IV, V, VI.

#### **1.6. GUARANTEE**

- A. Panelboards and distribution panels shall be guaranteed for two years from date of final acceptance for all labor, materials, tools, equipment, and services at the job site when field tested and certified by manufacturer's engineering services.
- B. Transient voltage surge suppressor shall be provided with a 10 year warranty as specified herein.

### **PART 2 - PRODUCTS**

#### **2.1 LIGHTING AND APPLIANCE PANELS AND DISTRIBUTION PANELS**

- A. Shall be in accordance with UL, NEMA, NEC, and as shown on the drawings.
- B. Shall be standard manufactured products. All components of the panelboards shall be the product and assembly of the same manufacturer. All similar units of all panelboards to be of the same manufacturer.
- C. Shall be dead front safety type. Arrange sections for easy removal without disturbing other sections.



- D. Shall be completely factory assembled with molded case circuit breakers.
- E. 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. Shall have the following features as a minimum:
  - 1. Nonreduced size copper bus bars, rated at 1000 amperes per square inch and connection straps bolted together and rigidly supported on molded insulators. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of branch circuit devices.
  - 2. Distribution Panels. Provide full size neutral bar, mounted on insulated supports.
  - 3. Lighting and appliance panelboards, provide 200 percent rated neutral bus.
  - 4. Buses braced for the available short circuit current, but not less than 22,000 amperes symmetrical for 120/208 volt and 120/240 volt panelboards, and 25,000 amperes symmetrical for 277/480 volt panelboards.
  - 5. All breakers and phase bus connections shall be arranged so that it will be possible to substitute a 2-pole breaker for two single pole breakers, and a 3-pole breaker for three single pole breakers, when trip is 30 amps or less and frame size is 100 amperes or less, without having to drill and tap the main bus bars at bus straps.
  - 6. Design interior so that protective devices can be replaced without removing adjacent units, main bus connectors, and without drilling or tapping. Panel phase bus connections to protective devices shall not be riveted to the panel bus and shall be field removable by means of a screw driver.
  - 7. Where designated on schedules as "space", include all necessary bussing, device support and connections. Provide blank cover for each space.
  - 8. In two section panelboards, the main bus in each section shall be full size. The first section with main lugs only shall be furnished with subfeed lugs on the line side with cable connections to the second section. The first section with main breaker shall be furnished with through feed lugs and cables to the second section. Panelboard sections with tapped bus or crossover bus are not acceptable.
  - 9. Series rated panelboards not acceptable.
  - 10. Panel main lugs only, sub-feed lugs overcurrent device cable lugs shall be UL approved for 75 degree centigrade and shall be copper only. AL/CU lugs not acceptable.

11. Terminals shall be UL listed for 75 degree centigrade wiring.
12. Circuits in 4-wire panelboards shall be sequence-phased. Thus: Circuits #1, #3 and #5 shall be connected to Phase A, B and C respectively, etc.
13. Provide UL listed wiring gutters.
14. Each circuit breaker (excluding main breakers), shall be numbered (white numerals on black background) corresponding to typewritten panelboard directory. Do not provide branch circuit breaker numbers for main breakers.
15. Panels shall be dead front with bolt-on type circuit breakers.
16. Where designated on panel schedule as "space" include all necessary bussing, device support and connections. Provide blank cover for each space.
17. Typewritten directories shall be computer generated and shall be provided in all panelboards and distribution panels. Provide CD-Rom to the Resident Engineer.
18. Provide engraved nameplates with one-quarter inch lettering indicating panel designation.
19. Main breakers shall only be mounted in an individual panel space at the top of the panel or at the bottom of panel depending on feeder entry. Main breakers mounted in branch breaker spaces 1-3-5, 2-4-6, 37-39-41, 38-40-42 are not acceptable.
20. All new panels shall be factory equipped with an equipment ground bus. Each ground bus shall be bonded to the panel enclosure per UL standards. Each ground bus shall be copper not less than 1/4-inch thick, drilled and tapped not smaller than 1/4-inch x 20 machine screws and sized to accommodate all conductors to be connected plus spare breakers specified. Each conductor shall be connected by a separate 1/4 x 20 hex nut non-slotted machine bolt. Provide terminations for feeder equipment grounding conductor.
21. Lighting and appliance panels phase bus shall not extend beyond the 42 poles limitation per panel or shall not extend beyond 42 poles limitation for each multi-panel section.
22. Riveted bus work to cross branch bus not acceptable.
23. Lighting and appliance panels shall not extend beyond 42 circuit breaker poles (excluding main breaker) under any circumstances.

## **2.2 CABINETS AND TRIMS (INCLUDES LIGHTING AND APPLIANCE PANELS AND DISTRIBUTION PANELS)**

### **A. Cabinets:**

1. Provide galvanized steel cabinets to house panelboards. Cabinets for outdoor panels shall be factory primed and suitably treated with a corrosion-resisting paint finish meeting UL standard for outdoor applications.
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.
4. Provide minimum of four interior mounted studs and necessary hardware for "in" and "out" adjustment of panel interior.
5. Cabinets for two section panelboards shall be arranged side by side, and shall be the same height. Flush mounted cabinets should be 38 mm (1-1/2 inches) apart and coupled by conduit nipple.
6. Gutter size in panel boxes, on all sides, shall be in accordance with the NEC and UL. Cabinets containing through feeders shall have the gutter space increased by the amount required for auxiliary gutters in the NEC. Penetrations through gutter to live area of the panelboard shall incorporate approved non-metallic-grommet type of insulation to protect wire passing through.
7. All appliance panels and distribution panels shall be provided with doors and key locks. Key to existing key system.

### **B. Trims:**

1. Fabricate trim of sheet steel consisting of frame with door attached by concealed hinges. Provide flush or surface trim as shown on the drawings.
2. Flush trims shall overlap the box by at least 19 mm (3/4-inch) all around.
3. Surface trim shall have the same width and height as the box.
4. Flush or surface trims shall not have ventilating openings.
5. Secure trims to back boxes by indicating trim clamps.
6. Provide a welded angle on rear of trim to support and align trim to cabinet.

7. Provide separate trims for each section of multiple section panelboards. Trims and doors of sections shall be of the same height.

C. Doors:

1. Provide doors with flush type latch and manufacturer's standard lock. Doors over 1200 mm (48 inches) in height shall have a vault handle and a three-point catch, arranged to fasten door at top, bottom, and center.
2. In making switching devices accessible, doors shall not uncover any live parts.
3. Provide concealed butt hinges welded to the doors and trims.
4. For magnetic contactors incorporated in panelboards, provide separate doors for the contactors.
5. Provide keyed alike system for all panelboards. In existing buildings where new panels are installed, provide keyed alike locks as directed by Resident Engineer.
6. Provide computer generated directory for each panelboard. Provide (2) hardcopies and (2) CD-Rom diskette to VA Resident Engineer in format required by VA Resident Engineer. Permanently mount holders on inside of doors.

D. Painting:

1. Thoroughly clean and paint trims and doors at the factory with primer and manufacturer's standard finish.

**2.3 MOLDED CASE CIRCUIT BREAKERS FOR PANELBOARDS**

- A. Breakers shall be UL listed and labeled, in accordance with the NEC, as shown on the drawings, and as specified.
- B. Circuit breakers shall be bolt on type.
  1. Molded case circuit breakers for lighting and appliance branch circuit panelboards shall have minimum interrupting rating as indicated but not less than:
    - a. 120/208 Volt Panelboard: 22,000 amperes symmetrical.
    - b. 120/240 Volt Panelboard: 22,000 amperes symmetrical.
    - c. 277/480 Volt Panelboard: 25,000 amperes symmetrical.
  2. Molded case circuit breakers for Distribution Panels shall have minimum interrupting ratings indicated but not less than:
    - a. 120/208 volt - 65,000 Amperes symmetrical minimum
    - b. 277/480 volt - 65,000 Amperes symmetrical minimum

3. Molded case circuit breakers for lighting and appliance panels shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less.
- C. 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.
    - a. Line connections shall be bolted.
    - b. Interrupting rating shall not be less than the maximum short circuit current available at the line terminals as indicated on the contract documents.
  8. An overload on one pole of a multipole breaker shall automatically cause all the poles of the breaker to open.
  9. For circuit breakers being added to existing panelboards, coordinate the breaker type with existing panelboards. Modify the panel directory as specified herein.

#### **2.4 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 suitable for the environmental conditions where the breakers are being installed.
  1. Indoor dry locations - NEMA 1
  2. Indoor wet locations - NEMA 4X
  3. Outdoor locations - NEMA 4X

## 2.5 DISTRIBUTION PANELS - CIRCUIT BREAKER TYPE

- A. All distribution panels shall be equipped with bolt-on overcurrent devices. Panels shall be provided with molded case circuit breakers.
- B. Molded case circuit breakers shall provide circuit overcurrent protection with inverse time and instantaneous tripping characteristics.
- C. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- D. Circuit breakers 400-ampere frame and below shall be equipped with thermal-magnetic trip units, and inverse time-current characteristics with interchangeable trip units.
- E. Circuit breakers 600-ampere through 1200-ampere frame shall be with microprocessor-based RMS sensing adjustable trip units.
  - 1. Each circuit breaker microprocessor-based tripping system shall consist of three (3) current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing current protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time-delay settings are reached.
  - 2. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed type. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
  - 3. System coordination shall be provided by the following microprocessor-based time-current curve shaping adjustments:
    - a. Programmable long-time setting
    - b. Programmable long-time delay with selectable  $I^2t$  or  $I^4t$  curve shaping
    - c. Programmable short-time setting (dependent on long-time setting)
    - d. Programmable short-time delay with selectable flat or  $I^2t$  curve shaping
    - e. Programmable instantaneous setting

4. The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.
  5. When the instantaneous setting has been selected, a selectable discriminator circuit shall be provided to prevent the breaker being closed and latched on to a faulted circuit..
  6. The trip unit shall have an information system that utilizes battery backed-up LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A trip reset button shall be provided to turn off the LED indication after an automatic trip. A test push-button shall energize an LED to indicate battery status.
  7. A red LED shall be provided on the face of the trip unit and pre-set to flash on and off when an adjustable high-load level is exceeded. A time-delay shall be provided to avoid nuisance alarms. The microprocessor-based trip units shall be capable of monitoring the following data:
    - a. Instantaneous value of phase, neutral and ground current.
    - b. Minimum and maximum current values.
    - c. Average demand current.
    - d. System diagnostic information such as alarms and cause of trip.
    - e. Approximate level of fault current that initiated an automatic trip operation.
  8. The monitored data shall be displayed by a hand-held programmer, a breaker interface module or a remote computer. Provide the VA Resident Engineer (one) hand held programmer with carrying case.
  9. The trip unit shall contain test capability. Testing shall be carried out by using a hand-held programmers, a breaker interface module or a remote computer to select the values of test current within a range of available settings. The basic protection functions shall not be affected during test operations. The breaker may be tested in either the "Trip" or "No Trip" test mode. Provide (2) auxiliary power modules to allow the breaker trip unit to be tested with a 120-volt external power source.
  10. The trip unit shall have provisions for future communications with the existing EMCS and MA&P systems. Communications shall be accomplished with the addition of a communications kit.
- F. Provide spare interchangeable trip units for breakers 400A and below. Provide (2) sets of each of the following spare trip units in original cartons properly labeled.

- a. 70A
  - b. 100A
  - c. 50A
  - d. 30A
  - e. 20A
- G. Rating Plugs. Provide spare interchangeable rating plugs for breakers 600A and above. Provide two spare interchangeable rating plugs for each rating from 600A to 1200A.
- H. Provide (one) hand held programmer and (one) auxiliary power module.

## **2.6 TRANSIENT VOLTAGE SURGE SUPPRESSION**

- A. General:  
Provide all required labor, materials, tools, equipment for providing transient voltage surge suppression (TVSS) integral in all panels, as specified, in conformance to manufacturer's written instructions, wiring diagrams and in conformance to applicable codes. Provide circuit breaker disconnect means for TVSS in the panel.
- B. Manufacturer's engineering services shall provide written certification certifying that each TVSS has been installed in compliance with the manufacturer's written instructions and the applicable National Electric code after all testing, correcting and retesting and certified ready for operation in all respects.
- C. Integral Surge Suppressor:
- 1. SPD (Surge Protective Devices) shall be Component Recognized and listed in accordance with UL 1449 Second Edition to include Section 37.3 highest fault category testing on devices intended for service entrance use. SPD shall also be UL 1283 listed.
  - 2. SPD shall be UL 67 listed, installed by and shipped from the electrical distribution equipment manufacturer's factory.
  - 3. SPD shall provide surge current diversion paths for all modes of protection; L-N, L-G, N-G, in WYE systems, and L-L, L-G in DELTA systems.
  - 4. Manufacturer shall be ISO 9001 or 9002 certified.
  - 5. Manufacturer of SPD shall be the same manufacturer as the panelboards.
  - 6. SPD shall be modular in design. Each mode shall be fused with a 200kAIC, UL recognized surge rated fuse and incorporate a thermal cutout device.
  - 7. SPD shall be integrally mounted to the bus bars of the switchboard.



8. Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm. An alarm push to test switch shall be provided as well.
9. SPD shall meet or exceed the following criteria:
  - a. Minimum total surge current and withstand capability with compliance to ANSI/IEEE C62.41 and NEMA LS1:
    - 1) Panelboards 120KA per phase
    - 2) 60KA per mode
    - 3) Surge withstand capabilities per ANSI/IEEE C3 wave (10KA) 9,000A
  - b. UL 1449 Second Edition Listed and Recognized Component Suppression Voltage Ratings (SVR's) for Service Entrance and Distribution Location equipment shall not exceed the following:
 

VOLTAGE	L-N	L-G	N-G	L-L
280Y/120	330V	330V	330V	700V
10. SPD shall have a minimum EMI/RFI filtering of -50Db at 100 kHz with an insertion ration of 50:1 using MIL-STD-220A methodology.
11. SPD shall be provided with 1 set of NO/NC dry contacts.
12. SPD shall have a warranty for a minimum period of ten years from date of final acceptance; incorporating unlimited replacements of suppressor parts if they are destroyed by transients during the warranty period. Warranty shall be the responsibility of the manufacturer and shall be supported by their respective field service engineering division.
  - a. Manufacturer shall provide a full 10 year warranty from date of final acceptance against any TVSS part failure when installed in compliance with manufacturer's written instructions and applicable National Electric Code.
  - b. Provide all required labor, materials, tools, equipment, services, lodging, meals and miscellaneous expenses. Manufacturer's engineering services shall provide a written certification ready for operation.
13. Maximum Continuous Operating Voltage (MCOV) - The MCOV shall be greater than 115% of the nominal system operating voltage.
14. TVSS Design
  - a. Balanced Suppression Platform - The surge current shall be equally distributed to all MOV components to

ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating TVSS modules which do not provide a balanced impedance path to each MOV shall not be acceptable.

- b. Electrical Noise Filter - Each unit shall include a high-performance EMR/RFI noise rejection filter. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283. Products not able to demonstrate noise attenuation of 55 dB at 100 kHz shall be rejected.
- c. Extended Range Filter - The Surge Protective Device shall have a High Frequency Extended Range Tracking filter in each Line to Neutral mode with compliance to UL 1283. The filter shall have published high frequency attenuation rating in the attenuation frequencies.

Attenuation Frequency	50kHz	100kHz	150kHz	1MHz	10MHz	100MHz
Insertion Loss (ratio)	56-1	562-1	89-1	631-1	501-1	282-1
Insertion Loss (dB)	35	55	39	56	54	49

- d. Internal Connections - No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
- e. Safety and Diagnostic Monitoring - Each unit shall be equipped with 200 kAIC internal fuses. Each unit shall provide the following three levels of monitoring:
  - 1) Continuous monitoring of fusing system.
  - 2) Internal infrared sensor system for monitoring individual MOVs (including neutral to ground). The system must be capable of identifying open circuit failures not monitored by conventional fusing systems.
  - 3) Thermal detection circuit shall monitor for overheating in all modes due to thermal runaway.
  - 4) A green/red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged. Fault detection will activate a flashing trouble

light. Units which can not detect open-circuit damage, thermal conditions and overcurrent will not be accepted.

