

# 23

## DIVISION

### HEATING, VENTILATING, and AIR CONDITIONING

## TABLE OF CONTENTS

DIVISION 23: HEATING, VENTILATING, and AIR CONDITIONING

|               |                                                                 |               |                                                                    |
|---------------|-----------------------------------------------------------------|---------------|--------------------------------------------------------------------|
| 230501        | Common Work Results for HVAC                                    | <b>234323</b> | <b><i>Air Cleaning System</i></b>                                  |
| 230507        | HVAC Piping                                                     | <b>235100</b> | <b><i>Breeching, Chimneys, and Stacks</i></b>                      |
| 230514        | Variable Frequency Drives                                       | <b>235213</b> | <b><i>Electric Boilers</i></b>                                     |
| 230519        | Meters and Gauges for HVAC Piping                               | <b>235216</b> | <b><i>Flue Gas Condensing Boilers</i></b>                          |
| 230523        | General Duty Valves for HVAC Piping                             | <b>235223</b> | <b><i>Cast Iron Boilers</i></b>                                    |
| 230525        | Roof Curbs                                                      | <b>235225</b> | <b><i>Steel Firebox Boilers</i></b>                                |
| <b>230529</b> | <b><i>Hangers and Supports for HVAC</i></b>                     | <b>235233</b> | <b><i>Flexible Water Tube Boilers</i></b>                          |
| 230548        | Vibration and Seismic Control for HVAC                          | <b>235239</b> | <b><i>Packaged Firetube Boilers</i></b>                            |
| 230553        | Identification for HVAC                                         | <b>235700</b> | <b><i>Heat Exchangers</i></b>                                      |
| <b>230593</b> | <b><i>Testing, Adjusting, and Balancing for HVAC</i></b>        | <b>236213</b> | <b><i>Refrigerant Condensing Units</i></b>                         |
| 230719        | HVAC Insulation                                                 | <b>236215</b> | <b><i>Multiple-Compressor Refrigerant<br/>Condensing Units</i></b> |
| <b>230923</b> | <b><i>HVAC Direct Digital Controls</i></b>                      |               |                                                                    |
| <b>230993</b> | <b><i>Sequence of Operation for HVAC</i></b>                    | <b>236416</b> | <b><i>Packaged, Centrifugal Water Chiller</i></b>                  |
| <b>231101</b> | <b><i>Liquid Petroleum Gas Piping</i></b>                       | <b>236423</b> | <b><i>Packaged, Scroll Water Chiller</i></b>                       |
| <b>232113</b> | <b><i>HVAC Piping Specialties</i></b>                           | <b>236426</b> | <b><i>Packaged, Rotary Screw Water Chiller</i></b>                 |
| <b>232117</b> | <b><i>Glycol Heat Transfer Fluid</i></b>                        | <b>236440</b> | <b><i>Refrigerant Monitoring Systems</i></b>                       |
| <b>232119</b> | <b><i>HVAC Flow Control</i></b>                                 | <b>236500</b> | <b><i>Packaged Cooling Towers</i></b>                              |
| <b>232123</b> | <b><i>HVAC Hydronic Pumps</i></b>                               | <b>236533</b> | <b><i>Closed Circuit Fluid Coolers</i></b>                         |
| <b>232300</b> | <b><i>Refrigerant Piping</i></b>                                | <b>237119</b> | <b><i>Ice Storage System</i></b>                                   |
| <b>232500</b> | <b><i>HVAC Water Treatment</i></b>                              | <b>237200</b> | <b><i>Air to Air Energy Recovery Equipment</i></b>                 |
| <b>233113</b> | <b><i>Low-Pressure Ductwork</i></b>                             | <b>237313</b> | <b><i>Modular Indoor Air Handling Units</i></b>                    |
| <b>233115</b> | <b><i>Medium-Pressure Ductwork</i></b>                          | <b>237323</b> | <b><i>Custom Indoor Air Handling Units</i></b>                     |
| <b>233117</b> | <b><i>Flexible Ductwork</i></b>                                 | <b>238113</b> | <b><i>Unitary Air Conditioning Equipment</i></b>                   |
| <b>233300</b> | <b><i>Ductwork Accessories</i></b>                              | <b>238123</b> | <b><i>Computer Room Air Conditioners</i></b>                       |
| <b>233313</b> | <b><i>Exterior Wall Louvers</i></b>                             | <b>238146</b> | <b><i>Water Source Heat Pumps</i></b>                              |
| <b>233400</b> | <b><i>HVAC Fans</i></b>                                         | <b>238156</b> | <b><i>Ground Source Heat Pumps<br/>(geothermal)</i></b>            |
| <b>233423</b> | <b><i>Rooftop Intake, Exhaust, &amp; Relief Ventilators</i></b> |               |                                                                    |
| <b>233513</b> | <b><i>Dust Collection System</i></b>                            | <b>238219</b> | <b><i>Fan Coil Units – Four Pipe</i></b>                           |
| <b>233515</b> | <b><i>Welding Exhaust System</i></b>                            | <b>238223</b> | <b><i>Unit Ventilators – Four Pipe</i></b>                         |
| <b>233600</b> | <b><i>Variable Air Volume Terminals</i></b>                     | <b>238233</b> | <b><i>Convectors</i></b>                                           |
| <b>233713</b> | <b><i>Air Outlets and Inlets</i></b>                            | <b>238239</b> | <b><i>Cabinet Unit Heaters</i></b>                                 |
| <b>233716</b> | <b><i>Fabric Air Distribution Devices</i></b>                   | <b>238240</b> | <b><i>Propeller Unit Heaters</i></b>                               |
| <b>233718</b> | <b><i>Underfloor Air Distribution System</i></b>                | <b>238316</b> | <b><i>Radiant Heating Hydronic System</i></b>                      |
| <b>233800</b> | <b><i>Kitchen Hood Ventilation System</i></b>                   |               |                                                                    |

## SECTION 230501

## COMMON WORK RESULTS FOR HVAC

**GENERAL GUIDELINES****1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:**

- A. Pipe and pipe fittings.
- B. Dielectric fittings.
- C. Mechanical sleeve seals.
- D. Piping specialties.
- E. Installation requirements common to piping systems and specification sections.
- F. Installation requirements common to equipment specification sections.
- G. Testing and repair.
- H. Final completion.
- I. Record drawings.
- J. Maintenance and operating manuals.
- K. Lubrication and packing.

**1.2 SUBMITTALS**

- A. Submittal data is required for dielectric fittings, flexible connectors, mechanical sleeve seals, and piping specialties.
- B. Refer to specific sections of this specification for additional submittal requirements.

**1.3 QUALITY ASSURANCE**

- A. Any manufacturer other than basis of design shall be responsible for any additional requirements for electrical service, physical space limitations, and capacities at no additional cost to the project.
- B. Materials and installation shall comply with requirements of governing regulations and controlling agencies.
- C. All materials used shall be first grade of their kind and shall be new and in first-class condition when installed.
- D. Work done by the Contractor shall include the services of an experienced superintendent.

**HVAC****CHAPTER 9: SPECIFICATIONS**

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**1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Piping and tubing shall include factory-applied end caps.
- B. All piping and tubing shall be elevated from grade for onsite storage.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

**1.5 SEQUENCING AND SCHEDULING**

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in the building structure during progress of construction.
- C. Coordinate installation sleeves and supporting devices with concrete and structural components.
- D. Coordinate connection of mechanical systems with underground and overhead utilities and services.
- E. Coordinate requirements for access panels and doors.
- F. Coordinate installation of identifying devices.

**1.6 PROJECT CONDITIONS**

- A. HVAC support shall only be permitted at steel joist panel points.
- B. Any supplemental steel required for support between building structural members shall be the responsibility of the HVAC Contractor.

**1.7 PIPE AND PIPE FITTINGS**

- A. Pipe threads shall meet ASME B1.20.1 for factory-threaded pipe and pipe fittings.
- B. Pipe-flange gasket materials shall meet ASME B16.21, nonmetallic, flat, asbestos-free.
- C. Pipe Flanges
  - 1. Full face shall be Class 125, cast iron and cast-bronze material.
  - 2. Narrow face shall be Class 250, cast-iron and cast steel material.
- D. Flange bolts and nuts shall meet ASME B18.2.1.
- E. Solder filler materials shall meet ASTM B 32.
  - 1. Alloy Sn95 and Sn94 shall be used.
- F. Brazing filler materials shall meet AWS A5.8.

- G. Welding filler metals shall comply with AWS D10.12.
- H. Solvent materials shall meet standard solvent cement requirements.
  1. CPVC piping shall meet ASTM F 493.
  2. PVC piping shall meet ASTM D 2564. Include primer according to ASTM F 656.
  3. Plastic pipe seals shall meet ASTM F 477
  4. Flanged, ductile-iron gasket, bolts, and nuts shall meet AWWA C 110.

### 1.8 DIELECTRIC FITTINGS

- A. Fittings shall be zinc plated with a thermoplastic liner, rated for 250 degrees F maximum.

### 1.9 MECHANICAL SLEEVE SEALS

- A. Seals shall be designed with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve and shall include connecting bolts and pressure plates.

### 1.10 PIPING SPECIALTIES

- A. Piping sleeves shall be constructed of galvanized sheet metal or steel pipe. Steel pipe shall meet requirements of ASTM A 53, Type E, Grade A, Schedule 40. Sleeves for copper piping shall be of compatible material to prevent interaction of piping materials.
- B. Escutcheons shall be manufactured wall, ceiling, and floor plates, split-type, and of heavy chrome-plated construction.

### 1.11 HVAC PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Division 23 piping/ductwork sections specify unique installation requirements.
- B. Install components with pressure rating equal to or greater than system operating pressure.
- C. Install all piping and ductwork at right angles or parallel to the building walls. Diagonal runs are prohibited.
- D. Install piping and ductwork tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for panel removal.
- E. Install all piping specialties to meet manufacturer's requirements.
- F. Install pipe sleeves at all wall penetrations. Provide Schedule 40 steel pipe.
  1. PVC pipe sleeves are not permitted.
  2. Do not install sleeves through structural members.
- G. Maintain fire rating at fire wall penetrations through the use of approved fire sealant materials installed in pipe sleeve.

- H. Install unions in piping 2 inch and smaller adjacent to each valve and at final connection to each piece of equipment.
- I. Install flanges in piping 2-1/2 inch and larger adjacent to flanged valves and at final connections to equipment with flanged pipe connections.

**1.12 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to facilitate service, maintenance, and repair or replacement of components.
- B. Maintain lubrication gaskets and packing during construction and assure that at time of acceptance by the Owner, equipment is in first-class operating condition.

**1.13 EQUIPMENT START-UP**

- A. Start-up of all HVAC equipment shall be video-taped by the HVAC contractor. Two copies shall be turned over to the Owner's maintenance staff.

**1.14 TESTING AND REPAIR**

- A. All piping and ductwork systems shall be thoroughly cleaned and flushed prior to final testing.
- B. Supply, return, and exhaust air ductwork systems shall be pressure tested to a minimum leakage rate.
- C. Pressure testing shall be completed for the following piping systems:
  - 1. Heating water, chilled water, heat pump condenser loop water, and cooling tower condenser water systems.
- D. All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.
- E. Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

**1.15 FINAL COMPLETION**

- A. All work shall be cleaned prior to issuance of Substantial Completion.
- B. Retouch or repaint factory painted prime and finish coats where scratched or damaged.
- C. Deliver filters, belts, and equipment, as required by this Specification, to Owner and obtained signed receipts of delivery.
- D. Clean equipment, restore damaged materials, and leave the Work in acceptable condition.
- E. Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.

- F. Contractor shall submit written certificates warranting each item of equipment.

#### **1.16** RECORD DRAWINGS

- A. The Contractor shall keep a running record of each change and deviation from the Drawings on a clean and undamaged set of Drawings.
- B. The final Project Record Drawings shall be submitted to the Engineer for approval at the completion of the project.
- C. Record Drawings shall include the location of concealed piping and ductwork.