- f. The unit must be equipped with transient event counter.
- g. Audible alarm actuated upon detection of fault condition.
- h. Remote Status Monitor - The TVSS device shall include form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three monitoring systems described detect a fault condition.
- i. Push-To-Test Feature - Each suppression unit shall incorporate an integral test feature which verifies the operational integrity of the unit's monitoring system.
- j. Minimum Repetitive Surge Current Capability as per ANSI/IEEE C62.41 and ANSI/IEEE C62.45 - 1992 suppression filter system must be repetitive surge tested in every mode utilizing a 1.2 x 50usec, 20kV open circuit voltage, 8 x 20usec, 10kA short circuit current Category C3 bi-wave at one minute interval without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current.  
Branch Location Panelboard: 9,000 impulse per mode.

15. Panelboard Requirements

- a. The TVSS equipment shall be installed in distribution panels and branch panels. The TVSS units shall be tested to demonstrate suitability for ANSI/IEE C62.41 Category C1 environments.
- b. Withstand - Each unit must be capable of surviving more than 2500 category C1 transients without failure or degradation of UL 1449 Suppression Voltage Rating.
- c. A direct bus bar connection shall be used to mount the TVSS component to the panelboard bus bar disconnect to reduce the impedance of the shunt path.
- d. The TVSS equipment shall be mounted within the panelboard by the manufacturer of the panelboard at the manufacturer's factory.

16. TVSS units shall be UL labeled and listed.

17. Provide three pole breaker in each respective panel with overcurrent device rating compatible with TVSS manufacturer's recommendations to disconnect TVSS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation shall be in accordance with NEC, and per manufacturer's instructions and diagrams.
- B. Locate panelboards so that the present and future conduits can be conveniently connected. Coordinate the sizes of cabinets with designated closet space.
- C. In accordance with section PAINTING, paint the panelboard system voltage, and feeder sizes as shown on the riser diagram in 1 inch block lettering on the inside cover of the cabinet door. Paint the words "LIFE SAFETY BRANCH", "CRITICAL BRANCH", or "EQUIPMENT SYSTEM" as applicable and the panel designation in one inch block letters on the outside of the cabinet doors.
- D. Install a typewritten schedule of circuits in each panelboard. Directories shall be computer generated typed on the panel directory cards and installed in the appropriate panelboards, incorporating all applicable contract changes pertaining to that schedule. Include the room numbers and items served on the cards. Circuit breakers shall be numbered corresponding to the directory. Provide (2) hard copies and (2) CD-Rom diskette with panel directories for all panels to the VA Resident Engineer.
- E. Provide engraved nameplate for all panels.
- F. Mount the panelboard so that maximum height of the top circuit breaker above finished floor shall not exceed 1980 mm (78 inches). For panelboards which are too high, mount panelboard so that the bottom of the cabinets will not be less than 150 mm (6 inches) above the finished floor.
- G. For panelboards located in areas accessible to the public, paint the exposed surfaces of the trims, doors, and boxes with finishes to match surrounding surfaces after the panelboards have been installed.
- H. Circuit numbers indicated on the drawings are shown for the purpose of clarifying the grouping of circuits. The actual number assigned to the circuit in the panelboard shall suit the bussing and branch circuiting of the panel. Provide Resident Engineer as-built drawings showing the actual circuit numbers being used for each device on each branch circuit.
- I. Where new panels are to be installed in existing backboxes, backboxes shall have rust and scale removed from inside. Paint inside of backboxes with rust preventive paint before the new panel interior is installed. Provide new trim and doors for these panels. New buswork, matte, trim, door mounting arrangement shall be compatible with existing panelboard enclosure.
- J. On the inside of the door of each panel provide 3"H x 4"W computer generated sticker identification stating source of power supply to the panel (**i.e. Panel "L-ICU-A Fed from Panel ICU-E1"**).

### **3.2 START-UP SERVICES**

- A. Provide warning/caution label within each panel to disconnect TVSS unit prior to performing megger testing. Measure, using a megger, the insulation resistance of each bus section phase-to-phase and phase-to-ground for one minute each, at minimum test voltage of 1000 volts DC; minimum acceptable value for insulation resistance is 1 MEGOHM. Provide additional field testing in conformance with IEEE, NEMA, NETA standards. Include Phase Sequence Rotation Testing.
- B. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.
- C. Thermograph the new panels bus connections, circuit breaker connections, all bolted connections under load. Minimum loading during thermograph testing shall be a minimum of 50% of bus rating. Submit detailed report with front end analysis stating potential faults, heating, loose parts or the like. Contractor shall repair or replace any faulty buswork, connections, bus details at no extra cost to the government. Thermograph shall be performed by manufacturer's engineering service. Provide detailed typewritten certified report.

### **3.3 CERTIFICATION**

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted, tested and certified ready for operation in accordance with the manufacturer's recommendations and contract documents.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification and test reports before final payment is made.
- C. All certifications shall be notarized, dated, signed by the manufacturer, the contractor and applicable sub-contractor.

### **3.4 SAFETY INSULATED MATS**

Provide 1000V minimum safety insulated mats for all panels, whenever front matte, trim, covers are removed, energized or de-energized. This includes without exception any distribution panel, panelboard, pullboxes and junction boxes, disconnect switches, with exposed energized or de-energized elements including but not limited to circuit breakers, cable lugs, buswork, wiring of any rating, any voltage classification, exposed switches, breaker cable lugs, and any equipment or wiring, without the benefit of approved coverplates, panel covers, mats, trims and the like. Provide danger safety warning signs at all panels, and junction boxes, switches, etc. and on all door entries to electric rooms and electric closets without exception.

### **3.5 TRANSIENT VOLTAGE SURGE SUPPRESSORS**

- A. TVSS manufacturer's engineering services and the contractor shall provide written certification certifying that each TVSS is ready for operation in conformance to manufacturer's instructions and installation manuals.
- B. All certifications shall be notarized, dated, signed by the manufacturer, the contractor and applicable sub-contractor.

### **3.6 MAINTAIN CONTINUITY OF SERVICE**

- A. Continuity of service shall be maintained for all systems at all times during the entire construction period. Provide all required wiring, conduits, temporary electrical equipment, cutovers during premium overtime periods, and all final connections for a complete installation, certified ready for operation.
- B. Include all required premium overtime in bid proposal in order to maintain continuity of services at all times for all buildings during the entire construction period. Date and time of day of cutovers and downtime shall be at the convenience of the VA.

### **3.7 EXISTING PANELS TO REMAIN**

- A. Existing panels C-1A, CL-1A, PL-1A and existing transformers to remain.
- B. Provide new panelboard computer generated panel directories for all existing branch circuits deleted; all for existing branch circuits to remain; for all new circuits added. Trace existing circuits to remain with electronic finder.
- C. Install a computer generated typewritten schedule of circuits in each panelboard. Directories shall be computer generated type on the panel directory cards and installed in the appropriate panelboards, incorporating all applicable contract changes pertaining to that schedule. Include the room numbers and items served on the cards. Circuit breakers shall be numbered corresponding to the directory. Provide (2) hard copies and (2) CD-Rom diskette with panel directories for all panels to the VA Resident Engineer.

- - - E N D - - -

**SECTION 16170**  
**DISCONNECT SWITCHES (MOTOR AND CIRCUIT)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. General electrical requirements and items that are common to more than one section of Division 16: Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- B. Conduits for cables and wiring: Section 16111, CONDUIT SYSTEMS.
- C. Cables and wiring: Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW).
- D. Requirements for personnel safety and to provide a low impedance path for possible ground faults: Section 16450, GROUNDING.

**1.3 SUBMITTALS**

Submit in accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).

- A. Shop Drawings:
  - 1. Include sufficient information, clearly presented, to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, enclosure types, fuse type and class.
  - 3. Show the specific switch and fuse proposed for each specific piece of equipment or circuit.
- B. 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. Identify terminals on wiring diagrams to facilitate maintenance and operation.
  - 3. Wiring diagrams shall indicate internal wiring and any interlocking.

- C. Certification: Two weeks prior to final inspection, deliver to the Resident Engineer four copies of the certification that the equipment has been properly installed, adjusted, and tested.

#### **1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - KS 1-96 . . . . . Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
- C. National Fire Protection Association (NFPA):
  - 70-99 . . . . . National Electrical Code (NEC)
- D. Underwriters Laboratories, Inc. (UL):
  - 98-94 . . . . . Enclosed and Dead-Front Switches
  - 198C-86 . . . . . High-Interrupting-Capacity Fuses, Current Limiting Types
  - 198E-88 . . . . . Class R Fuses
  - 977-94 . . . . . Fused Power-Circuit Devices

#### **1.5 WARRANTY**

- A. All disconnect switches shall be warranted for two years for all labor, materials, tools, equipment and services at the jobsite for two years from date of final acceptance.

### **PART 2 - PRODUCTS**

#### **2.1 LOW VOLTAGE FUSIBLE SWITCHES RATED 600 AMPERES AND LESS**

- A. Shall be quick-make, quick-break type in accordance with UL 98, NEMA KS 1 and NEC.
- B. Shall be 600 volts horsepower rated.
- C. 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 shall have lock-open padlocking provisions.



5. Mechanical interlock shall permit opening of the door only when the switch is in the OFF position, defeatable by a special tool 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: One 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 which are most suitable for the environmental conditions where the switches are being installed.
  - c. Shall be finished with manufacturer's standard gray baked enamel paint over pretreated steel (for the type of enclosure required).
- D. Low Voltage Fusible Switches shall be NEMA classification Heavy Duty (HD). These switches shall be horsepower rated to match or exceed motor nameplate horsepower.
- E. Furnish switches completely fused. Furnish a complete set of spare fuses for each switch being installed. Provide additional sets of spare fuses to constitute not less than two complete sets for the type, size, and rating of each set installed. Deliver the fuses to the Resident Engineer prior to the final inspection.

## **2.2 LOW VOLTAGE NONFUSED SWITCHES RATED 600 VOLTS**

Shall be the same as Low Voltage Fusible Switches Rated 600 volts, except it shall not accept fuses.

## **2.3 MOTOR RATED TOGGLE SWITCHES**

Refer to Section 16155 for motor rated toggle switches.

## **2.4 IDENTIFICATION**

- A. Install identification nameplates on each disconnect switch to identify the equipment controlled.
- B. Nameplate 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.
- C. Provide circuit identification on the inside cover of each disconnect means. Identification shall clearly indicate power source (i.e. from panel PD-3). Identification shall be sticker type 3"H x 4"W; white background; black lettering.

- 2.5 Fuses shall be current limiting, time delay, with rejection type fuse clips, 2000,000A RMS symmetrical rating equal to Bussmann Low Peak for 600A less and equal to Bussmann KRPC Hi-Cap for above 600A

### **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.

#### **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.

#### **3.3 THERMOGRAPH**

- A. Thermograph the new disconnect switch cable connections, under load. Minimum loading during thermograph testing shall be a minimum of 50% of bus rating. Submit detailed report with front end analysis stating potential faults, heating, loose parts or the like. Contractor shall repair or replace any faulty, connections, at no extra cost to the government. Thermograph shall be performed by manufacturer's engineering service. Provide detailed typewritten certified report.

#### **3.4 CERTIFICATIONS**

- A. Provide typewritten certifications stating the disconnect switches have been furnished, installed, wired per applicable codes, and the contract documents are certified ready for operation in all respects.
- B. Certification shall be notarized, signed, dated by the manufacturer, the contractor and applicable sub-contractor.

- - - E N D - - -

**SECTION 16450**  
**GROUNDING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies general grounding and bonding requirements of electrical installations for personnel safety and 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 including made, supplementary, lightning protection system and 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 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL): General electrical requirements and items that are common to more than one section of Division 16.
- B. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW): Low Voltage power and lighting wiring.
- C. Section 16685, PATIENT WALL SYSTEMS
- D. Section 16460, TRANSFORMERS (GENERAL PURPOSE)
- E. Section 16140, WIRING DEVICES
- F. Section 16111, CONDUIT SYSTEM
- G. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW)
- H. Section 16510, LIGHTING

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- 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. National Fire Protection Association (NFPA):
- 70-2002 . . . . . National Electrical Code (NEC)
- 99-2002 . . . . . Health Care Facilities
- B. Underwriters Laboratories, Inc. (UL):
- 44-1999 . . . . . Thermoset-Insulated Wires and Cables
- 83-1998 . . . . . Thermoplastic-Insulated Wires and Cables
- 467-1993 . . . . . Grounding and Bonding Equipment
- 486A-2000 . . . . . Wire Connectors and Soldering Lugs for Use  
With Copper Conductors
- C. American Society for Testing and Materials (ASTM):
- B1-2001 . . . . . Standard Specification for Hard-Drawn Copper  
Wire
- B8-1999 . . . . . Standard Specification for Concentric-Lay-  
Stranded Copper Conductors, Hard, Medium-Hard,  
or Soft
- D. 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

## **PART 2 - PRODUCTS**

### **2.1 GROUNDING AND BONDING CONDUCTORS**

- A. Equipment grounding conductors shall be UL 83 insulated stranded copper, except that sizes No. 12 AWG and smaller shall be solid copper. Insulation color shall be continuous green for all equipment grounding conductors, except that wire sizes No. 4 AWG and larger shall be identified with green color electrical tape at each termination and in each junction box.
- B. Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes No. 12 AWG and smaller shall be ASTM B1 solid bare copper wire.
- C. All equipment grounding conductors shall be 600 volt type VW-1 XHHW-2 FR-XLPE insulation with a dielectric constant of 3.5 or less, green in color.
- D. Conductor sizes shall not be less than what is shown on the drawings and not less than required by the NEC, whichever is greater.

### **2.2 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).

## **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.
- 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.
- D. Special Grounding: For patient care area electrical power system grounding, conform to Chapter 4, "Electrical Systems", of NFPA 99, and Article 517, "Health Care Facilities" of NFPA 70.

### **3.2 ACCESSIBLE GROUNDING CONNECTIONS**

All grounding connections shall be accessible.

### 3.3 SECONDARY EQUIPMENT AND CIRCUITS

#### A. Distribution Panels:

1. Connect the various feeder equipment grounding conductors to the ground bus in the enclosure with suitable pressure connectors.
2. Connect metallic conduits, which terminate without mechanical connection to the housing, by grounding bushings and grounding conductor to the equipment ground bus.

#### B. Transformers:

1. Separately derived systems (transformers downstream from service equipment): Ground the secondary neutral at the transformer. Provide a grounding electrode conductor from each transformer to Emergency Department main ground bus.

#### C. Conduit Systems:

1. Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
2. 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, power branch circuits 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.
2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
3. Provide ground bus in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.

#### F. Motors and Starters: Provide lugs in motor terminal box and starter housing or motor control center compartment to terminate equipment grounding conductors.

#### G. Receptacles shall not be grounded solely 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.

#### H. Ground lighting fixtures to the equipment grounding conductor of the wiring system. Fixtures connected with flexible conduit shall

have a green ground wire included with the power wires from the fixture through the flexible conduit to the fixture outlet box. Bond to fixture outlet box and to light fixture.

- I. Fixed electrical appliances and equipment shall be provided with a ground lug for termination of the equipment grounding conductor.
- J. Panelboard Bonding: The equipment grounding terminal buses of the normal and essential branch circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not less than No. 6 AWG.

### **3.4 CONDUCTIVE PIPING**

- A. Bond all conductive piping systems, interior and exterior, to the building grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.
- B. In 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 PATIENT CARE AREAS**

- A. Provide equipotential grounding system and bonding of all metallic parts of the electrical system.
- B. Provide equipment grounding conductors installed with circuit or feeder conductors in the same respective conduit system.
- C. Provide for bonding of all metallic parts in the patient vicinity.
- D. Provide reference ground bus in patient head wall system. Provide grounding and bonding all receptacles, medical gases, light fixtures, all metallic parts within the patient vicinity.

### **3.6 TESTING**

- A. Grounding System
  - 1. Perform point to point testing to determine resistance to ground at main building ground bus; existing first floor electrical closet ground bus; Emergency Department ground bus; each patient reference ground bus, each applicable panel ground bus, and major equipment frames, system neutral and derived system neutral/ground points. Test per NFPA99-2002 Edition. Submit detailed typewritten certified report.
- B. Refer to specification Section 16685.
- C. All certifications shall be notarized, signed, dated by the manufacturer of electrical equipment, manufacturer of patient wall systems, the contractor and all applicable sub-contractors.