#### **1.17** MAINTENANCE AND OPERATING MANUALS

- A. The Maintenance and Operating Manuals shall comply with other Sections of this Specification. Submit in triplicate for inclusion in Maintenance and Operating Manuals.
- B. Bind the written operating instructions, approved shop drawings, equipment catalog cuts, equipment warranties, and manufacturer's instructions into a binder.

END OF SECTION

## SECTION 230507

## HVAC PIPING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for HVAC piping.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

**1.3 QUALITY ASSURANCE**

- A. Follow manufacturer's requirements for installation.
- B. Welding procedures per ANSI/ASME Section 9, AWS D10.9 and D1.1 and the National Certified Pipe Welding Bureau.
- C. Brazing procedures per ANSI B31.5 and the ASME Boiler and Pressure Vessel Code SFA-5.8, Section II.
- D. Soldering procedures per ANSI B16.18.
- E. Comply with ANSI B31 pressure code for pressure piping.

**1.4 HVAC PIPING**

- A. Heating, Chilled, Cooling Tower Condenser, and Heat Pump Condenser Water Supply and Return Piping
  - 1. Black steel piping
    - a. Piping shall be standard weight black steel for 2-1/2 inch and smaller per ASTM A53 or A120. Fittings shall be class 125 cast iron threaded per ANSI B16.4.
    - b. Piping shall be standard weight black steel for 3 inch and larger per ASTM A53 or A120. Fittings shall be butt welded.
  - 2. Copper piping
    - a. Piping 2-1/2 inches and smaller shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22.
  - 3. Grooved piping (option)
    - a. Grooved piping with ductile iron or bronze couplings and EPDM gaskets.
    - b. Copper and steel pipe shall be as listed above.
  - 4. Copper press fittings may be used as an option per ASTM B16.18 or ASTM B16.22. O-Rings shall be EPDM.
  - 5. Underground piping
    - a. Piping shall be pre-insulated piping system with copper or steel pressure carrier pipe, polyurethane insulation and PVC jacket.
    - b. Piping system shall include o-ring seals and expansion compensation.
    - c. Piping system shall incorporate thrust blocks and other accessories as recommended by system manufacturer.

- B. Underground, Ground Source Heat Pump System Piping
  - 1. High density polyethylene piping
    - a. Material classification per ASTM D-1248.
- C. Air Conditioning Condensate Drain Piping
  - 1. Piping shall be Schedule 40 PVC with solvent joints per ASTM D2665, D2564, D2665.
  - 2. In air plenums and through fire walls, Piping shall be type L copper per ASTM B88. Fittings shall be wrought copper per ANSI B16.22

## 1.5 INSTALLATION

- A. Terminate vent piping through roof, a minimum of 12 inches above the roof.

END OF SECTION

## SECTION 230514

## VARIABLE FREQUENCY DRIVES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for electronic variable frequency drive with motor starter.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product descriptive literature demonstrating compliance with written specification and, at a minimum, shall include the following:
  - 1. Inverter efficiency and power factor curves.
  - 2. Performance curves.
  - 3. Substantiating data for Mean Time Between Failure (MTBF).

**1.3 QUALITY ASSURANCE**

- A. Variable frequency drives shall comply with applicable requirements of the latest standards of ANSI, IEEE, NEMA, and NEC.
- B. Each drive shall be UL Listed.
- C. Drives used throughout a project site shall be provided by the same manufacturer for all applications (fans and pumps).
- D. Audible motor drive noise shall be no more than 5 db louder than across line starter operation.

**1.4 WARRANTY/TRAINING**

- A. Manufacturer shall warrant complete drive system for a period of 1 year.
- B. A factory trained representative shall provide a minimum of 8 hours on-site training to Owner selected personnel on the operation and maintenance of each drive installed.

**1.5 ELECTRONIC REQUIREMENTS**

- A. Each drive shall be microprocessor based, fully transistorized with 3 phase, full wave diode bridge input, and pulse-width-modulating sine-coded output waveform.
- B. Output transistors shall be of the Insulated Gate Bipolar Transistor (IGBT) type.
- C. Minimum 20 years MTBF required.
- D. Maximum switching frequency of 15 KHZ.
- E. Displacement power factor shall be 0.98 or better over the entire operating frequency and load range.

**1.6** PROTECTIVE FEATURES

- A. Drive enclosure shall be NEMA 1 and shall be wall-mount or free standing as indicated on the Drawings.
- B. Controlled acceleration and deceleration shall be adjustable from 3 to 600 seconds. Current limits shall prevent overflow trips.
- C. Minimum switching frequency shall be adjustable from 0 to 100 percent of base frequency.
- D. Maximum switching frequency shall be adjustable from 110 to 0 percent of base frequency.
- E. Automatic boost for 100 percent starting torque.
- F. Hand-off-auto switch mounted in front door of mounting enclosure.
- G. Fault contact for remote indication.
- H. Contact closure for remote indication that drive is operating.
- I. Automatic restart on fault that is programmable for 0 to 5 restarts.
- J. Minimum of 2 critical frequency avoidance points with programmable deadband.
- K. Output signal for motor speed shall be 0 to 10 vdc or 4-20 milliamp.
- L. Output voltage regulation.
- M. Continued operation of drive at 80 percent of last speed reference input if control command is lost.

**1.7** OPERATION PROTECTION

- A. Current limit control for protection against normal transients and surges from incoming power lines, grounding systems, or runaway incoming speed reference signal.
- B. Protection from phase-to-phase and phase-to-ground faults.
- C. Torque limit control.
- D. Capabilities to start into a spinning load and windmilling operation.
- E. Instantaneous overcurrent trip to monitor peak currents and provide shutdown without component failure.
- F. Input line reactors with a minimum of 3 percent rating on all incoming phase lines.
- G. DC link choke to reduce current and voltage harmonics reflected to the AC power supply.

**1.8 OPERATING CONDITIONS**

- A. Unit shall comply to the following operating conditions:
  - 1. Line voltage: +10 percent, -10 percent of rating.
  - 2. Line frequency: + or - 5 percent
  - 3. Overload: 100 percent
  - 4. Ambient temperature: 0 degrees to 40 degrees C.
  - 5. Altitude: 3,300 feet or less
  - 6. Atmosphere: 95 percent relative humidity, noncondensing
  - 7. Efficiency: 97 percent at 100 percent load, 100 percent base speed. 80 percent at 12.5 percent load, 80 percent speed.
  - 8. Fundamental power factor shall be 0.98 at all speeds and loads.
  
- B. Digital operator/keypad is required and shall include the following features:
  - 1. Motor speed indication, in RPM, percent speed, or frequency (Hz)
  - 2. Speed reference signal
  - 3. Alpha-numeric fault trip annunciation
  - 4. Output current
  - 5. Output power
  - 6. Output voltage
  - 7. Bus voltage
  
- C. Indicator lights as follows:
  - 1. Power on light
  - 2. Run light
  - 3. VFD trip light
  - 4. External fault light

**1.9 INSTALLATION**

- A. Install in accordance with manufacturers requirements.
  
- B. A factory authorized and trained technician shall preform the initial startup on all drives.

END OF SECTION

## SECTION 230519

## THERMOMETERS AND GAUGES FOR HVAC EQUIPMENT

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for thermometers and fittings, as well as pressure gauges and fittings.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

**1.3 COMPONENTS**

- A. Thermometers: 1-percent accuracy.
  1. Direct-Mounting Filled-System Dial Type: Vapor actuated, thermal bulb, precision brass gear.
  2. Remote-Reading, Filled-System Dial Type: Vapor actuated, thermal bulb; precision brass gear.
  3. Bimetal Dial Type: Direct mounting, bimetal coil.
  4. Insertion Dial Type: Bimetal coil.
  5. Non-toxic, organic filled liquid-in-glass, column type thermometer.
- B. Pressure Gauges: Phosphor-bronze Bourdon-tube gages, 1-percent accuracy.
  1. Vacuum Range: 30 inches Hg of vacuum to 15 psig of pressure .
  2. Pressure Range: Two-times operating pressure.
  3. Liquid filled pressure gauge where appropriate. **Liquid shall be non-toxic, organic type.**

**1.4 INSTALLATION**

- A. Provide thermometers at the following locations:
  1. Inlet and outlet chilled water connection to chillers
  2. Inlet and outlet heating water connections to boilers.
  3. Heating water, heat pump condenser loop, and chilled water supply and return loop to and from the building if primary/secondary pumping is used or if a 3-way valve is used to reset the building heating water temperature.
  4. At all coil connections at main air handling units.
  5. Condenser water supply and return piping.
  6. Heat exchanger inlet and outlet piping.
- B. Provide pressure gauges at the following locations:
  1. One pressure gauge with 2 independent needle valves piped to the suction and discharge piping of all pumps except coil recirculating pumps.
  2. Inlet and outlet piping of each chiller.
  3. Outlet piping of each boiler unless integral to the boiler.
  4. Domestic cold water fill connection to the HVAC hydronic loop downstream of the pressure reducing valve.

END OF SECTION

## SECTION 230523

## GENERAL DUTY VALVES FOR HVAC PIPING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for valves.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting type materials, sizes, and dimensions.

**1.3 QUALITY ASSURANCE**

- A. The following standards apply.
  - 1. ANSI B16.10, MSS SP-67-90 Butterfly Valves.
  - 2. MSS SP-70-90 Cast Iron Gate Valves, Flanged or Threaded Ends.
  - 3. MSS SP-78-92 Cast Iron Plug Valves Flanged and Threaded.
  - 4. MSS SP-80-87 Bronze Gate, Globe, and Check Valves.
  - 5. MSS SP-85-85 Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.
  - 6. MSS SP-110-92 Ball Valves Threaded, Socket-Welded, Solder Joint, Grooved and Flared Ends.

**1.4 COMPONENTS**

- A. Gate Valves
  - 1. 2-1/2 Inch NPS and Smaller: Cast-iron body with threaded connections for steel piping systems. Bronze body with soldered or threaded connections for copper piping systems, solid-bronze wedge, Class 125 or 150, rising stem, and soldered or threaded connections.
  - 2. 3 Inch NPS and Larger: Cast-iron body and bonnet, Class 125, solid cast-iron wedge, outside screw and yoke, and flanged connections.
- B. Ball Valves
  - 1. Bronze body and bonnet, two-piece construction, chrome-plated ball, standard port for 2-1/2 inch NPS and smaller and full port for 3 inch NPS valves, Class 150, with stem extensions for insulated piping and memory stops.
- C. Globe Valves
  - 1. 2-1/2 Inch NPS and Smaller: Cast-bronze body and bonnet, Class 125 or 150, with threaded or soldered connections.
  - 2. 3 Inch NPS and Larger: Cast-bronze body and bonnet, Class 125, outside screw and yoke, with flanged connections.

- D. Butterfly Valves: Cast-iron body and bonnet, Class 250, 200 psig working pressure, stainless-steel stem; lug, or grooved style connections. (For HVAC systems only)
  - 1. Disc Type: [Aluminum bronze] [stainless steel]
  - 2. Operator:
    - a. Standard lever handle.
    - b. Standard lever handle with memory stop.
    - c. Lever handle with latch lock.
    - d. Gear with position indicator.
    - e. Gear with position indicator and chain wheel.
    - f. Chain wheel.
  
- E. Check Valves
  - 1. Swing Type, 2-1/2 Inch NPS and Smaller: Bronze body, Class 125 or 150, horizontal swing, with threaded or soldered connections.
  - 2. Swing Type, 3 Inch NPS and Larger: Cast-iron body, Class 125, horizontal swing, with flanged or grooved connections.
    - a. Wafer Type: Class 125, cast-iron body, bronze disc, with stainless-steel pins and springs.
    - b. Lift Type: Class 125, bronze body and cap, horizontal or vertical pattern, bronze disc, with threaded or soldered connections.

### 1.5 INSTALLATION

- A. Install all threaded valves with a union joint on the downstream side of the valve.
- B. Provide valves to isolate all equipment and coils.
- C. Provide valves of like material as the piping systems.
- D. Provide dielectric connections between all dissimilar metals.

END OF SECTION

## SECTION 230525

## ROOF CURBS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for roof curbs for equipment mounting and piping penetrations.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include material, quantities, and dimensions.