- - - E N D - - -





**SECTION 16460**  
**TRANSFORMERS (GENERAL PURPOSE)**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

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

**1.2 RELATED WORK**

- A. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL): General electrical requirements and items that are common to more than one section of Division 16.
- B. Section 16111, CONDUITS: Conduits and outlet boxes.
- C. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW): Cables and wiring.
- D. Section 16450, GROUNDING: Requirements for personnel safety and to provide a low impedance path for possible ground fault currents.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical rating, impedance, dimensions, weight, mounting details and materials, 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. Submit, simultaneously with the shop drawings, companion copies of complete operating and maintenance manuals including technical data sheets and wiring diagrams.
  - 2. Two weeks prior to the final inspection, submit four copies of the final updated maintenance and operating manuals, if any changes are necessary, to the Resident Engineer.
- 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 transformers conform to the requirements of the drawings and specifications.
2. Certification that the equipment has been properly installed and tested.
3. Certifications shall be notarized, signed and dated by the contractor, manufacturer and applicable sub-contractors.

#### **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 Fire Protection Association (NEPA):  
70-2002 . . . . . National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA):  
ST 20-1992 . . . Dry-Type Transformers for General Applications

#### **1.5 MANUFACTURER**

- A. Cutler Hammer to match existing transformers provided under electrical phases I, II, III, IV, V, VI.

#### **1.6 GUARANTEE**

- A. Transformers shall be guaranteed for two year from date of final acceptance for all labor, materials, tools, equipment, and services at the job site when field tested and certified by manufacturer's engineering services.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL PURPOSE DRY TYPE TRANSFORMERS**

- B. Unless otherwise specified, dry type transformers shall be in accordance with NEMA, NEC and as shown on the drawings. Transformers shall be UL listed or labeled.
- C. Dry type transformers shall have the following features:
  1. Self-cooled by natural convection, isolating windings, indoor, dry type. Autotransformers shall not be accepted.
  2. Rating and winding connections shall be as shown on the drawings.
  3. Ratings shown on the drawings are for continuous-duty without the use of cooling fans.

4. Insulation systems:
  - a. Transformers 30 KVA and larger: UL rated 220 degree C system having an average maximum rise by resistance of 150 degree C in a maximum ambient of 40 degree C.
  - b. Transformers below 30 KVA: Same as for 30 KVA and larger or UL rated 185 degree C system having an average maximum rise by resistance of 115 degree C in a maximum ambient of 40 degree C.
5. 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, silicon steel.
  - c. Coils shall be continuous windings without splices except for taps.
  - d. Coil loss and core loss shall be optimum for efficient operation.
  - e. Primary and secondary tap connections shall be brazed or pressure type.
  - f. Coil windings shall have end fillers or tie downs for maximum strength.
6. Certified sound levels determined in accordance with NEMA, that do 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

7. Nominal impedance shall be as per NEMA standards.
8. Single phase transformers rated 15 KVA through 25 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All three phase transformers rated 30 KVA and larger shall have two, 2-1/2 percent full capacity taps above normal rated primary voltage, and four, 2-1/2 percent full capacity taps below normal rated primary voltage.
9. Core assemblies shall be grounded to their enclosures by adequate flexible ground straps.

10. Enclosures:
  - a. Not less than code gage steel.
  - b. 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.
  - c. Ventilation openings shall prevent accidental access to live components.
  - d. Thoroughly clean and paint at the factory with manufacturer's prime coat and standard finish.
11. Standard NEMA features and accessories shall be provided including but not limited to ground pad, lifting provisions and nameplate with the wiring diagram and sound level, impedance, tap arrangement, electrical characteristics indicated.
12. Transformer dimensions and configurations shall conform to the spaces designated for their installations.
13. Transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor of 4 without exceeding the rated temperature rise.
14. Transformers shall be provided with electrostatic shielding. An electrostatic shield shall be provided between the primary and secondary winding and shall be factory grounded.
15. Provide integral equipment ground bus bonded to transformer frame for terminating primary and secondary equipment grounding conductors; for grounding and bonding of the neutral conductor; for bonding transformer enclosure; for bonding electrostatic shielding.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Installation shall be in accordance with the NEC, and as per manufacturer's instructions and recommendations.
- B. Install the transformers with adequate clearance at a minimum of 100 mm (4 inches) from wall and adjacent equipment for air circulation to remove the heat produced by transformers.
- C. Install transformers on vibration pads designed to suppress transformer noise and vibrations.
- D. Use flexible metal conduit to contain the conductors from the transformer to the raceway system. Provide grounding conductor in all flexible conduits.

- E. Transformers shall be trapeze platform mounted or wall-mounted. For trapeze mounted transformers, provide all necessary angle irons, rods, channels, supports, hangers for a complete suspended transformer installation
- F. Provide primary and secondary overcurrent protection for all transformers per applicable codes.

### 3.2 TESTING

- A. Dry Type Transformers
  - 1. Compare equipment nameplate data with drawings and specifications.
  - 2. Inspect physical and mechanical condition.
  - 3. Verify that resilient mounts are free and that any shipping brackets have been removed.
  - 4. Perform insulation-resistance test. Calculate polarization index. Measurements shall be made from winding-to-winding and each winding-to-ground. Test voltages and minimum resistance shall be in accordance with applicable tables. Results to be temperature corrected in accordance with applicable tables.
  - 5. Verify that winding turns-ratio measurements and polarities are in accordance with nameplate.
  - 6. Verify that as-left tap connections are proper.
  - 7. Testing per NETA standards. Submit detailed typewritten report.
  - 8. Measure primary and secondary voltages. Adjust transformer taps accordingly. Submit report.
  - 9. Submit certified typewritten report, notarized, signed, dated by the contractor, manufacturer, and all applicable sub-contractors, stating that the transformer installation has been tested and ready for operation in all respects.

- - - E N D - - -

**SECTION 16510**  
**BUILDING LIGHTING, INTERIOR**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of the interior lighting systems.
- B. Provide all labor, materials, tools, equipment, and services, including but not necessarily limited to all light fixtures, light fixture assemblies, louvers, support angles, lamps, lenses, electronic ballasts, conduits, wiring, light switches, fixture supports, channels, hangers, pendants, and all miscellaneous and incidental hardware and final connections for a complete installation ready for operation in conformance with all applicable codes.

**1.2 RELATED WORK**

- A. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL): General requirements that are common to more than one section of Division 16.
- B. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW): Cables and wiring.
- C. Section 16140, WIRING DEVICES: Wiring devices used as part of the lighting systems.
- D. Section 16450, GROUNDING: Requirements for personnel safety and to provide a low impedance path to ground for possible ground fault currents.
- E. Section 16685, PATIENT WALL SYSTEMS

**1.3 QUALITY ASSURANCE**

- A. Refer to Paragraph, QUALIFICATIONS, in Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- B. Refer to Paragraph, GUARANTY, in Section 01001, GENERAL CONDITIONS.

**1.4 SUBMITTALS**

- A. In accordance with Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL), 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, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, lenses, louvers, lamps, and controls.
3. When catalog data and/or shop drawings for fluorescent fixtures are submitted for approval, photometric data from an independent testing laboratory shall be included with the submittal, indicating average brightness and efficiency of the fixture, as specified in specification or as shown on the drawings. Coefficient of utilization data will not be considered a suitable substitute.

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. Typewritten certification by the Contractor that the equipment has been properly installed, adjusted, and tested.
  - b. Include with shop drawings, certification from the manufacturers that all electronic high-frequency ballasts meet the transient protection required by IEEE C62.41, Cat. A. Include with initial shop drawing submittal.
  - c. Certification shall be signed by the manufacturer,, the contractor and applicable sub-contractors.

## 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):

C78.1-91 . . . . . Fluorescent Lamps - Rapid-Start Types -  
Dimensional and Electrical  
Characteristics

- C78.2-91 . . . . . Fluorescent Lamps - Preheat-Start Types  
- Dimensional and Electrical  
Characteristics
- C78.3-91 . . . . . Fluorescent Lamps - Instant Start and  
Cold Cathode Types - Dimensional and  
Electrical Characteristics
- C78.376-91 . . . . . Chromaticity of Fluorescent Lamps  
(ANSI/NEMA C78/376-96)
- C. Certified Ballast Manufacturers Association (CBM):  
Requirements for Ballast Certification.
- D. Institute of Electrical and Electronic Engineers (IEEE):  
C62.41-91 . . . . . Recommended Practice on Surge Voltage in  
Low Voltage AC Power Circuits
- E. National Fire Protection Association (NFPA):  
70-02 . . . . . National Electrical Code (NEC)  
101-00 . . . . . Life Safety Code
- F. 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
- G. Underwriters Laboratories, Inc. (UL):  
496-96 . . . . . Edison-Base Lampholders  
542-99 . . . . . Lampholders, Starters, and Starter  
Holders for Fluorescent Lamps  
924-95 . . . . . Emergency Lighting and Power Equipment  
935-01 . . . . . Fluorescent-Lamp Ballasts  
1598-00 . . . . . Luminaires
- H. Federal Communications Commission (FCC):  
Code of Federal Regulations (CFR), Title 47, Part 18



#### **1.6 LIGHT FIXTURES (GENERAL) :**

- A. The Contractor shall at time fixtures are received at site, unpack and examine all fixtures for condition and cleanliness and shall immediately notify manufacturer, in writing, of any faults.
- B. Lenses and frames shall be cleaned prior to installation. In finished areas, lenses and frames shall not be installed until finished floor covering is installed.
- C. The Contractor shall be fully responsible for ordering recessed fixtures with correct trim to provide exact fit required for the type of ceiling and ceiling support system specified. Before placing order for fixture, contractor shall examine his final approved ceiling shop drawings to verify compatibility between fixtures and ceiling construction.
- D. The finish of each installed lighting fixture shall be uniform in quality and free from defects, such as scratches, holidays, whirls, discolorations, sand and dust spots, cracks, chips, and paint runs.
- E. Wiring channels and wireways shall be free from any projections and any burred rough or otherwise sharp edges. Points or edges over which conductors pass and that may cause damage or wear to the insulation of the conductors shall be fully rounded smooth and provided with bushings, sleeves or other approved means of protecting the insulation of the conductors.
- F. Lighting fixtures shall be completely factory wired by the lighting fixture manufacturer in accordance with the project requirements and shall be furnished to be fully compatible with the project electrical system.
- G. All light fixtures shall be stored in an indoor, dry, heated location.
- H. All light fixtures provided in plenum return ceilings or spaces shall be approved for the purpose; and shall be in conformance to the applicable codes; and shall be UL listed for use in plenum ceilings or spaces.

#### **1.7 GUARANTEE**

- A. Guarantee for all light fixtures shall include all required labor, materials, tools, equipment, and services at the jobsite for one year from date of final acceptance. In addition, fluorescent ballast guarantee shall be as specified herein.
- B. Electronic fluorescent ballast shall be guaranteed for (5) years from date of final acceptance.

## **PART 2 - PRODUCTS**

### **2.1 LIGHTING FIXTURES (LUMINAIRES)**

- A. Shall be in accordance with NFPA 70, UL 1598 and shall be 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. Where lighting fixtures are detailed with minimum 20 gauge housing, minimum 22 gauge housings will be acceptable provided they have strengthening embossed rib and break formations, which give the equivalent rigidity of a 20 gauge housing.
  - 4. 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.
  - 5. Hinged door closure frames shall operate smoothly without binding when the fixture is in the installed position, and 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. Contacts for recessed double contact lampholders and for slimline lampholders shall be silver plated. Lampholders for bi-pin lamps, with the exception of those for "U" type 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. Incandescent: Shall have porcelain enclosures and conform to the applicable requirements of UL 496.
  - 3. High Intensity Discharge (H.I.D.): Shall have porcelain enclosures.
- E. Recessed incandescent fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

- F. Fluorescent fixtures with louvers or light transmitting panels shall have hinges, latches and safety catches to facilitate safe, convenient cleaning and relamping. Vapor tight fixtures shall have pressure clamping devices in lieu of the latches.
- G. 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.
- H. Metal Finishes:
  - 1. The manufacturer shall apply his 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.
  - 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.
- I. Provide all lighting fixtures with a specific means for grounding their metallic wireways and housings to an equipment grounding conductor.
- J. Light Transmitting Components for Fluorescent Fixtures:
  - 1. Shall be 100 percent virgin acrylic plastic or water white, annealed, crystal glass.
  - 2. Flat lens panels shall have not less than 3.2 mm (1/8 inch) 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.
- K. Lighting Fixtures in Hazardous Areas: Fixtures shall be suitable for installation in flammable atmospheres (Class and Group) as defined in NFPA 70 and shall comply with UL 844.
- L. Compact fluorescent fixtures shall be manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Assemblies designed to retrofit incandescent fixtures are prohibited except when specifically indicated for renovation of existing fixtures. Fixtures shall be designed for lamps as specified.

## 2.2 Fluorescent lamp ballasts

- A. Where applicable, fluorescent lamps and ballasts shall comply with the National Energy Policy Act of 1992.
- B. Ballasts shall comply with NEMA 82.1, 82.2 and 82.11, NFPA 70, and UL 935 unless otherwise specified.
- C. Lamp types F32T8 and F32T8/U shall be operated by electronic, high frequency ballasts. Refer to drawings for additional electronic ballast; electronic dimming ballast; and electronic compact fluorescent ballast data and information.
- D. Electronic high-frequency ballasts:
  - 1. Ballasts shall operate the lamps at a frequency between 20 and 60 KHz from an input frequency of 60Hz with no detectable lamp flicker.
  - 2. Ballast package:
    - a. Case marking: Mark the ballast to indicate the required supply voltage, frequency, RMS current, current surge during starting, input watts, and power factor at the design center voltage, open circuit voltage, crest factor and efficacy.
  - 3. Performance:
    - a. Light output:
      - 1) At the design voltage, the light output shall be at least equal to that obtained by a core-and-coil ballasted system meeting ANSI, NEMA and CBM standards. The comparison test shall be measured in the same fixture at 25 degrees C (plus or minus one degree) ambient room temperature.
      - 2) Tests shall be made in fixtures designed only for the number of lamps being tested.
      - 3) For other applications (higher ambients, etc.) the tests should be operated with equivalent lamp wall temperatures plus or minus 4 degrees C.
    - b. Efficacy: The efficacy of the high-frequency, electronically ballasted system shall be at least 15 percent greater than the equivalent CBM core-and-coil ballasted system (see "Light output" above).
    - c. Starting: The ballast shall be capable of starting and maintaining operation of lamps at an ambient temperature of 10 degrees C (50 degree F) or more for

an input voltage of plus or minus 10 percent about the center design voltage unless otherwise indicated.

d. Operation:

- 1) The ballast shall safely and reliably operate in a room ambient temperature from 10 degrees C (50 degree F) to 40 degrees C (105 degree F).
- 2) The light output shall not vary by more than plus or minus 5 percent for a plus or minus 10 percent variation of the input voltage about the center design voltage. Light output shall remain constant for a plus or minus 5 percent variation of the input voltage.
- 3) The ballast shall operate the lamps in a manner that will not adversely curtail the normal life of the lamp.

e. Transient protection: The ballast shall comply with IEEE C62.41, Cat. A.

f. Flicker: The flicker shall be less than 2 percent and without visible flicker.

g. Noise: The audible noise levels should be equivalent to or better than the Class A rating of CBM certified ballasts.

h. Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI): The EMI and RFI limits shall meet the requirements of the Federal Communications Commission Rules and Regulations (CFR 47 Part 18).

i. Rated life: The ballast shall have a rated life of 10 years or 30,000 hours (based on a 10 hour day).

j. The two-lamp ballast shall safely operate two F32T8 RS, 32- watt lamps or two F32T8/U lamps. The three lamp ballast shall safely operate three F32T8 RS, 32- watt lamps.

k. Power factor: Not less than 99 percent.

l. Reliability:

- 1) Labels: Ballasts must be labeled or listed by UL and CBM/ETL.
- 2) Submit, simultaneously with shop drawings, a certified test report by an independent testing laboratory showing that the electronic ballasts meet or exceed all the performance requirements in this specification.