**1.3 COMPONENTS**

## A. Roof Curbs

1. Roof curb shall be constructed of galvanized steel with welded corner beams and pressure treated 2 by 2 wood nailer.
2. Curbs shall be preinsulated with 1-1/2 inch rigid insulation.
3. Top of curb shall set dead level.
4. Base of curb shall match roof slope.
5. Provide 18 inches for kitchen hood exhaust fans.

## B. Box Curb

1. Box section curbs shall be constructed of welded, heavy gauge galvanized steel with mitered and welded corners, integral base plate, and pressure treated wood nailer.
2. Curb shall be insulated with minimum 1-1/2 inch rigid insulation.

## C. Equipment Support

1. Rails shall be 18 gauge welded galvanized steel with a welded galvanized counterflashing. Unit to have integral base plate, and 2 by 4 pressure treated wood nailer.
2. Rails to be of the length and strength required to support the specified equipment.
3. Equipment rails shall be internally reinforced to conform with manufacturers load bearing factors.

## D. Pipe Roller Supports

1. Pipe support shall be constructed from heavy gauge galvanized steel with continuous welded corner seams, 2 by 4 treated wood nailer, galvanized steel counterflashing and galvanized steel channel track.

## E. Pipe Curbs

1. Pipe curb shall consist of a heavy gauge galvanized steel roof curb of unitized construction, with integral base plate, 3 pound density insulation, and 2 by 2 nailer. Curb shall be covered with a thermoplastic cover, fastening screws, graduated step boots with stainless steel adjustable clamps.

**1.4 INSTALLATION**

- A. Roof curbs and equipment rails shall be mounted with top dead level, properly anchored to the deck.
- B. Roof curbs for metal roof systems shall be provided by the metal roof system manufacturer.

END OF SECTION

## SECTION 230529

## HANGERS AND SUPPORTS FOR HVAC

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for piping hangers and supports, and equipment hangers and supports.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and types.

## 1.3 COMPONENTS

- A. Hangers, supports, and components shall be factory fabricated according to MSS SP-58, the latest edition.
- B. Hangers for piping shall be of a compatible material or coating.
- C. Continuous threaded rod shall be used wherever possible. **An engineered cable support system is acceptable.** Chain, wire, or perforated straps shall not be permitted.
- D. Concrete inserts into poured concrete floor systems are permitted.
- E. Beam clamps, trapeze hangers, and clevis hangers shall be permitted.
- F. Supports from roof decking systems are not permitted.
- G. Concrete inserts into precast concrete plank are permitted.
- H. Powder activated fasteners are not allowed.

## 1.4 INSTALLATION

- A. All hangers and supports shall be attached to the building structural steel system.
- B. Support from steel joist panel point is required.
- C. All hangers, supports, and fastening methods used shall be suitable for the weight of the components being supported.

END OF SECTION

## SECTION 230548

## VIBRATION and SEISMIC CONTROL for HVAC

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for vibration isolators, equipment bases, and flexible connectors.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting calculations, materials, sizes, and dimensions.

**1.3 COMPONENTS**

- A. Vibration isolators as follows:
  - 1. Isolator Pads: Oil- and water-resistant [rubber] [fiberglass or cork].
  - 2. Rubber Isolator Mounts: Double-deflection type.
  - 3. Spring Isolators: Freestanding, laterally stable, open-spring type.
  - 4. Restrained Spring Isolators: Vertically restrained, freestanding, laterally stable, steel open-spring type.
  - 5. Rubber Hangers: Double-deflection type.
  - 6. Spring Hangers: Combination spring and elastomeric hangers with coil spring and elastomeric insert in compression.
- B. Equipment bases as follows:
  - 1. Concrete filled, steel constructed inertia bases.
  - 2. Structural steel bases without inertia pad.
- C. Flexible piping connectors as follows:
  - 1. Molded reinforced neoprene construction with steel flanges and control rods.
  - 2. Flexible steel braided construction with steel flanges.

**1.4 INSTALLATION**

- A. Installation of vibration isolation, piping connections, and inertia bases shall be in accordance with the manufacturer's recommendation.
- B. Rigid connections between vibrating equipment and the building shall not be permitted.

END OF SECTION

## SECTION 230553

## IDENTIFICATION FOR HVAC

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for HVAC identification methods, materials and devices.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions for identification systems.
- B. Submittals are required of valve schedules.

**1.3 QUALITY ASSURANCE**

- A. Identification requirements shall meet ASME A13.1.

**1.4 COMPONENTS**

- A. Equipment Nameplates: Aluminum, permanently fastened to equipment, engraved or stamped.
- B. Stencils: Standard stencils shall be black enamel on a white background or white enamel on a dark background.
- C. Snap-on Plastic Pipe Markers: Preprinted, semi-rigid type, color-coded.
- D. Pressure-Sensitive Pipe Markers: Preprinted, color-coded, vinyl type with permanent adhesive.
- E. Pipe Markers: Full band type.
- F. Plastic Duct Markers: Laminated plastic, color coded, and engraved with the service.
- G. Plastic Tape: Color-coded, pressure-sensitive, self-adhesive vinyl.
- H. Valve Tags: Polished tags with numbers and letters.
- I. Access Panel Markers: Engraved plastic laminate.
- J. Engraved Plastic-Laminate Signs: Sizes required to contain message.
- K. Plastic Equipment Markers: Standard color-coded, laminated plastic.
- L. Plasticize Tags: Preprinted, accident prevention.
- M. Valve Location Tags: 3/4 inch diameter colored, pressure-sensitive adhesive paper circles.

**HVAC****1.5 VALVE CHARTS**

- A. Valve charts shall be furnished by each respective Contractor and shall include the following items:
  - 1. Valve identification
  - 2. Location
  - 3. Purpose
- B. Valve charts shall be included in the Maintenance and Operating Manuals.

**1.6 INSTALLATION**

- A. Piping, equipment and valve identification shall be completed prior to issuance of Substantial Completion.

END OF SECTION

## SECTION 230593

## TESTING, ADJUSTING, AND BALANCING FOR HVAC

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for the testing, adjusting, and balancing of the HVAC air and water systems; includes the performing contractor's certification requirements.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include the complete certified report for all air and water system pressure testing and balancing including all electrical performance of each piece of HVAC equipment.
- B. Prior to commencement of the work described in this Section, the testing, adjusting, and balancing contractor shall submit verification of his AABC or NEBB certification to the Design Professional for acceptance.

## 1.3 QUALITY ASSURANCE

- A. The testing, adjusting, and balancing contractor shall be either AABC or NEBB certified for the work described herein.
- B. *Project will be Commissioned. Refer to section 9101-01900 for additional information.***

## 1.4 COMPONENTS

- A. The Contractor shall provide his own properly calibrated equipment to pressure test, air balance, water balance and to measure electrical characteristics of each piece of HVAC equipment. ***Include a list of instruments to be used for procedures, along with Proof of Calibration.***

## 1.5 REQUIREMENTS

- A. Testing, adjusting, and balancing plan.
- B. Systems readiness checks.
- C. Testing, Adjusting, and Balancing Procedures: AABC's National Standards or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".
- D. Equipment settings marked to show final settings.
- E. Balancing shall be performed to meet the requirements of ASHRAE Standard 90.1.
- F. Pumps with variable speed drives shall be balanced with all valves 100% open (not including balancing valves at coils).

**HVAC**

## CHAPTER 9: SPECIFICATIONS

- G. For variable speed fans, fan and motor pulleys shall be replaced (or adjusted, when applicable) so that motor is fully loaded at 100% speed. Balance to design air flow by adjusting maximum variable speed drive output below 100%.

**1.6 HVAC SYSTEMS AIRFLOW AND WATER FLOW RATE TOLERANCES**

- A. Supply, Return, and Exhaust Fans: Plus 5 percent to plus 10 percent.
- B. Air Outlets and Inlets: 0 to minus 10 percent.
- C. Heating Water Flow Rate: 0 to minus 10 percent.
- D. Cooling Water Flow Rate: 0 to minus 5 percent.

**1.7 REPORTING**

- A. Initial Construction Phase Report: Based on examination of Contract Documents, on adequacy of design for systems balancing devices.
- B. Status Reports: As Work progresses.
- C. ***Draft "Pencil Copy" Report: Provide draft air balance report when the balancing is complete to the Engineer and Commissioning Authority for review before final report.***
- D. ***Commissioning Verification Report: Commissioning Authority will randomly verify TAB work and produce report. TAB Contractor shall make corrections based on this report.***
- E. Final Report: Certification sheet, with content and format according to AABC or NEBB standard forms.
- F. ***Seasonal Testing: If initial TAB procedures were not performed during near peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near peak summer or winter conditions.***
- G. ***11 month Warranty Walk: TAB to perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to report unusual conditions with recommendation of adjustments. TAB Contractor shall allow two (2) days for this work.***

END OF SECTION

## SECTION 230719

## HVAC INSULATION

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for interior and exterior pipe insulation, jackets, and accessories.
- B. Qualitative requirements for field-applied insulation on hot and cold equipment surfaces.
- C. Qualitative requirements for exterior and interior duct and plenum insulation and accessories.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product data noting materials, thickness for each service or piece of equipment, aged thermal qualities, and accessories.

**1.3 QUALITY ASSURANCE**

- A. Fire performance characteristics in accordance with ASTM E 84 for flame spread of 25 and smoke developed of 50.
- B. Materials and installation in accordance with NFPA 255 and UL 723.
- C. Insulation thickness shall meet the requirements of ASHRAE Standard 90.1.

**1.4 MATERIALS**

- A. Glass Fiber: All-purpose jacket and vapor-barrier coated.
  - 1. Preformed: ASTM C 547, Class I, rigid, jacketed, and vapor-coated.
  - 2. Board: ASTM C 612, Type 2, rigid and semi-rigid.
  - 3. Blanket: ASTM C 553, Type II, Class F-1.
  - 4. Adhesive: UL classification; nonflammable.
  - 5. Maximum "K" Value: 0.23 at 75 degrees F.
- B. Cellular Glass: Insulation with factory-applied, laminated-foil, flame-retardant, vinyl facing.
  - 1. Piping: Preformed foamed or cellulated glass, jacketed pipe insulation.
  - 2. Facing: ASTM C 921, Type 1.
  - 3. Blocks: ASTM C 552, Type I.
  - 4. Boards: ASTM C 552, Type IV.
  - 5. Special Shapes: ASTM C 552, Type III.
  - 6. Maximum "K" Value: 0.35 at 75 degrees F.

- C. Flexible Elastomeric Cellular: Flexible cellular elastomeric material, molded or sheet.
  - 1. Preformed: ASTM C534, Type II.
  - 2. Adhesive: Waterproof vapor retarder.
  - 3. Maximum "K" Value: 0.28 at 75 degrees F.
- D. Calcium Silicate
  - 1. Piping: Rigid molded block insulation, asbestos free ASTM C553, Type I.
  - 2. Maximum "K" Value: 0.40 at 300 degrees F.
- E. Duct Liner Insulation
  - 1. Material: Flexible blanket, ASTM C518.
  - 2. Coating: ASTM C1071. Microbial growth resistant.
  - 3. Adhesive: UL listed waterproof.
  - 4. Fasteners: Galvanized steel pins, welded or mechanically fastened.
  - 5. Maximum "K" Value: 0.25 at 75 degrees F.
- F. Insulating Cements
  - 1. Mineral fiber, hydraulic-setting insulating and finishing cement.
  - 2. Expanded or exfoliated vermiculite.
- G. Adhesives: MIL-A-3316C, Classes 1 and 2, Grade A.
- H. Jackets shall be adjusted for the application.
  - 1. Piping: PVC or aluminum
  - 2. Equipment: Foil and paper.
  - 3. Ductwork: Foil and paper.
- I. Polyisocyanurate: Rigid closed cell polyisocyanurate thermal insulation, fabricated into shapes required to insulate pipes, valves, fittings, vessels, and/or special shapes as required.
  - 1. Density: 2 lb/cf
  - 2. Permeance: Less than or equal to 3 perm-inch
  - 3. Provide with a vapor retardant cross laminated high density polyvinylidene chloride polymer film.
  - 4. Material shall not contain or be produced with any of the U.S. EPA regulated CFC compounds listed in the Montreal Protocol of the United Nations Environmental Program.