- m. Total harmonic distortion (THD) shall be less than 10 percent.
  - n. All ballasts for fluorescent lamps shall be UL labeled Instant Start high efficiency electronic type. Parallel lamp operation for continuous operation of remaining lamps.
  - o. Instant Start ballast shall be guaranteed for five years for all labor and materials for ballast replacement at the jobsite after date of final acceptance.
  - p. All fluorescent fixture ballasts shall be energy saving for full light output.
  - q. Third harmonic distortion less than 10 percent.
  - r. Lamp current crest factor less than 1.7.
  - s. Instant Start ballast shall comply with applicable ANSI/IEEE standards/guides for harmonic distortion and line voltage transient protection.
  - t. Ballast shall provide normal rated lamp life as stated by lamp manufacturer.
  - u. Ballast shall operate from 60 or 50 Hz input source of +/- 10% nominal ballast line voltage.
- E. Ballasts for lighting fixtures controlled by dimming devices shall be the electronic, high frequency type as specified on the drawings and herein.
  - F. All ballasts serving straight or "U" type lamps shall be mounted by four non-turning studs (or captive bolts) equipped with lock washers and nuts or locking type nuts, or by four thread cutting (TC) sheet metal screws which are firmly secured against the fixture body (or wireway) to maximize dissipation of heat and minimize noise. Exception: electronic high-frequency ballasts may be mounted at a minimum of two points, one at each end of unit.
  - G. 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.
  - H. Where three-lamp fixtures are indicated, unless switching arrangements dictate otherwise, utilize a common three-lamp electronic ballast to operate all three lamps.

## 2.3 LAMPS

- A. Fluorescent Lamps:
  - 1. Rapid start fluorescent lamps shall comply with ANSI C78.1; preheat-start type shall comply with ANSI C78.2; and

instant-start and cold-cathode lamps shall comply with ANSI C78.3.

2. Chromacity of fluorescent lamps shall comply with ANSI C78.376.
3. The lamps shall include the F32T8, F32T8/U 32 watt energy saving type.
4. Except as indicated below, lamps shall be energy saving type, have a color temperature between 3500 and 4100°K, a Color Rendering Index (CRI) of not less than 75, and an initial lumen output not less than 2800. "U" tube lamps shall have the same color temperature and CRI limits as the above.
  - a. In utility areas (Electrical, Communication and Mechanical) Service rooms and closets), maintenance closets and non-medical storage spaces, utilize energy saving light-white lamps.
  - b. Over the beds in Intensive Care, Coronary Care, Recovery, Life Support, and Observation and Treatment areas; Emergency Rooms, Electromyographic, Autopsy (Necropsy), Surgery, corridors, nurses stations, offices, linen rooms, pharmacy, Recovery, Labs, Treatment, and X-Ray) use color corrected lamps having a CRI of 90 or above and a correlated color temperature between 5000 and 6000°K.
  - c. Other areas as indicated on the drawings.
- B. Incandescent lamps shall be the general service, inside frosted type rated 130 volts except where otherwise shown on the drawings.
- C. Compact Fluorescent Lamps: Shall be 4100°K, 10,000 hours average rated life, and as indicated on the drawings.

#### **2.4 RADIO-INTERFERENCE-FREE FLUORESCENT FIXTURES**

- A. Shall be specially designed for suppressing radio-frequency energy produced within the fixtures. The Rules and Regulations of FCC (CFR 47, Part 18) shall apply.
- B. Lenses shall have a light-transparent layer of metal permanently bonded to them, and in positive contact with the steel housing or equal to prevent the radio-frequency interferences from passing through the lenses. The effective light transmittance of the lenses shall be not less than 75 percent.
- C. Install line filters within the body of the fixtures and wired in series with the supply circuit conductors to eliminate the transmission of radio frequency energy into the supply circuit.

## **2.5 X-RAY FILM ILLUMINATORS**

- A. Shall be the high-intensity type, flush-mounted in the walls. Multiples of the basic unit may be combined in a common housing.
- B. Shall have the following features:
  - 1. Fluorescent lighting, designed to provide uniform diffusion of the light.
  - 2. Box dimensions approximately 525 mm (21 inches) high, 350 mm (14 inches) wide and 100 mm (4 inches) deep.
  - 3. Frame shall be satin chrome-plated brass or stainless steel and shall extend approximately 40 mm (1-1/2 inches) from the edges of the box.
  - 4. Viewing glass shall be the heat resistant, borosilicate type or 100 percent virgin acrylic plastic and not less than 3 mm (1/8 inch) thick.
  - 5. Viewing glass shall have adequate dimensions so the films will not overlap the frame and will be positioned with respect to the light source for even illumination without shadows.
  - 6. An ON-OFF switch.
  - 7. Power supply voltage shall be 120 volts, 60 Hz.
  - 8. Provide grounding lug for terminating equipment ground conductor.
- C. Fluorescent lamps shall be the cool-white, rapid-start type.
- D. Ballast shall be low leakage type with leakage not exceeding 30 microamperes.

## **2.6 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 cast or extruded aluminum, or rolled steel.
  - 2. 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. Inscription panels shall be cast or stamped aluminum a minimum of 2.25 mm (0.090 inch) thick, stenciled with 150 mm (6 inch) high letters, baked with red color stable plastic or fiberglass. Lamps shall be luminous red 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; maximum of 3.5 watts for single face and 7 watts for double-faced fixtures that do not use diffuser panels in front of the LEDs. LED exit light fixtures that use diffuser panels shall require a maximum of 1.0 watt per fixture for single or double face fixtures.
2. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
3. 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.

## **2.7 TROFFERS**

- A. Troffers shall be lay-in type, recessed fixtures. Troffers shall be approximately 6 inches deep. Troffer bottoms shall be as called for in the Lighting Fixture Schedule. Provide steel channels for mounting of troffers where required. Install U.L. approved safety clips for securing flush mounted troffers to concealed tee bar system, at a minimum of four points per fixtures in accordance with NEC 410. Fixtures shall be secured in compliance with applicable codes. Light fixtures installed in plenum ceilings or in plenum areas shall be approved for the purpose.

## **2.8 COMPLIANCE:**

- A. All lighting fixtures shall comply with the rules and regulations of the applicable codes. Any material required in connection with the installation of all fixtures in a rigid and efficient manner shall be furnished and installed whether or not same is specifically mentioned herein. All fixtures shall bear Underwriters' Laboratories Label.

## **2.9 RECESSED INCANDESCENT AND FLUORESCENT DOWNLIGHTS:**

- A. Recessed fixtures shall have thermal protection to protect against overheating by insufficient clearance from insulation or other building materials and obstructions and overlamping. All recessed fixtures shall be identified as thermally protected, listed by a recognized testing laboratory and shall be acceptable to the Electrical Inspection Section.

## **2.10 LENSES:**

- A. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fadometer or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years. Minimum thickness shall be .125.

## **2.11 LIGHT FIXTURE GROUNDING**

- A. All light fixtures including x-ray viewers shall be factory equipped with a equipment grounding conductor (green) securely factory bonded to the light fixture metallic enclosure per UL standard. Length of grounding conductor shall be the same normal length as the fixture branch circuit conductors. Equipment grounding conductor shall be installed in the same flexible conduit as the light fixture circuit conductors. Provide all fixtures with flexible conduit complete with N-G conductors prewired and connected to light fixtures, ready for connection to circuit conductors.

## **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. Avoid interference with and provide clearance for equipment. Where the indicated locations for the lighting fixtures conflict with the locations for equipment, change the locations for the lighting fixtures by the minimum distances necessary as approved by the Resident Engineer.
- D. For suspended lighting fixtures, the mounting heights shall provide the clearances between the bottoms of the fixtures and the finished floors as specified on the drawings. '
- E. Fluorescent bed light fixtures shall be attached to the studs in the walls. Attachment to gypsum board only is not acceptable.
- F. 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 minimum.
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 6 mm (1/4 inch) 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 a plaster ceiling at four points spaced near the corners of each fixture. Pre-positioned 1/4 inch 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 toggle bolts may be used on new or existing ceiling provided the plaster and lath can safely support the fixtures without sagging or cracking.
- G. Furnish and install the specified lamps for all lighting fixtures installed and all existing lighting fixtures reinstalled or re-lamped under this project.
- H. Coordinate between the electrical and ceiling trades in advance, 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.
- I. Bond lighting fixtures and metal accessories to the grounding system as specified in Section 16450, GROUNDING.

- J. At completion of project, relamp all fixtures which have failed/burned-out lamps. Clean all fixtures, lenses, diffusers and louvers that have accumulated dust/dirt during construction.
- K. Connect fixtures with code approved flexible conduit from outlet box to fixture. Location of outlet box relative to fixture and length of flexible conduit shall be as specified herein. All outlet boxes shall be equipped with coverplates.
- L. Contractor shall be fully responsible for checking the locations of all ceiling fixtures to verify that such fixtures do not interface with the swing of any ceiling height doors which may be shown on the Architectural Drawings. Any such interference shall be called to the attention of the Contracting Officer's Technical Representative before the ceiling outlet box and conduit are installed. Boxes shall be relocated nearby in a location approved by the Contracting Officer's Technical Representative without any additional cost to the Contractor.
- M. Each recessed light fixtures shall be wired with a flexible metal conduit at least 4'-0" long but not longer than 6'-0" originating from a junction box at least 1'-0" from the fixture. Provide grounding conductor installed with circuit conductors in all flexible conduits.
  - 1. Ground light fixtures according to requirements of Grounding: Section 16450.
  - 2. Relamp permanent light fixtures used for temporary lighting during construction with Contractor's lamps. Remove temporary lamps at acceptance of work and install new proper lamps in each fixture. New lamps shall be in perfect working order.
- N. Lighting fixtures shall be rigidly supported except where specified or indicated for chain, aircraft cable or stem pendant method, and shall be installed in a manner otherwise as approved.
- O. For installation in suspended ceilings, insure that the lighting fixtures are supported such that there is no resultant bowing or deflection of the ceiling system greater than 1/360 of the length of the total span of the ceiling member.
- P. Coordinate the lighting system installation with all applicable trades to avoid interferences with hangers, mechanical duct, sprinklers, pipes, steel, etc.
- N. Finish coatings that are disturbed in any way during construction due to handling, installation, or construction work shall be touched up or refinished in a manner satisfactory to the Contracting Officer's Technical Representative.

### **3.2 TESTING AND ADJUSTING:**

- A. Test each lighting fixture and lighting fixture accessory for proper function and operational performance in the presence of the Contracting Officer's Technical Representative (COTR). Report and

immediately correct any and all deficiencies as they arise. Provide complete documentation of all tests, inspections, and adjustments.

### **3.3 INSPECTION:**

- A. Verify the work of other trades to the extent that light fixtures may be installed over substrates or incorporated into integrated systems.
- B. Verify locations and clearances of other Trades Work and coordinate lighting fixtures accordingly prior to doing any work.
- C. Prior to submitting shop drawings or purchasing light fixtures, flush mounted or lay-in installed lighting fixtures, verify their locations, clearances, ceiling construction, and ceiling construction compatibility to light fixtures. Coordinate with all other trades.

### **3.4 FIXTURE CLEANING:**

- A. Follow the cleaning procedures as recommended by the fixture manufacturer with respect to the new fixture cleaning for construction work practice.
- B. Use only those products for cleaning as outlined in the fixture manufacturer's literature.

### **3.5 EMERGENCY FIXTURE WIRING:**

- A. All emergency branch circuit wiring Life Safety Emergency System shall be #10 minimum.

### **3.6 PENDANT MOUNTED FLUORESCENT FIXTURES INSTALLATION:**

- A. Pendant mounted fixtures shall be stem or aircraft cable supported with heavy duty stems or chains on each end and swivel aligning fixtures.
- B. Where pendant mounted fluorescent lamp fixtures are mounted in continuous row over 12 feet long, fixtures shall be supported from Kindorf or Unistrut Channel 1-5/8" x 1-5/8" x 12 gauge which will limit deflection to acceptable values.
- C. Where channel is used for fixture support, the channel may be used as a wireway, thus eliminating conduit as running parallel to the channel. Channel must have closure plate if used for wireway.
- D. All continuous row pendant or surface mounted fluorescent fixtures shall be aligned to the satisfaction of the Architect.
- E. Furnish and install all supports, clamps, stems, cross member channels between joints, etc., to properly support and align fluorescent fixtures to the satisfaction of the Architect.

- F. When using channel for continuous row fluorescent fixtures run wiring in channel except for connection to fixture. All wiring within 3 in. of ballast shall be type THNN 90 degrees.
- G. Stems for pendant mounted lighting fixtures shall be provided to match the lighting fixtures, unless specified otherwise in the lighting fixture schedule. Stems shall be equipped with self-aligning joints to provide proper and neat alignment.

### **3.7 RECESSED FIXTURE CONSTRUCTION**

- A. All recessed fixtures shall be provided with housings or enclosures suitable and approved for the particular construction they are to be installed in. All recessed light fixtures installed in plenum ceilings shall be UL labeled and approved for plenum use in conformance to applicable codes.

### **3.8 PLASTER FRAMES:**

- A. Furnish and install plaster frames for recessed fixtures in plastered or drywall ceilings. Verify ceiling construction prior to shop drawing submittals.

### **3.9 DELIVERY AND HANDLING:**

- A. The Contractor shall at time fixtures are received at site, unpack and examine all fixtures for condition and cleanliness and shall immediately notify manufacturer, in writing, of any faults.
- B. Lenses and frames shall be cleaned prior to installation. In finished area, lenses and frames shall not be installed until finished floor covering is installed, unless otherwise protected.

### **3.10 FIXTURE HOUSINGS:**

- A. All fixture housings shall be grounded.

### **3.11 LIGHT FIXTURE CONNECTIONS**

- A. Each recessed type moveable light fixture shall be connected with flexible conduit, using approved Connectors between junction box and light fixtures as per applicable codes. Provide grounding conductor with branch circuit conductors in all flexible conduits.

### **3.12 LAMP REPLACEMENT**

- A. At Date of Substantial Completion, replace lamps in interior lighting fixtures which are observed to be noticeably defective, as judged by the Engineer.

### **3.13 GROUNDING:**

- A. Provide all necessary electrical grounds for the entire system.

- B. Grounding shall be in accordance with requirements of all codes specified herein.
- C. Ground wires shall be installed in all conduits for all light fixtures or devices.
- D. Grounding conductor shall be installed in each flexible conduit.
- E. Ground surface mounted light fixtures with grounding conductor installed with circuit conductors to junction box and to light fixture housing.

**3.14 COORDINATION WITH MOUNTING CONDITIONS:**

- A. Contractor is responsible for coordinating the mounting accessories and luminaire trims with the ceiling conditions for which each luminaire will be installed. No extra compensation will be permitted for failure to coordinate.

**3.15 COORDINATION WITH AMBIENT CONDITIONS:**

- A. Contractor is responsible for coordinating the characteristics and the U.L. labeling of the luminaires and their components with the ambient conditions that will exist when the luminaires are installed. No extra compensation will be permitted for failure to coordinate the luminaires with their ambient conditions. These areas of coordination include but are not limited to the following:
  - 1. Plenums and air handling spaces.
  - 2. Fire rated ceilings.

**3.16 EXISTING PCB BALLASTS**

- A. Contractor shall provide all labor, materials, tools, equipment, and services to remove and legally destroy existing PCB ballast removed from light fixtures. Provide all documentation, cartage, handling, and disposal of PCB ballast at an approved USEPA decommissioning facility. Provide all required documentation. Include all costs in bid proposal.

**3.17 PLENUM AIR CEILINGS**

- A. All recessed light fixtures and associated boxes, conduits, fittings, shall be suitable for use in plenum air ceilings, in conformance to all applicable codes.

**3.18 EXISTING LAMPS**

- A. Contractor shall provide all labor, materials, tools, equipment, and services to remove existing lamps from light fixtures. Provide all documentation, cartage, handling, and disposal of lamps at an approved USEPA decommissioning facility. Provide all required documentation. Include all costs in bid proposal.