### 1.5 APPLICATIONS

- A. Exposed Interior Piping Systems
  - 1. Hydronic heating water
  - 2. Hydronic chilled water
  - 3. Hydronic heat pump condenser loop water
  - 4. Condensate drain
  - 5. Refrigerant suction and hot gas bypass
- B. Concealed Interior Piping Systems
  - 1. Hydronic heating water
  - 2. Hydronic chilled water
  - 3. Hydronic heat pump condenser loop water
  - 4. Condensate drain
  - 5. Refrigerant suction and hot gas bypass

- C. Exposed Exterior Piping Systems
  - 1. Refrigerant suction and hot gas bypass
  - 2. Hydronic chilled water
  - 3. Hydronic heating water
  
- D. Concealed Exterior Piping Systems
  - 1. Refrigerant suction and hot gas bypass
  - 2. Hydronic chilled water
  - 3. Hydronic heating water
  
- E. Concealed Piping Systems in Crawl Spaces or Other Moist Environments:
  - 1. Polyisocyanurate insulation required for cold services (chilled water) where 25/50 smoke/flame rating is not required, unless specific product is rated for such.
  
- F. Indoor Equipment
  - 1. Chilled water equipment, tanks, pumps, and heat exchangers.
  - 2. Following items are not insulated:
    - a. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
    - b. Flexible connectors.
    - c. Vibration control devices.
    - d. Testing laboratory labels and stamps.
    - e. Nameplates and data plates.
    - f. Access panels and doors in air distribution systems.
    - g. Factory insulated equipment such as boilers.
  
- G. Ductwork Systems
  - 1. Interior concealed supply, return, and outside air ductwork.
  - 2. Interior exposed supply, return, and outside air ductwork.
  - 3. Exterior exposed supply and return ductwork.
  - 4. Kitchen range hood supply air ductwork.
  - 5. Items not insulated as a part of the Specification Section
    - a. Metal ducts with duct liner.
    - b. Factory-insulated flexible ducts.
    - c. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
    - d. Flexible connectors.
    - e. Vibration control devices.
    - f. Testing laboratory labels and stamps.
    - g. Nameplates and data plates.
    - h. Access panels and doors in air distribution systems.
  
- H. Insulation Jacketing Systems
  - 1. Provide protective jacketing for all exposed pipe systems located in mechanical rooms, boiler rooms, and storage rooms.
  - 2. Provide protective jacketing for all exterior pipe systems.
  - 3. Provide protective jacketing for all exposed ductwork installations.

**HVAC****CHAPTER 9: SPECIFICATIONS**

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**1.6 EXAMINATION AND PREPARATION**

- A. Leak test piping and ductwork system before installing insulation systems.

**1.7 INSTALLATION**

- A. Install material in accordance with manufacturer=s recommendations and in conformance with building codes and industry standards.
- B. A continuous vapor barrier is required.
- C. Provide proper support at piping hanger systems.
- D. Insulate valves and fittings in cold water systems.
- E. Ductwork insulation shall be wrapped in lieu of liner for all applications except for specific sound attenuation means.
- F. All insulation shall be applied so that there is no fiberglass exposed to the air stream without filters downstream. All fiberglass insulation, including all exposed edges, shall be coated, or mylar or other suitable material shall be provided between fiberglass and the air stream.

END OF SECTION

## SECTION 230923

## HVAC DIRECT DIGITAL CONTROLS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for control equipment for HVAC systems and components, software requirements, and installation requirements for a complete HVAC direct digital control (DDC) electronic temperature control system.

**1.2 SUBMITTALS**

- A. Submittals are required and shall include product descriptive literature demonstrating compliance with written specification and, at a minimum, shall include the following:
  - 1. Equipment and component specifications.
  - 2. Software capabilities and operation.
  - 3. Graphics capabilities and proposed solutions.

**1.3 QUALITY ASSURANCE**

- A. Electric components shall be UL Listed.
- B. Damper components shall comply with AMCA 500.
- C. Energy management components shall comply with NEMA EMCI.
- D. Enclosures shall comply with NEMA 250.
- E. Electrical requirements shall meet NFPA 70.
- F. Installation as a part of the HVAC system shall comply with NFPA 90A.
- G. System installation shall allow **for application** of the “BACnet” protocol to meet requirements of ASHRAE 135 or “Lonworks” protocol.
- H. Control systems shall meet the requirements of ASHRAE Standard 90.1.

**1.4 DAMPERS**

- A. Dampers shall be low-leakage type, as required to meet the requirements of ASHRAE Standard 90.1., not less than 22 gauge galvanized steel frames.
- B. Modulating dampers shall be opposed blade type.
- C. Dampers shall be sized for 1000 to 1500 FPM air velocity.

**HVAC****CHAPTER 9: SPECIFICATIONS****1.5 VALVES**

- A. Factory fabricated of type, body material, pressure class, and at a maximum 5 psi pressure drop.
  - 1. 2-way valves shall have equal percentage characteristics.
  - 2. 3-way valves shall have linear characteristics
- B. Globe Valves
  - 1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with back seating capacity repackable under pressure.
  - 2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.
  - 3. Service at 125 psi WSP and 250 deg F.
  - 4. Internal construction shall be replaceable plugs and seats of stainless steel or brass.
- C. Butterfly Valves
  - 1. Iron body, bronze, aluminum-bronze or stainless steel disc, resilient, replaceable seat for service to 200 deg F., lug ends, and extended neck.
  - 2. Service at 125 psi WSP and 250 deg F.
- D. Terminal Unit Control Valves
  - 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
  - 2. Service at 125 psi WSP and 250 deg F.

**1.6 VALVE AND DAMPERS ACTUATORS**

- A. Damper actuators shall be electronic, low voltage. Actuator response shall be linear in response to sensed load.
  - 1. Dampers on outside air intakes/exhaust shall be spring return closed.
- B. Valve operators shall be electronic, low voltage and properly selected for the valve body and service.
  - 1. Actuators shall be fully proportioning unless otherwise indicated.
  - 2. Heating water valve actuators in the path of outside air shall be spring return open.
  - 3. Cabinet heater and radiant ceiling panel valves shall be 2-position.