- - - E N D - - -

**SECTION 16721**  
**MODIFICATIONS TO EXISTING FIRE ALARM SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This is a performance specification with express requirements that the contractor shall fulfill to the satisfaction of the contract documents and to the requirements of the Veterans Affairs, VA Hines Medical Center, Hines, Illinois. Provide all labor, materials, tools, equipment services and instrumentation, and all final connections for new fire alarm devices connected to the existing Building 200 fire alarm control panel and to new transponder panel; modifications to the existing Building 200 fire alarm control panel and modifications to existing main site fire alarm panel located in Building One; complete testing of the entire fire alarm system; provide corrective action; retest the entire fire alarm system. New devices and equipment shall include, but not be limited to, alarm initiating devices, alarm indicating devices, auxiliary control devices, backup battery and battery chargers, power supplies, pull stations, chime signals, smoke detectors, duct smoke detectors, audio and strobes, wiring of smoke dampers; wiring of fire dampers; modifications to existing Building One and Building 200 fire alarm control panels; modifications all wiring in a conduit system; new transponder panels compatible to existing fire alarm control panels and all final connections certified in writing complete in place; ready for operation in all respects, in conformance to all applicable codes and NFPA standards.
- B. Fire alarm systems shall be provided in compliance with requirements of NFPA 72. 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 five years experience installing fire alarm systems.
- C. Provide coded fire alarm signals to notify staff personnel occupants to evacuate. The coded signal shall identify the area of the endangered building from which the alarm was initiated. The alarm system shall be completely electrically supervised. The new transponder panel shall be electrically compatible to the existing fire alarm systems in all respects, ready for operation.
- D. Provide fire alarm system including but not be limited to new fire alarm transponder panel, all wiring, raceways, pull boxes, terminal cabinets, outlets and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, and all other accessories and miscellaneous items



required shall be provided for a complete operating system even though each item is not specifically mentioned or described or specified herein. The system layout on the drawings is generic. Contractor shall field verify existing Building 200 and Building One fire alarm control panels and existing conditions prior to bid proposal.

- E. Provide shielded twisted pair data cable in conduit from new Emergency Room transponder panel to Building 200 first floor main fire alarm control panel. Make all final connections.
- F. All wiring shall be provided in a raceway system.
- G. Existing Fire Alarm Equipment: Existing fire alarm equipment shall be maintained fully operational until the new equipment has been tested and accepted by the VA Resident Engineer. As new equipment is installed, it shall be labeled, "NOT IN SERVICE" until the new equipment is accepted. Once the new system is completed, tested, and accepted it shall be placed in service. All new equipment shall have tags removed and the existing equipment shall be tagged "NOT IN SERVICE" until removed from the premises.
- H. Equipment Removal: After acceptance of the new system by the Government, all existing equipment not connected to the new system shall be removed including all conduits, wiring boxes, fire alarm devices. All damaged wall, ceiling, floor surfaces shall be restored. Materials shall be removed from the site and legally disposed of by the Contractor.
- I. Provide new transponder panel including but not necessarily limited to pull stations, chime fire signal, horns, visual strobes, smoke detectors, duct detectors, door holders, wiring in conduit to first floor fire alarm control panel, standby batteries and battery chargers; maintain continuity of existing alarm system at all times during the entire construction period. Provide all required testing, correcting, and retesting.
- J. Provide for removal and legal disposal of all existing fire alarm equipment rendered obsolete and not connected to the new system.
- K. Provide a complete fire alarm system including but shall not be limited to all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, notification devices, smoke detectors, alarm initiating devices, and control equipment and all other accessories and miscellaneous items required for a complete and operating system although each item is not specifically mentioned or described herein, or specified herein.
- L. All panel and device installations shall be completed prior to wiring terminations in existing Building 200 fire alarm control panel; new transponder panel; and existing Building One fire alarm control.
- M. Contractor shall provide prior written notice to the Contracting Officer and to the Contracting Officer's Technical Representative a minimum of three weeks in advance of any fire alarm system downtime

period. Downtime periods shall be kept to an absolute minimum. Downtime periods and cutovers shall be strictly at the convenience of VA Hines Medical Center.

- N. All devices, components, modules, panels, instrumentation, battery plants, battery chargers, etc. shall be provided by Simplex.
- O. Contractor shall not deviate from coordination with all applicable trades and shall not deviate from coordination with the Contracting Officer and the Contracting Officer's Technical Representative.
- P. Simplex technicians shall review all termination point wiring and supervise all final termination connections to all devices, and panels for alarm, trouble and supervisory prior to final connections. The electrical contractor shall not be permitted to terminate any wiring to any devices and panels without direct Simplex supervision.
- Q. Simplex technicians shall witness all preliminary and all final fire alarm testing.
- R. Simplex technicians shall assist the contractor for trouble shooting testing malfunctions and testing failures. The contractor shall schedule retesting of the fire alarm system after corrective action is completed.
- S. The contractor and Simplex shall jointly provide typewritten certifications stating in effect the complete fire alarm system has been provided in conformance to all applicable codes; and that the fire alarm system is ready for operation in all respects.
- T. Provide all required fire alarm head-end equipment in Village of Broadview Fire Alarm Dispatch Center as required for receiving all additional fire alarm, trouble alarm and supervisory alarms from VA Hines. Pay all Village of Broadview fees and costs. Include all fees and costs in Bid Proposal.
- U. The term "provide" or "provided", or "providing" as stated herein, shall be defined by these contract documents as: furnished, installed, wired, functional, tested, corrected, retested. Typewritten certifications, notarized, signed, dated by the manufacturer; all applicable sub-contractors and the contractor; stating the fire alarm systems has been furnished and installed per manufacturer's instructions and recommendations, in conformance to all applicable codes; NFPA standards and Underwriter Laboratories standards, complete in place ready for operation in all respects.

## **1.2 RELATED WORK**

- A. Section 01010, GENERAL REQUIREMENTS
- B. Section 09900, PAINTING.
- C. Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- D. Section 16111, CONDUIT SYSTEMS.
- E. Section 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW)
- F. Section 16450, GROUNDING
- G. Section 13930, WET SPRINKLERS
- H. Section 01340, SAMPLES AND SHOP DRAWINGS
- I. Section 07270, FIRESTOPPING SYSTEMS
- J. Section 08710, BUILDER'S HARDWARE
- K. Section 09300, PAINTING

## **1.3 SUBMITTALS**

- A. Submit in accordance with section 01340, SAMPLES AND SHOP DRAWINGS and Section 16050, BASIC METHODS AND REQUIREMENTS (ELECTRICAL).
- B. Shop Drawings
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include ratings, power requirements, dimensions, mounting, equipment, device arrangement, complete wiring diagrams (including floor plans), connection diagrams with terminal identification, material, and description of operation. Wiring and connection diagrams shall be certified by the fire alarm manufacturer.
  - 3. Riser diagram, drawing and auxiliary functions. - AutoCAD Release (verify with COTR).
  - 4. Product data sheets and equipment description including UL listing for components.
  - 5. Detailed drawings of transponder fire alarm panel.
  - 6. Bill of Materials listing all components and devices.
  - 7. A list of every network node address.
  - 8. A list of every address of every device connected to a network node that is provided for purposes of alarm initiation, status monitoring, supervised notification appliance circuits, and auxiliary control.
  - 9. System wiring and interconnection diagrams.
  - 10. Storage Batteries.
  - 11. Battery Charger.
  - 12. Cabinet.

13. Manual Pull Stations.
14. Pre-signal Chimes.
15. Terminal Cabinets/Assemblies.
16. Addressable Relays
17. Duct detectors and remote indicators with test switches.
18. Smoke Detectors.
19. Provide point-to-point wiring diagrams (AutoCAD Release \_\_\_\_\_ verify with COTR)) showing the points of connection and terminals used for all electrical field connections in the system, including all interconnections between the equipment or systems which are supervised or controlled by the system. Diagrams shall show all connections from field devices to the FACP and transponder panel, initiating circuits, switches, relays and terminals. Provide isometric drawing showing device locations, terminal cabinet locations, and all circuit layouts.
20. Provide a complete typewritten description of the system operation.
21. Provide complete battery calculations for both the alarm and supervisory power requirements and power requirements for smoke damper actuators. Ampere-hour requirements for each system component shall be submitted with the calculations.
22. Provide complete riser diagrams (AutoCAD Release \_\_\_\_\_ verify with COTR) indicating the wiring sequence of all devices and their connections to the control equipment. Provide a color code schedule for the wiring. Provide floor plans showing the location of all devices and equipment.
23. Provide data for each circuit to indicate that there is at least 25% spare capacity for notification appliances, 25% spare capacity for initiating devices.
24. Provide written sequence of operation for all functions of the system.
25. Provide transponder panel cut sheets, data sheets physical size.
26. Provide Record Drawing Software: Provide two (2) sets of floppy diskettes containing CADD based drawings of all as-built drawings and schematics in the format required by the VA Resident Engineer and two (2) sets of hard copy drawings and schematics.

#### **1.4 INSTRUCTION AND TRAINING FOR VA SELECTED PERSONNEL**

- A. Instructor: Include in the project the services of an instructor, who shall have received specific training from the manufacturer for the training of other persons regarding the inspection, testing and maintenance of the system provided. The instructor shall train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm
- B. Qualifications: Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical operation and maintenance work.
- C. Required Instruction Time: Provide not less than six hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer.

#### **1.5 AS-BUILT DRAWINGS**

- A. General: Prepare and submit to the Contracting Officer six sets of detailed "As Built Drawings". The drawings shall include complete wiring diagrams showing connections between all devices and equipment, both factory and field wired. Include a riser diagram and drawings showing the as-built location of all devices and equipment. The drawings shall show the system as installed, including all deviations from both the project drawings and the approved shop drawings. The drawings shall be prepared on uniform sized sheets of the same physical as the contract documents. Drawings shall be submitted within two weeks after the final acceptance testing. Provide (3) copies of CD-Rom diskettes, of as-built drawings in the format determined by the VA Resident Engineer and (6) hard copies of as built full size drawings.

#### **1.6 OPERATION AND MAINTENANCE MANUALS**

- A. Provide complete operating and maintenance manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
  - 1. Wiring diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
  - 2. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
  - 3. Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment and system.
  - 4. Approvals will be based on complete submissions of manuals together with shop drawings.

5. Wiring diagrams for each fire alarm device.
- B. Two weeks prior to final inspection, provide four copies of the final updated operating and maintenance manual to the Resident Engineer.
1. The manual shall be updated to include any information necessitated by shop drawing approval.
  2. Complete "As Installed" wiring and schematic diagrams shall be provide which show al items of equipment and their interconnecting wiring.
  3. Indicate all terminal identifications.
  4. Provide information for testing, repair, trouble shooting, assembly, disassembly, and recommended maintenance intervals.
  5. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
  6. Indicate all codes.
  7. Furnish manuals in loose-leaf binder or manufacturer's standard binder.

#### **1.7 CERTIFICATIONS**

- A. Typewritten Certifications from the contractor and the manufacturer shall be provided for the existing to remain equipment and new fire alarm equipment stating that all fire alarm devices furnished are listed by UL as being compatible and operable with the existing and new fire alarm control equipment.
- B. Typewritten Certifications from the contractor and the manufacturer for the new and existing fire alarm equipment to remain shall be provided stating that the wiring and connection diagrams meet this specification, and all applicable UL and NFPA requirements, and manufacturer's instructions, wiring diagrams.
- C. Two weeks prior to final inspection, deliver to the Resident Engineer four copies of the typewritten certifications by the contractor and the authorized representative of the manufacturer of the fire alarm equipment stating that the entire system has been provided properly installed, adjusted, and tested, and certified ready for operation in all respects.
- D. Together with the shop drawing submittal, provide the technician's NICET level III fire alarm typewritten certifications as well as typewritten 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.

- E. Together with the shop drawing submittal, provide typewritten certifications 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.
- F. Together with the shop drawing submittal, provide typewritten certifications from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.
- G. All certifications shall be notarized, signed and dated by the manufacturer the contractor and applicable sub-contractor.
- H. Provide typewritten certifications for pre-testing each phase of Emergency Department renovation.
- I. Provide typewritten certifications for final testing the entire fire alarm system after all fire alarm system renovations are completed.

#### **1.8 GUARANTEE**

- A. Guarantee all new wiring and terminal equipment to be free from inherent and mechanical defects due to workmanship and materials used for a period of two years from date of final acceptance. The fire alarm manufacturer, and the contractor, provide in writing a two years warranty for all labor, materials, tools, equipment, services and instrumentation. Warranty shall list all equipment in the system and state that equipment to be free from inherent and mechanical defects due to workmanship and materials for a period of two years from date of acceptance. Warranty service for the equipment shall be provided by the system supplier's factory trained representative Monday through Sunday 24 hour service.

#### **1.9 APPLICABLE PUBLICATIONS**

- A. The publications listed below 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):
  - 70-2002 . . . . . National Electrical Code (NEC).
  - 72-1999 . . . . . National Fire Alarm Code
  - 101-2000 . . . . . Life Safety Code
  - 90A-1999 . . . . . Installation of Air Conditioning and Ventilating Systems

- C. Underwriters Laboratories, Inc. (UL):
- 50-1995 . . . . . Safety Enclosures for Electrical Equipment
  - 268-1989 . . . . . Smoke Detectors for Fire Protective Signaling Systems; July 20, 1987
  - 864-80 . . . . . Control Units for Fire Protective Signaling Systems;
  - UL-228 . . . . . Door Holding Devices
  - UL-464 . . . . . Audible Signal Appliances
  - UL-1638 . . . . . Visual Signaling Appliance Standards
  - UL-864 . . . . . Control Units for Fire Protection Signaling Systems
  - UL-1971 . . . . . Signaling Devices for Hearing Impaired
  - UL-2000 . . . . . Fire Protection Equipment Directory

#### **1.10 QUALIFY ASSURANCE**

- A. Provide, design, materials, performance, and devices for a protected premises fire alarm system, complete, conforming to National Fire Protection Association Standard 72, except as additionally specified herein.
- B. Installation shall be accomplished by an electrical contractor with a minimum of five years experience in the installation and wiring of fire alarm systems in the Chicago area. Provide documentation of proposed installers by submitting evidence of such qualifications. The services of a technician provided by the control equipment manufacturer shall be provided to supervise installation, adjustments, and tests of the system.

### **PART 2 - PRODUCTS**

#### **2.1 SIMPLEX FIRE ALARM INTERFACE**

- A. Simplex fire alarm system proprietary materials, equipment, devices shall be used.
- B. In general all work and device installation shall occur prior to panel (FACP, FAAP) termination.
- C. Terminations within fire alarm control panel, existing system interruption shall follow GC-subcontractor-VA project manager notification. Contractor must not deviate from this protocol or attempt panel bypass without VA and Simplex supervision.
- D. Existing service down time must be scheduled and planned to be absolute minimum of events, with minimum downtime. Submit prior



written notice of downtime schedules to the VA Resident Engineer and the Contracting Officer three weeks in advance of all shutdowns.

- E. All terminations shall be under direct Simplex supervision in all instances.
- F. Device and system testing shall follow the previously defined communication protocol.
- G. Simplex certifications shall occur upon total system completion for each phase.

## **2.2 EQUIPMENT AND MATERIAL**

- A. All equipment and components provided shall be new, and shall be of the same manufacturer as the existing fire alarm system and totally compatible with the existing fire alarm systems. The materials, appliances, equipment and devices shall be tested and listed by Underwriters Laboratories, Inc., or Factory Mutual Research Corporation. The contractor and the authorized representative of the manufacturer of the existing fire alarm system shall be responsible for satisfactory total system operation and its final certification.
- B. All fire alarm equipment, materials and components provided shall be Simplex to match existing site fire alarm systems.
- C. Provide all required labor, materials, tools, equipment, services and instrumentation for providing fire alarm, trouble alarms, supervisory alarms, fan shutdowns, wiring for fire dampers and smoke dampers, including but not necessarily limited to providing new semi-flush mounted transponder panel; provide new components, device modules, zone initiating modules, battery backup and battery chargers, power supplies, zone modules, trouble modules, supervisory modules, modems, all required telecommunications wiring, jacks, MINTS, PONI cards for transmitting alarm, trouble, and supervisory to the Emergency Department new transponder panel/ to the main fire alarm control panel located on the first floor in Building 200 and main site fire alarm control panel located in Building One and to Village of Broadview Fire Department. The new transponder panel fire alarm zones shall be linked with and transmit all zones, alarms, supervisory and trouble conditions and fan shutdowns, fire dampers, smoke dampers for each zone, data to the first floor Building 200 main FACP and to the Hines Veterans Administration Hospital Fire Alarm and Detection control panel located in Building One and to Village of Broadview Fire Department. The data link shall be accomplished via dedicated phone lines with dial tones and modems in the quantity required and at locations required. Provide all required upgraded software and new software, hardware, new programming for existing Building One fire alarm control panel and existing main fire alarm control panel located on the first floor of Building 200 and for new transponder panel serving the Emergency Department.

- D. Provide all required labor, materials, tools, equipment, services and instrumentation for including but not necessarily limited to the following:
1. Provide transmission of fire alarm, trouble alarm, supervisory alarm, to new Emergency Department transponder panel and to Building 200 first floor main fire alarm control panel and to Building One Fire Alarm Control Panels; and to Village of Broadview Fire Department.
  2. Provide all required wiring, conduits, instrumentation relays in each existing FACP and new transponder panel for release of magnetic door holders, unlock door locks; operate smoke and fire dampers
  3. Provide visual indication for initiating devices operated on new transponder panel, Building 200 main FACP, Building One FACP., for alarm, trouble, supervisory.
  4. Provide recording of each alarm, trouble, supervisory, event on Building 200 main FACP system printer and Building One printer.
  5. Provide for fan shutdown of HVAC units.
  6. Provide wiring in conduit and instrumentation for proper operation of fire dampers and smoke dampers. Dampers shall close in a fire alarm condition.
  7. Provide pre-signal annunciation.
  8. Provide audio/visual alarms.
  9. Provide smoke detectors.
  10. Provide duct detectors complete with all required instrumentation and wiring for operating fire dampers and smoke dampers.
  11. Provide remote duct detector LED indicator with integral key test switch.
  12. Provide release door holders after the first gong.
  13. Provide standby battery plant and battery charger.
  14. Provide all wiring, conduits, and all final connections.
  15. Provide testing, correcting and retesting.
  16. Provide all instrumentation and wiring for electrically unlocking locked doors.
  17. Provide all fire alarms, trouble alarms, and supervisory alarms with transmission to Village of Broadview Fire Department.

18. Provide smoke detectors with sounder base for sleeping rooms.

- E. Provide all labor, materials, tools, equipment, services and instrumentation for providing fire alarms, trouble alarms, supervisory alarms, fan shutdown for HVAC units, wiring in conduit system for smoke dampers and fire damper controls, including but not necessarily limited to new transponder panel; Building 200 and Building One fire alarm control panels with new components, device modules, zone initiating modules, battery plant and battery chargers, power supplies, zone modules, trouble modules, supervisory modules, all required wiring in a conduit system, for transmitting alarm, trouble, supervisory from new transponder panel and from upgraded Building 200 first floor FACP devices to Building One second floor upgraded fire alarm control panel for separate fire alarm zones, trouble zones, supervisory zones to Village of Broadview Fire Department. Provide all required devices, equipment, connections, to Village of Broadview fire alarm head-in equipment for accepting VA Hines fire alarm zones, trouble zones, supervisory zones. Make all final connections to Village of Broadview head-end equipment as required. Include all Village of Broadview installation fees in bid proposal. Buildings 200 fire alarm systems shall be tested, corrected, retested and certified ready for operation by the fire alarm system manufacturer and the contractor. All final connections shall be made by the fire alarm system manufacturer's technicians.
- F. Provide all required upgraded new Fire Alarm System equipment and hardware and software, new equipment and programming, and reprogramming to perform Multiplexed Fire Alarm and Detection for existing first floor Building 200 and Building One fire alarm control panels and transmit all Building 200 fire alarm, trouble alarm, supervisory alarms to Village of Broadview Fire Department.
- G. Each component and device of the Fire Alarm System added or modified to the existing Fire Alarm System shall be listed under the appropriate category by the Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. The Control Equipment shall be listed under UL category UOJZ.
- H. Provide; modify and upgrade existing Fire Alarm control panels located in Building 200 first floor and in Building One as required for a complete and operational fire alarm system including transmission of fire alarm trouble alarm, supervisory alarm, trouble alarms to Village of Broadview Fire Department.
- I. The System shall be provided with supervised multiplex data communications circuits, closed loop initiation circuits, individual zone supervision, and individual audio and visual signal circuit supervision. Provide all required panel components, zone and trouble modules, supervisory modules, signal modules, alarm modules, wiring for fire dampers and smoke dampers, fan shutdown modules, relays, transmission modules, power supplies, supervisory modules and devices, all wiring, outlet boxes, and all other necessary material for a complete operating system from new Emergency Department transponder panel to Building 200 first floor main fire

alarm control panel; to Building No. One second floor site fire alarm control panel to Village of Broadview Fire Department.

- J. All circuits requiring system operating power shall be 24 VDC and shall be individually fused at the control panel. A minimum of five (5) amps auxiliary fused power shall be provided. Increase capacity as required for operating smoke and fire damper actuators; unlocking electric locks; door holder relay coils. Verify by battery calculations.
- K. All equipment specified shall be U.L. listed and cross listed for use with the main fire alarm control panel and shall bear the same manufacturer's name on the main control panel as well as all the remote devices. Systems having equipment with various manufacturers' names will not be acceptable.
- L. Provide Manufacturer's Services:
  - 1. Supervision of installations and terminations shall be provided by a factory trained service technician employed by the fire alarm system manufacturer. The Technician shall be NICET certified and have had a minimum of five (5) years of service experience in the fire alarm industry. The technician's name as well as the NICET certification number shall appear on equipment submittals. A letter of certification from the fire alarm manufacturer shall be provided at the completion of the project. The manufacturer's service technician shall be responsible for the following items:
    - a. Pre-installation visits to the job site to review equipment submittals and verify method by which the system should be wired.
    - b. During job progress, provide periodic job site visits to verify installation and wiring of system.
    - c. Upon completion of wiring, final connections shall be made under the supervision of this technician, and final checkout and certification of the system.
    - d. At the time of final checkout, technician shall provide operational instructions to the VA Personnel and/or his representative on the system.
    - e. Provide all required hardware, software, programming and reprogramming, software and upgraded software for Buildings 1, 200, existing fire alarm control panels. Provide all required upgrades, programming, software interface devices, modems, and equipment, power supplies, zone modules, control modules, fan shutdown modules, relays; provide all required upgrades, programming, software, interface devices and equipment in order to transmit alarm and trouble, fan shutdown, from Emergency Department new transponder panel and Building 200 existing fire alarm control panels to

existing main fire alarm control panel located in Building One - 2nd Floor and to Village of Broadview Fire Department.

- f. Manufacturer's factory service technicians shall make all final connections to existing and new equipment.
- 2. All manufacturer's job site visits shall be dated and documented in writing and signed by the contractor and the VA Resident Engineer. Any discrepancy shall be noted on this document and a copy kept in the system job folder which shall be made available to the project engineer any time during the project.
- M. The equipment shall provide complete and compatible electronic communication interface to the existing Hines Veterans Administration Hospital Main Fire Alarm Control Panel located in Building One and Building 200 first floor Fire Alarm Control Panel, such that all zone alarm, supervisory and status data shall be transmitted to and logged at the Building One (1) Fire Alarm Center, via outside telephone lines with dial tones and modem; with transmission for alarm, trouble and supervisory to the Village of Broadview Fire Department.
- N. The contractor shall provide and install all required modifications and instrumentation to fire alarm systems for Buildings One, 200 fire alarm control panels in conformance with all applicable codes, NEC wiring criteria, and the manufacturer's recommendations, wiring diagrams, and instructions. All communications wiring shall be twisted and shielded cables. All wiring shall be in a conduit system separate from all other building wiring. All junction boxes shall be sprayed red and labeled "Fire Alarm".
- O. The manufacturer's authorized representative shall provide all required on-site hardware, software modifications and supervision of installation of the complete Fire Alarm System installation, perform a complete functional test of the system, and submit a written report to the contractor attesting to the proper operation of the completed system.
- P. Provide Building 200, Building One, new Emergency Department transponder panel testing. The existing fire alarm panels on the first floor of Building 200 and Building One and new Emergency Department transponder panel shall be fully tested for each new and existing fire alarm zone, trouble alarm zone, supervisory zone, pull stations, smoke detectors, horn/strobes, smoke dampers and fire dampers, fan shutdown by the contractor in the presence of the VA Resident Engineer and the manufacturer's technical representative. Provide all required labor, materials, tools, equipment, services, and instrumentation for correcting all fire alarm system defects. Upon completion of a successful test, the contractor and the fire alarm manufacturer shall so certify in writing to the Contracting Officer. All certifications shall be typewritten, notarized, signed, dated by the manufacturer, the contractor and applicable sub-contractor.

- Q. Provide all required hardware, upgraded software, new software, all required programming and re-programming.
- R. All final connections shall be provided. All final connections shall be made by the fire alarm equipment manufacturer's factory trained technician. Fire alarm system shall be tested and certified ready for operation by the contractor and the fire alarm manufacturer.
- S. Provide 120V 20 Ampere 2#10 and 1#1 GRD - 3/4" conduit life safety branch circuits for new transponder panels. Provide additional 120V-120A circuits for additional equipment and devices requiring a 120 volt source of supply.

## **2.3 WIRING - GENERAL**

- A. Conduit and Wire sections 16111, CONDUIT SYSTEMS and 16127, CABLES, LOW VOLTAGE (600 VOLTS AND BELOW) shall apply:
  - 1. Provide wiring in accordance with NEC, and as recommended by the manufacturer of the fire alarm system. All wires shall be color coded and installed in metallic conduit system. Conduit fill shall not exceed 40 percent of interior cross sectional area. Number and size of conductors shall be as recommended by the fire alarm system manufacturer but not less than 18 AWG. Minimum conduit shall be 19 MM (3/4 inch).
  - 2. All wiring in junction boxes and cabinets shall be permanently tagged and identified with metal or phenolic tags attached by nylon ties.
  - 3. Provide all required instrumentation and wiring and all final connections for fan shutdown, fire dampers, smoke dampers, damper actuators, remote duct detector key test switch and remote lamp.
  - 4. Addressable circuits and wiring used for multi-plex communication loop shall be twisted pair and shielded.
  - 5. Provide identification on all fire alarm conduits. Provide conduit identification stickers white background red lettering reading "Fire Alarm System". Provide stickers every ten feet. Provide identification stickers on all junction boxes.
- B. Provide Terminal Boxes, Junction Boxes and Cabinets:
  - 1. Shall be galvanized steel and in accordance with UL.
  - 2. Paint box and cover red and identify with letters of white paint stenciled as "Fire Alarm System" in accordance with Section 09900, PAINTING.
  - 3. Junction boxes shall have a volume 40 percent greater than required by the NEC. Minimum sized wire shall be considered as 14 AWG for calculation purposes.

- 4. Terminal cabinets shall have identified pressure type terminal strips.
- C. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry are not acceptable.

## **2.4 MANUAL STATIONS**

- A. Stations shall be metal construction , red in color.
- B. Stations shall be of the single action pull down type with suitable operating instructions provided on front in raised or depressed letters.
- C. Unless otherwise specified, all exposed metal parts shall be anodized, or given a prime coat and one or more finishing coats of red lacquer or red enamel to provide a smooth, hard, durable finish. Other approved equivalent finish with red lettering is acceptable.
- D. Operating handles shall be metal. On operation, the lever shall lock in alarm position and remain so until reset. A key or wrench shall be required to gain access for resetting, or conducting tests or drills. Gravity, mercury, or other switches which may be tripped by vibration or jarring are not acceptable. Unit shall be furnished with terminal blocks clearly marked to indicated connections.
- E. Shall be addressable; non breakable glass.

## **2.5 SMOKE DETECTORS**

- A. Provide smoke detectors photoelectric system addressable type, complying with applicable UL standards. Install in accordance with the manufacturer's recommendation and NFPA 72. All detectors shall have an insect screen. Detectors shall have an indicator lamp to denote an alarm condition. Also provide a set of auxiliary contacts, one each normally open and normally closed (Form "C") for each smoke detector. Provide remote indicating lamp wherever smoke detectors are installed in individual rooms or spaces. Provide engraved nameplate indicating room name, room number, fire alarm zone.
- B. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensor of any photoelectric detector shall be factory set at 3.0 percent plus or minus 0.25 percent obscuration per 300 mm (foot). These detectors shall be mounted as required for detection of the particles of combustion at the installed location without causing nuisance activation.
- C. Duct smoke detectors shall be provided and connected by means of an addressable reporting interface device. Duct detectors shall be listed and labeled for duct installation. 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). Duct detectors whose operation requires the heads to be mounted inside of ducts are not acceptable.

Provide all required wiring in conduit interlocked with fans for fan shutdown, interlocked with smoke dampers and fire dampers in the event of a fire alarm condition. Provide combination duct detector test key switch and remote indicator lamp with identification engraved nameplates (equipment duct smoke detector and location) for each duct smoke detector. Each duct detector shall be connected to separate and independent fire alarm zones and trouble zones. Provide all required wiring in conduit and all final connections to duct detectors, smoke dampers, fire dampers. Provide all required relays. Provide duct detector auxiliary contacts to close fire dampers and smoke dampers on duct detection activation. Verify damper operation (i.e. power maintained: damper open: loss of power: damper spring return closed. Damper shall be same electrical characteristics as fire alarm duct detectors. Make all final connections. Coordinate with mechanical sub-contractor.

- D. Provide address reporting interface modules for existing flow switches and tamper switches.
- E. Provide guaranteed simultaneous operation: Detector power supply shall be such that guaranteed simultaneous operation of all detectors shall result in alarm reporting and detector function of all detectors without losing any detector signal. Detectors shall be supplied with power circuit wiring separate from the alarm circuit wiring with sufficient capacity to operate all detectors simultaneously.
- F. Control and power supplies necessary for operation of duct detectors smoke detectors, fire dampers, smoke dampers, shall be provided integral within the new fire alarm transponder control panels. Detectors and associated power supplies must be compatible with the existing building fire alarm control panel and new transponder panel suitable for use in supervised circuits. Detectors shall be capable of functioning upon loss of normal AC system operating power and all necessary equipment and devices to permit such operation shall be provided. Malfunction of the circuitry to the detector or its control, or power units shall result in operation of the system trouble devices. Reset of detectors, after alarm, shall be from the fire alarm transponder panels.
- G. In addition to the items specified, provide all equipment devices, relays, required for satisfactory operation of the detector installation.
- H. Coordinate electrical characteristics for power supplies, fire dampers, smoke dampers and duct detectors.

## **2.6 PROVIDE NEW LOCATION CHARTS**

- A. Print with easily readable, uppercase type, minimum 5 mm (3/16 inch) size letters.
- B. Show all of the codes used in the building and the locations of the zones. Also show the auxiliary alarm transmitter and trouble transmitter codes.



- C. Laminate or mount under plexiglass in a frame, and install adjacent to the fire alarm control panel. Deliver six additional framed charts to the Resident Engineer.

## **2.7 PROVIDE NEW TRANSPONDER PANEL**

- A. The existing Simplex Pre-signal Fire Alarm System shall be expanded with the addition of a new Simplex Type 4100-8019 semi-flush Transponder panel. Transponder panel shall be provided with minimum 60 hours battery back-up with minimum 15 minutes in alarm and sufficient alarm initiating circuit modules and sufficient notification appliance modules to monitor and control all devices provided. Provide all required instrumentation for (9) spare zones ready for operation and provisions for additional (6) future zones as a minimum. Provide battery calculations for all zones including all spare zones and provisions for all future zones.
- B. Transponder panel shall be connected to the existing Building 200 first floor fire alarm control panel with two hour rating riser cable installed in a conduit system. Provide 20A-120V life safety dedicated circuit to each new transponder panel. Make all final connections.
- C. New fire alarm devices shall include but not necessarily be limited to:

2099-9138	Manual Pull Stations
4098-9605	Smoke Detectors
4098-9682	Detector Bases
4903-9247	Audio Visual devices
4904-9178	Visual devices
4466B-0-14-24	Chimes
4098-9685	Duct Detectors
2098-2806	Remote duct detector indicator complete with key test switches
2088-9608	Magnetic Door Holders - 120 volt

Provide required relays and wiring in conduit for release of electrical door locks, door holders, smoke dampers, fire dampers. Provide smoke detector with sounder base in sleeping rooms.

## **2.8 BUILDING ONE**

- A. Provide upgraded modifications to Building One fire alarm control panel by providing additional extender panel or new transponder panel to receive all fire alarms, trouble alarms, supervisory alarms from new transponder panel and subsequent fire, trouble, supervisory alarm transmission to Village of Broadview Fire Department. All modifications shall be electrically compatible with existing fire alarm control panels in all respects. Provide all required equipment, programming, software reprogramming, instrumentation, modules, relays, as required. Provide testing, correcting, retesting of Building One fire alarm control panel.

## **2.9 BUILDING 200**

- A. Provide upgraded modifications to first floor Building 200 fire alarm control panel by providing additional extender panel or new transponder panel to receive all fire alarms, trouble alarms, supervisory alarms from Emergency Department transponder panel and subsequent transmission to Village of Broadview Fire Department via Building One main site fire alarm control panel. All modifications shall be electrically compatible with existing fire alarm control panels in all respects. Provide all required equipment, programming, software reprogramming, instrumentation, modules, relays, as required. Provide testing, correcting, retesting of Building 200 fire alarm control panel.

## **2.10 WIRING - DETAILS**

- A. Provide shielded twisted pair riser wiring two hour fire rating when installed in a conduit system from new transponder panel to existing Building 200 first floor fire alarm control panel. All wiring shall be installed in a conduit systems. All wiring shall be in complete conformance with the manufacturer's wiring diagrams, and instructions.
- B. Provide 120V - 20A life safety circuits to new transponder panel for magnetic door holders. Provide relays and all related wiring in a conduit system and instrumentation for holding doors open and releasing doors only in a fire alarm condition. Door holders shall not release when exercising standby generator or on a loss of normal utility power supply.
- C. Provide all required wiring in conduit; relays and instrumentation to release electrically locked doors only in a fire alarm condition. Provide all required wiring, conduits, boxes, relays, instrumentation, testing, correcting, retesting, and all final connections. Door electric locks shall not be released when standby generators are exercised or on a loss of normal utility power supply.
- D. Smoke Dampers - Provide all required wiring in conduit; relays and instrumentation for smoke and fire damper actuators to close dampers when associated duct detector is activated to a fire alarm condition. Provide required circuits, relays, duct detectors, detector auxiliary contacts, with coordinated electrical characteristics for a complete operating duct detector - smoke/fire damper installation. Provide (2) 120V-20A critical circuits to fire alarm panel relays with 24V coils or 24V fire alarm wiring to damper actuators as applicable; coordinated with spring return dampers. Power to be in the open position; loss of power spring return close dampers. Damper actuator shall not operate smoke dampers when exercising standby generators. Provide all required instrumentation to operate smoke dampers coordinated upon duct smoke detector detection of smoke particles via damper actuators. Exercising of standby generators or on a loss of utility power supply shall not cause the smoke damper to go into a failsafe position. Provide for reset in new transponder panel.

## **2.11 ZONES**

Provide all required labor, materials, tools, equipment, services, and instrumentation for transmitting fire alarm zones; trouble zones; supervisory zones from Emergency Department new emergency department transponder panel; to Building 200; and Building One fire alarm control panels and to Village of Broadview Fire Department including but not limited to the following:

- A. Provide transmission of fire alarms, supervisory alarms, trouble alarms from new fire alarm devices to new emergency department transponder panel; from new Emergency Department transponder panel to existing first floor Fire Alarm Control panel; from existing first floor fire alarm control panel to Building One Section F existing main site fire alarm control panel for alarm, trouble, supervisory alarms. Provide separate zones for each duct smoke detector and each room smoke detector; provide separate zones for each pull station; provide separate zones for fan shutdown of each air handling unit; provide separate zones for fire and smoke dampers; trouble and supervisory for each zone. Provide separate supervisory zones for tamper switches; provide separate fire alarm zones for each flow switch. Provide all required fire alarm modules and all required instrumentation for alarm zones, trouble zones, supervisory, fan shutdown, fire dampers activation and reset, smoke dampers activation and reset, initiation, pre-signal alarm, all telecommunications wiring and hardwiring in conduit. Final connections to new transponder panel shall be provided by fire alarm equipment manufacturer authorized technician. Provide spare zones certified ready for activation, complete with all required equipment for alarm, trouble, supervisory, in new transponder panel and all required instrumentation and modifications to existing fire alarm panels in Building One and Building 200 as required.

## **2.12 ADDRESSABLE INTERFACE DEVICES**

- A. New addressable interface modules shall be provided wherever required for interfacing normally open direct contact devices such as waterflow switches, valve tamper switches and non-addressable initiating devices to addressable signaling line circuits.
- B. Provide New Zone Addressable Modules (ZAMS) suitable for monitoring in a standard electric outlet box. ZAMs shall include cover plates to allow for surface or flush mounting. ZAMs shall receive their 24VDC power from a separate two wire pair provided by an appropriate power supply, and shall provide supervised monitored circuits capable of reporting status changes non addressable devices. Each ZAM shall be capable of being programmed for its "address" location on the addressable device signaling line circuit.

## **2.13 PROVIDE NEW TRANSPONDER PANEL EMERGENCY STANDBY POWER SUPPLY**

- A. Batteries: Provide sealed, maintenance-free, lead-calcium batteries as the source for emergency power to the remote fire alarm control panel. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state UL listed and labeled battery charger. Provide an

automatic transfer switch to transfer the load to the batteries in the event of failure of primary power. Batteries shall have lead bolt-on or wind-nut-type terminals. Batteries with fast-tab terminals are unacceptable.

- B. Capacity: Provide the batteries with sufficient capacity to operate all signaling line circuits, initiating device circuits, smoke dampers, fire dampers, and notification appliance circuits in normal or supervisory (non-alarm) mode for a period of not less than 60 hours. Following this period of operation on battery power, the batteries shall have sufficient capacity to operate all components of the system in alarm mode for a period of 15 minutes. All normal operating, supervisory, and battery power, and fault conditions shall be electrically supervised and annunciated.
- C. Provide typewritten illustrative battery calculations. Include spare and future zones with 15 minutes in alarm.
- D. Battery Charger: Provide a UL labeled and listed solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 150 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged the charger shall recharge them back to 95% of full charge within 48 hours. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided. Provide a separate ammeter for recording rate of charge and a separate voltmeter to indicate the state of the battery charge or provide a system which displays this information as an integral part of the transponder panels.

#### **2.14 ADDRESS REPORTING INTERFACE DEVICES**

- A. All reporting devices shall be provided with unique addresses that reports directly to the new transponder panel.
- B. Shall be configurable to monitor normally open or normally closed devices for both alarm, trouble alarm, and supervisory alarm.
- C. Shall have terminal designations clearly differentiating between the circuit to which they are reporting from and the device that they are monitoring. All terminations shall be identified corresponding to transponder panel identification.
- D. Shall be UL listed for fire alarm use and compatibility with the panel to which they are connected.

#### **2.15 SMOKE BARRIER DOOR CONTROL**

- A. Provide Electromagnetic Door Holders:
  - 1. 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. Coordinate with the Architect and hardware supplier.

2. Electrical characteristics of door holder and operation shall match existing Building 200 fire alarm system door holder electrical characteristics and door release operation in Building 200. Provide 120V circuits from critical branch panel to new transponder panel relays for release of magnetic door holders after one round of code. Door holders shall be coordinated as to voltage, amperes, and voltage drop, wiring and fire alarm system for operation as specified.
  3. Magnetic door holders shall only release in a fire alarm condition. Door holders shall not release when standby generators are exercised or on normal loss of utility power supply.
- B. Door holders shall be wired to allow releasing doors by smoke zone.
  - C. Provide smoke detectors on both sides of door per NFPA requirements.
  - D. Door holder control circuits shall be electrically supervised.
  - E. Door holders shall not release until after one full round of fire alarm code.
  - F. Smoke detectors shall not be incorporated as an integral part of door holders.
  - G. Provide all required instrumentation, relays, power supplies for a complete and functioning installation.

#### **2.16 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 to match existing keying system.
- 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.
- D. Match existing keying.

#### **2.17 SPARE AND REPLACEMENT KEYS:**

- A. Provide spare and replacement parts as follows:
  1. Fire alarm strobes - 2
  2. Smoke detectors - 2
  3. Control equipment keys - 10
  4. Key operated manual pull station keys - 10
  5. Monitor modules - 1

6. Control modules - 1

- B. Spare and replacement parts shall be in original packaging with identification and submitted to the COTR.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Installation shall be in strict conformance with all applicable publications specified herein as a minimum and in conformance to the manufacturer's instructions, wiring diagrams, manuals, recommendations.
- B. Install smoke detector heads not more than two weeks prior to final inspection. Provide dust cover baggies for each smoke detector. Remove all dust covers when construction is substantially completed. Coordinate with COTR.
- C. At the final inspection, the contractor and a factory trained representative of the manufacturer of the major equipment shall provide the testing specified herein for existing Building 200 fire alarm control panel, Building One fire alarm control panel and new fire alarm transponder panel. The contractor and the fire alarm system representative shall provide and demonstrate that the entire Building 200 fire system alarm system including new transponder panel and Building One fire alarm system functions properly in every respect in the presence of VA Resident Engineer. Provide typewritten certifications.
- D. Fire Alarm Systems shall be provided and tested in the presence of VA Resident Engineer and the Contracting Officer's Technical Representative (COTR); and the Village of Broadview Fire Department. Contractor shall provide all required corrections and re-testing. Pay all required fees to Village of Broadview Fire Department.
- E. Installation of all fire alarm devices equipment, wiring, installations, shall be in strict conformance with NFPA 70, 72, 90A, and 101. Fire alarm wiring shall be provided in conduit. All conduit and wire shall be provided in accordance with Section 16111, CONDUIT SYSTEMS, Section 16127 CABLES, LOW VOLTAGE, and all penetrations of smoke and fire barriers shall be protected as required by Section 07270, FIRESTOPPING SYSTEMS.
- F. All new conduits, junction boxes, conduit supports and hangers shall be concealed. All existing accessible fire alarm conduit not reused shall be removed and shall be legally disposed of.
- G. All exposed conduit shall be painted in accordance with Section 09900, PAINTING to match surrounding finished areas and red in unfinished areas. All fire alarm conduits exposed and above ceilings shall be provided with conduit markers reading "Fire Alarm System" red lettering on a white background every 10 feet.
- H. All fire detection and alarm system devices, transponder panels, etc. shall be flush mounted or semi-flush mounted as applicable when

located in finished areas and may only be surface mounted when located in unfinished areas. Exact locations to be approved by the COTR.

- I. Strobes shall be flush wall mounted 80 inches above the floor or 6 inches below ceiling, whichever is lower. Locate and mount to maintain a minimum 36 inches clearance from side obstructions.
- J. Manual pull stations shall be provided not less than 42 inches from finished floor to bottom of device and within 60 inches of a stairway or an exit door.
- K. Operation of a smoke detector at corridor doors used for automatic closing shall release only the magnetic door holders in that smoke zone and only after one full round of code.
- L. Operation of duct smoke detectors shall cause a system fire alarm condition and shut down the applicable HVAC system and close associated fire dampers and smoke dampers. Provide all required wiring and instrumentation
- M. Operation of any sprinkler tamper switch shall cause a system supervisory condition.
- N. Electric door locks shall release to an unlocked position in a fire alarm condition.
- O. Devices such as magnetic door holders, electric locks, smoke dampers, fire dampers shall not release magnetic door holders; unlock door locks; or close smoke and fire dampers wherever standby generators are in exercise mode or upon loss of normal utility power supply.

### **3.2 TYPICAL OPERATION (BUILDING 200)**

- A. Normal System Operation: Actuation of any manual station, detector, or water flow switch shall cause the following operations to occur:
  - 1. Operate the audible chimes; transmitting four rounds of coded pre-signals.
  - 2. After manual pull station is activated, visual strobes will flash in unison with audible signals. Visual strobes shall continue to flash march time until reset at the fire alarm control panel.
  - 3. Light the associated zone and category lamp on the Building 200 fire alarm control panel and Emergency Department transponder panel.
  - 4. Release all magnetic door holders on the floor from which alarm was initiated after one full round of code. Single impulses with time delay shall not release the door holders.
  - 5. Transmit a separate code alarm signal, via an individual auxiliarized transmitter and base loop wiring, to new

transponder panel, existing Building 200 FACP, and the Building One fire alarms control panel; and transmission to Village of Broadview Fire Department.

6. Record events for each fire alarm, each trouble alarm, each supervisory alarm on the fire alarm printer; date stamped/time stamped.
  7. Operation of any sprinkler and standpipe valve supervisory switch shall cause the system to go into trouble alarm condition.
  8. Door holders shall release doors (only after one round of code gong).
  9. Electrically locked doors shall be unlocked.
    - a. It shall not cause the system to go into alarm condition.
    - b. It shall not prevent any flow switch from actuating an alarm.
  10. Fan shutdown for all HVAC equipment serving the zone.
  11. Activation of fire dampers and smoke dampers.
  12. Each event shall be recorded on the fire alarm printer.
- B. System Supervision: System supervision shall include the following conditions:
1. Loss of operating or standby power.
  2. A single ground or open circuit in alarm initiating circuits, alarm indicating circuits, and auxiliarized transmitter trip circuits, and sprinkler and standpipe valve circuits. Each zone shall have its own supervisory devices.
  3. Off-normal position of sprinkler and standpipe valves.
  4. Each supervision event shall be recorded on the fire alarm printer.
  5. System supervision shall be transmitted to Building 200 fire alarm system; to Building One second floor fire alarm panel; to Village of Broadview Fire Department.
- C. Trouble Signals:
1. Derangement of any of the above supervised conditions shall be visually and audibly annunciated at the fire alarm control panel. Each circuit or zone shall have individual visual annunciation.



2. Operation of the sprinkler and standpipe valves towards the closed position shall cause a trouble alarm signal.
3. Trouble signals shall be re-transmitted, via an individual auxiliarized transmitter and base loop wiring, to Building 200 fire alarm control panel; Building One fire alarm control panel; to Village of Broadview Fire Department. This signal shall be separate, coded, and different from all other signals.
4. Each trouble event shall be recorded by the fire alarm printer.

### **3.3 PROVIDE PRELIMINARY ACCEPTANCE TESTING FOR EACH PHASE OF RENOVATION**

- A. Provide the services of a Simplex NIET Level III competent, factory-trained engineers or technicians authorized by the manufacturer of the fire alarm equipment to supervise and participate during all of the adjustments and tests for each fire alarm system. Make all adjustments and tests in the presence of the Resident Engineer.
- 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 Resident Engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meet or exceed all contract documents, and all applicable codes and standards. After the system has passed the preliminary test and been approved by the Resident Engineer, the contractor shall request a final inspection when all phases of renovation have been completed. Final acceptance of the entire system shall not be made until retested at final inspection.
- C. Notify Village of Broadview Fire Department three weeks in advance of all testing to witness testing. Pay Village of Broadview witness fees.
- D. Notify the Contracting Officer and the Resident Engineer in writing when the system is ready for final acceptance testing. Submit request for test at least 21 calendar days prior to the preliminary test date. A final acceptance test will not be scheduled until all phases of renovations have been completed. Provide the following for review and acceptance.
  1. Marked-up red line as-built drawings of the system as actually installed.
  2. Megger test results.
  3. Loop resistance test results.
  4. Complete program printout including all input/output addresses.
  5. Detailed report of preliminary testing.

- E. The preliminary testing and final tests shall be witnessed by VA COTR and VA Resident Engineer and Village of Broadview Fire Department. Pay Village of Broadview witness fees. At this time, any and all required tests shall be repeated at the discretion of the Government.
- F. General: Preliminary test the system in accordance with the procedures outlined in NFPA 72 as a minimum in addition to testing stipulated below. The required tests include but are not necessarily limited to the following:
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. Open each initiating and notification to see if trouble signal actuates.
  4. Open audible signal circuits to see if the trouble signal actuates.
  5. Ground fire alarm station circuits and verify response of trouble signals.
  6. Ground each alarm initiating and notification circuit, and verify response of trouble signals.
  7. Verify code transmission to Village of Broadview Fire Department of all Emergency Department fire alarm devices and verify proper operation of positive non-interfering succession requirements by operating two fire alarm stations simultaneously.
  8. Operate all panels with battery backup. Verify battery charge rate per manufacturer's specifications.
  9. Fire alarm and detection equipment including existing main fire alarm control panel located in Building No. One; existing fire alarm control panel located in Building 200; all alarm zones, trouble zones, supervisory zones. Verify wiring, zone, trouble supervisory identification, battery plant testing, battery charger testing, lamp testing.
  10. Verify instrumentation and operation and wiring for all fan shutdown, fire dampers, smoke dampers.
  11. Test, correct and retest transmission of fire alarms, trouble alarms, supervisory alarms to Village of Broadview.
  12. Test all duct detectors, smoke and fire dampers and all room smoke detectors.

13. Provide Megger Tests: After all wiring has been installed, and prior to making any connections to panels or devices, all wiring shall be megger tested for insulation resistance grounds and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.
14. Provide Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit original. The tests shall be witnessed by the VA COTR, VA Resident Engineer and test results recorded for use at the final acceptance test.
15. Conduct preliminary testing to ensure that all devices and circuits are functioning properly. Tests shall meet the requirements of this Performance Specification as a minimum. After preliminary testing is completed, provide typewritten pre-certification notarized, signed, dated by the fire alarm manufacturer, the contractor and all applicable sub-contractors certifying that the installation is complete and fully operable. The pre-certification shall state that each initiating and indicating device was tested in place and functioned properly. The pre-certification shall also state that all panel functions were tested and operated properly. The pre-certification shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments. VA Resident Engineer and COTR must be present at the preliminary test. Provide prior written notice to COTR.
16. Submit all preliminary test reports with detailed front end synopsis of each event and corrective action taken. Provide six copies in (3) ring binders. All reports shall be dated and time stamped.
17. All preliminary test reports shall be typewritten, notarized, signed, dated by the manufacturer, the contractor and all applicable sub-contractors.

**3.4 PROVIDE FINAL ACCEPTANCE TESTING AFTER COMPLETION OF ALL PHASES OF RENOVATIONS**

- A. Provide the services of a Simplex NET Level III competent, factory-trained engineers or technicians authorized by the manufacturer of the fire alarm equipment to supervise and participate during all of the adjustments and tests for each fire alarm system. Make all adjustments and tests in the presence of the Resident Engineer.
- B. After all phases of renovations and systems have been completed and prior to the scheduling of the final inspection, provide testing

equipment and perform the following tests in the presence of the Resident Engineer. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meet or exceed all contract documents, and all applicable codes and standards. After the system has passed the test and been approved by the Resident Engineer, Village of Broadview Fire Department, the contractor shall request a final inspection. Final acceptance of system shall not be made until retested at final inspection.

- C. Notify the Village of Broadview Fire Department three weeks in advance of all testing. Pay all required Village of Broadview witness testing fees.
- D. Notify the Contracting Officer and the Resident Engineer in writing when the system is ready for final acceptance testing. Submit request for test at least 21 calendar days prior to the test date. A final acceptance test will **not** be scheduled until the O & M Manuals are provided to the Contracting Officer and the following are submitted for review and acceptance.
  - 1. Provide marked-up red line as-built drawings of the system as actually installed. Provide (3) sets of as-built hard copy drawings and (3) CD-Rom diskettes in the format as determined by the VA Resident Engineer. Diskettes shall be clearly identified for this project.
  - 2. Provide megger test results.
  - 3. Provide loop resistance test results.
  - 4. Complete program printout including all input/output addresses.
  - 5. Provide detailed report of preliminary testing.
- E. The final tests shall be witnessed by VA COTR and VA Resident Engineer and the Village of Broadview Fire Department. Pay Village of Broadview witness fees. At this time, any and all required tests shall be repeated at the discretion of the Government.
- F. General: Test the system in accordance with the procedures outlined in NFPA 72 as a minimum in addition to testing stipulated below. The required tests include but are not necessarily limited to the following:
  - 1. Verify the absence of ground faults and unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
  - 2. Verify that the Emergency Department transponder panel and Building 200 first floor fire alarm control panel and Building One FACP are in the normal condition as detailed in the manufacturer's operating and maintenance manual.

3. Test each initiating and indicating device and circuit for proper operation and response at the control unit.
4. Test the system for all specified functions in accordance with the contract drawings and specifications and the manufacturer's operating and maintenance manual.
5. Test both power and secondary standby power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified in NFPA 72.
6. Determine that the system is operable under trouble conditions.
7. Visually inspect all wiring.
8. Test the battery charger and batteries.
9. Verify that all software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided by the Contracting Officer.
10. Verify absence of ground faults.
11. Measure the current in circuits to assure there is the calculated spare capacity for the circuits.
12. Measure voltage readings for circuits to assure that voltage drop is not excessive.
13. Disconnect the verification feature for smoke detectors during tests to minimize the amount of smoke or test gas needed to activate the detector.
14. Measure the voltage drop at the most remote appliance on each notification appliance circuit.
15. The complete system shall be free from grounded or open circuits.
16. Test each room smoke detector, each chime, strobe, horn, duct smoke detector, remote indicating lamp, pull station, flow switch, tamper switch.
17. Test each chime for proper coded signals.
18. Test each smoke damper and each fire damper.
19. Each alarm initiating device functions as specified and produces the specified alarm actions.
20. Abnormal condition of any circuit or device required to be electrically supervised shall result in the specified trouble signals.

21. The battery charger and standby emergency power source (battery backup) is capable of operating the system per contract documents.
22. The system shall be operable under the specified trouble conditions.
23. Final testing shall be witnessed by the Village of Broadview Fire Department. Pay the Village of Broadview the required fee payments.
24. Test, correct, all deficiencies and retest fire alarm system until accepted by VA Resident Engineer, Contracting Officer's Technical Representative and the Village of Broadview Fire Department.
25. Submit six detailed typewritten printed test reports in (3) ring binder books, with front end synopsis detailing each event and corrective action taken. All reports shall be dated and time stamped.
26. All test reports shall be notarized, signed, and dated by the manufacturer, the contractor, and all applicable sub-contractors.
27. Provide signed Certificate of Approval from Village of Broadview Fire Department in (5) three ring binder books. {au required Village of Broadview fees.

### **3.5 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. Provide typewritten certified test reports in (5) three ring binders indicating system defects and corrections all certifications shall be notarized, signed, dated by the manufacturer, the contractor, and all applicable sub-contractors.
- B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the test in Article FINAL TESTING 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.

### **3.6 INSTRUMENTATION/ WIRING**

- A. Provide all required data wiring and equipment including but not necessarily limited to jacks, wiring, modems, outside telephone lines with dial tones, conduits, software, upgraded software, hardware, programming, boxes, coverplates, and all final connections

for a complete installation, tested, corrected and re-tested, certified ready for operation in all respects.

- B. Provide all required telecommunications wiring and hardwiring for fire alarm, trouble alarm, supervisory alarm in a conduit system from new fire alarm devices to new transponder panel and to existing first floor fire alarm control panel. Upgrade existing Building 200 first floor FACP and upgrade Building One FACP with all required modules, power supplies, wiring, devices, components, software, programming, upgrading existing software all final connections certified complete in place ready for operation.
- C. Provide all required software, upgraded software, instrumentation, modems, drivers, interface components for transmitting fire alarms, trouble alarms, supervisory alarms from upgraded Building 200 FACP to Building One existing upgraded fire alarm control panel; and to Village of Broadview Fire Department via modems, outside telephone lines with dial tones, jacks, AIMS, MINTS, programming, reprogramming.
- D. Provide all required programming, software, upgraded software, instrumentation, modems, drivers, MINTS, interface components for transmitting fire alarm condition, trouble condition, and supervisory condition from new transponder panel and upgraded existing Building 200 first floor fire alarm control panel to upgraded Building One second floor main fire alarm control panel; and to Village of Broadview Fire Department. Provide all testing, correcting, retesting, and written certification.
- E. Provide Connections:
  - 1. Provide screw terminals for each notification appliance. Terminals shall be designed to accept the size conductors used in this project without modification.
- F. Provide all testing, correcting, retesting, and typewritten certification.
- G. Provide all required instrumentation, modules, sufficient standby power supplies, devices, wiring, conduits, final connections, components for wiring and controls for operating fan shutdown, smoke dampers, fire damper and associated damper actuators operation, fire alarm, trouble alarm, supervisory alarm conditions from Emergency Department transponder panel to Building 200 first floor fire alarm control panel and to Building One fire alarm control panel; to Village of Broadview Fire Department. Provide all testing, correcting, retesting, and certification.
- H. Provide all required category 6 twisted shielded four pair #22 telecommunications wiring, outside telephone lines with dial tones, arrange for required telephone numbers, all wiring to VA telecommunications distribution frames, modems, AIMS, MINTS, AEMS, upgraded software, software programming, all required jacks, and all final connections for a complete in place installation certified ready for operation in all respects.

- I. Existing Building 200 first floor fire alarm control panel. Provide all labor, materials, tools, equipment and services for transmitting fan shutdown, fire alarm, trouble and supervisory to Building No. One 2nd floor existing main fire alarm control panel, via modem and analog input modules, modems, fire alarm panel extensions, AEMS zone modules, trouble modules, fire alarm modules, supervisory modules, power supplies, printed circuit cards, device modules, telecommunications wiring, outside telephone lines with dial tones, programming, software, hardware.
- J. Provide all required modems, outside telephone lines with dial tones and analog input modules for transmission of fire alarm and detection conditions and trouble and supervisory for smoke dampers, fire dampers and fan shutdown conditions to existing site main fire alarm control panel located in Building No. One on 2nd floor Section F. Provide all required programming, software, upgraded software, modems, category 5 jacks and telephone wiring in conduit with outside telephone lines with dial tones for receiving fire alarm and trouble at the Building One 2nd floor Section F site main fire alarm control panel and transmit to Village of Broadview Fire Department. Provide all telecommunications wiring, jacks, and all final connections.
- K. Provide all required wiring, conduits, modules, relays, instrumentation, software, programming, reprogramming, wiring, conduits for fan shutdown, fire dampers, smoke dampers, alarm, trouble, supervisory, for a complete installation ready for operation in all respects.

### **3.7 POWER CIRCUITS**

- A. Provide 120V-20A power circuits for new transponder panels from life safety panel. Provide circuit breaker lock-on device with red label, white lettering "Emergency Department Fire Alarm Device" adjacent to designated circuit breakers.

### **3.8 PROVIDE SYSTEM FIELD WIRING**

- A. Wiring Within Component Enclosures and Terminal Cabinets:
  - 1. All wiring shall be provided in a neat and workmanlike manner and shall be trained parallel with or at right angles to the sides and back of any enclosure or cabinet. All circuit conductors entering or leaving any enclosure or cabinet shall be connected to terminal blocks with each terminal and conductor marked in accordance with the wiring diagram for identification. Connections shall be made with either crimp-on terminal spade lugs or with approved pressure type terminal blocks. A terminal cabinet shall be installed where circuit risers originate or where any circuit tap is made. All wiring within the panel shall be readily accessible without removing any component parts.
- B. Manual Pull Stations
  - 1. Manual stations shall be mounted with the operating handle at 42 inches above the floor level and within 5 feet of each means of egress from that floor. Manual stations shall be flush mounted.



- C. Provide System Field Wiring:
- a) All conductors shall be provided in rigid conduit or electrical metallic tubing installed concealed. Exposed mounting boxes shall be seamless metal boxes without knockouts. Each conductor used for the same specific function shall be distinctively color coded. All conductors shall be tagged or marked. Two different color codes shall be used for initiating device circuits. Power supply and wiring connecting the secondary source of power shall be as indicated. Wiring for the fire alarm system shall be installed in a conduit system separate from any other wiring system.
- D. Addressable device wire shall be not less than 16GA shielded twisted pair. Strobe wire shall be not less than 12GA THHN. Wiring from addressable zone modules to non-addressable devices shall not be less than 12THHN. Wire size shall be sufficient to prevent voltage drop problems. Revise wire gauge accordingly for long distances. Circuits operating at 24 VDC shall not operate at less than 121.6 volts. Circuit operating at any other voltages shall not have a voltage drop exceeding 10% of nominal voltage. Power wiring, operating at 120 VAC minimum, shall be No. 12 AWG solid copper having similar insulation. Install all conductors in rigid conduit or electrical-metallic tubing. The use of flexible conduit not exceeding a six foot length shall be permitted in initiating device circuits. Install conduit or tubing concealed. For shielded wiring, the shield shall be grounded at only one point, which shall be in or adjacent to the FACP.
- E. Conductor Terminations shall be provided under the direct supervision of the manufacturer. Color coding as per existing fire alarm/voice communications standard and existing building wiring conditions. Provide labeling for all terminal blocks in terminal cabinet, and new fire alarm transponder panels each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Transponder fire alarm control panels shall contain a laminated drawing that indicates each conductor, its label, circuit and terminal. The laminated drawing shall be neat, using 12 point lettering minimum size, and mounted within each cabinet, panel or unit so that it does not interfere with the wiring or terminals.
- F. Provide riser cable in conduit from new transponder panel to existing first floor Building 200 main fire alarm control panel. Provide, furnish, install fire alarm riser cable installed in minimum 3/4 inch EMT conduit for minimum full two hour fire rating. Cable shall be shielded twisted pair; FPL (UL1424); NPLF (UL1425) two hour rated in 3/4 inch EMT; 300V, 72V utilization, low smoke, zero halogen jacket, solid conductors. Two twists per foot. Wire size #12.
- G. Wire magnetic door holders at 120V via relays in transponder panels with 24V Dc coils. Wire smoke detectors on each side of the door to release magnetic door holders after one round of code. Provide relays and instrumentation and all required wiring. Make all final connections.
- H. Provide required wiring and installation to release electrically locked doors for fire alarm condition. Provide all required wiring,

relays, testing, correcting and retesting. Make all final connections. Relays shall be provided with 24 VDC coils. Verify electric lock voltages prior to doing any work.

### **3.9 FIRESTOPPING**

- A. General: Firestop all holes and openings for conduit, piping, or other penetrations which pass through floor slabs, fire-rated walls, partitions with fire-rated doors, vertical service shafts, or any fire-rated assemblies.

### **3.10 INSTALLATION OF FIRE ALARM INITIATING AND INDICATING DEVICES**

- A. Transponder Panel: Flush mount the enclosure with the top of the cabinet 70 inches above the finished floor. All conductor terminations shall be labeled and a drawing containing all conductors, their labels, their circuits and their interconnections shall be permanently mounted in the transponder panel.
- B. Manual Pull Stations: Install and mount stations so that their operating handles are 42 inches above the finished floor.
- C. Notification Appliance Devices: Mount assemblies on walls 80 inches above the finished floor. Ceiling mounted speakers shall conform to NFPA 72.
- D. Smoke Detectors: Detectors located on the ceiling shall be installed not less than 100 mm from a side wall to the near edge. Those located on the wall shall have the top of the detector at least 100 mm below the ceiling, but not more than 300 mm below the ceiling.

### **3.11 KEYS**

- A. General: Keys and locks shall be provided for all equipment shall be identical. Provide not less than six keys of each type required.

### **3.12 SOFTWARE AND HARDWARE**

- A. The manufacturer's authorized representative shall provide all on-site software and hardware modifications and submit a typewritten report to the VA Resident Engineer attesting to the proper operation of the completed system.

### **3.13 MAINTAIN CONTINUITY OF EXISTING FIRE ALARM SYSTEM**

- A. The fire alarm devices, appliances, wiring shall be provided, complete in place ready for operation with complete compatibility in all respects with the existing Building 200 fire alarm system and Building One fire alarm system. The existing Building 200 fire alarm systems shall be maintained in complete operation at all times during the entire construction period without exception.

### **3.14 SPARE PARTS AND TOOLS**

- A. Keys and locks for all equipment shall be identical. Not less than 6 keys for each type required shall be provided. Keys shall be identified by an appropriate number stamped on the key or on a metal tag attached thereto.

### **3.15 INSTRUCTION**

- A. The manufacturer's authorized representative shall provide instruction and training to the VA as follows:
  - 1. Minimum two three-hour sessions to engineering staff, security police and central attendant personnel for simple operation of the system. One session at the completion of installation and one 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 when activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72. Provide four binders. Provide four CD-Rom diskettes in the format as determined by the VA Resident Engineer.

### **3.16 VILLAGE OF BROADVIEW FIRE DEPARTMENT**

- A. Contractor shall pay Village of Broadview fees for all Village of Broadview services rendered as required to completion of Emergency Department Renovations. Include all costs in Bid Proposals. Verify prior to Bid Proposal.

- - - E N D - - -