**1.7 RELAYS**

- A. Relays shall be UL Listed and sized for not less than 140 percent of the connected amperage load.

**1.8 SENSING DEVICES**

- A. Electronic Temperature Sensors.
- B. Electronic Room Temperature Sensors.
- C. Electronic Duct Temperature Sensors.

- D. Electric Thermostats.
- E. Sensor Guards.
- F. Safety Low Limit Thermostats.
- G. Electronic Pressure Sensors.
- H. Humidity Sensors.
- I. Current Sensing Status Switch.
- J. Photo Sensitive Resistor.
- K. Carbon Dioxide Sensors.

### 1.9 CONTROL CABINET/ENCLOSURES

- A. Shall be constructed of extruded aluminum, galvanized steel, or factory-hardened plastic.
- B. Enclosures for electrical devices shall be constructed of code gauge steel with a UL Label.
- C. Panels shall be labeled with nameplates and legends as required.
- D. Each major control cabinet/enclosure (minimum one per mechanical room) shall be equipped with a fold-out laptop shelf at an appropriate height. Provide a DDC connection port at each.

### 1.10 BUILDING AUTOMATION SYSTEM

- A. The entire system shall utilize electric/electronic DDC technology and actuation. Pneumatics is not permitted.
- B. Personal operator workstation complete with color monitor, internal modem, keyboard, and printer.
- C. Host Computer Software
  1. Energy management report generation.
  2. Trend logs setup and storage.
  3. Alarm generation, status, and prioritization.
  4. User interface with English language applications.
  5. Dynamic graphics applications.

### 1.11 BUILDING AUTOMATION EQUIPMENT

- A. Global Control Panel
  1. Central, microprocessor host controller

- B. Software functions
  - 1. English language terminal mode interface
  - 2. Customized report generation
  - 3. Time and event based trending
  - 4. Maximum predictive algorithms
  - 5. Central system optimization
  - 6. Functional library of operations and applications
- C. On-board modem of the latest Kbaud rate for external monitoring and serial connection.
- D. AHU Controllers
- E. Boiler Plant Unitary Controllers
- F. VAV Terminal Controllers
- G. Packaged Terminal Equipment Controllers

#### 1.12 TEMPERATURE CONTROL WIRING

- A. Where control wiring is installed in conduit, conduit shall be 2 inch minimum size.
- B. Wiring in air plenums shall be open wired UL Listed plenum cable or it shall be installed in conduit.
- C. Open wiring shall be secured with plastic tie wraps to permanent building structure.
- D. Final wiring terminations shall be made by the Temperature Control Contractor.

#### 1.13 INSTALLATION

- A. Install in accordance with manufacturers requirements.

#### 1.14 SEQUENCE OF OPERATION

- A. Refer to Specification Section **230993** for all equipment sequences.

#### 1.15 DAY/NIGHT ZONE CONTROL

- A. Building zone control shall be through the DDC computer.
- B. General exhaust fans shall be operated through zone control.

#### 1.16 WARRANTY

- A. All equipment shall be warranted for a period of 1 year after issuance of Substantial Completion.
- B. Temperature Control Contractor shall provide support for operation of the system and improvements to energy usage to the Owner throughout the first year of operation.

**1.17 TRAINING**

- A. The system manufacturer shall provide on-site training on the operation of the complete DDC system.
- B. All training shall be video-taped by the HVAC contractor. Two copies shall be turned over to the Owner's maintenance staff.

**1.18 FINAL CHECK-TEST-START OF SYSTEM**

- A. Check and/or oil all electric motors furnished under control system.
- B. Lubricate all damper bearings.
- C. Check damper travel, adjust and tighten all set screws.
- D. Lubricate valve stems, check packing.
- E. Calibrate all instruments.
- F. Check and verify all circuitry.
- G. Calibrate and check all controllers, fusing, and electrical connections.
- H. Run software through program diagnostics and debug as required.
- I. Startup and test operation of variable frequency drive with factory authorized personnel.

END OF SECTION

## SECTION 230993

## SEQUENCE OF OPERATION FOR HVAC

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for the Sequences of Operation for HVAC systems and terminal units.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include detailed descriptions of the proposed sequence of operations for all systems specific to the project.
- B. The following information shall be submitted as a very minimum to the Engineer:
  1. System diagrams denoting the operation of each individual system, folded to an equivalent 8-1/2 inch by 11 inch bound packet.
  2. DDC logic diagrams.
  3. Written sequences of operation with each specific diagram.

## 1.3 SYSTEM DESCRIPTION

- A. Specific system sequences of operation shall be denoted as subsections to this section.
- B. Sequences of operation shall meet the requirements of ASHRAE Standard 90.1.

1.4 The following control sequences are examples only. It is the responsibility of the design professional to provide the appropriate custom control sequences for each individual project. Any setpoints listed in these sequences are arbitrary and do not reflect specific requirements of OSFC.

## A. Two Boiler System

1. Boiler System - Run Conditions:

- a. The boiler system shall be enabled to run whenever outside air temperature is less than ***the unoccupied/occupied reset schedule***.
- b. To prevent short cycling, each boiler shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
- c. Each boiler shall run subject to its own internal safeties and controls.
- d. The boiler system shall also run for freeze protection whenever the outside air temperature is less than 38°F (adj.).

2. Boiler 1 Safeties:

- a. The following safeties shall be monitored:
  - 1) Boiler alarm.
  - 2) Low water level.
- b. Alarms shall be provided as follows:
  - 1) Boiler alarm.
  - 2) Low water level alarm.

3. Boiler 2 Safeties:

- a. The following safeties shall be monitored:
  - 1) Boiler alarm.
  - 2) Low water level.

- b. Alarms shall be provided as follows:
  - 1) Boiler alarm.
  - 2) Low water level.
  
- 4. **Primary Hot Water Pump Lead/Standby Operation:**
  - a. The two **primary** hot water pumps shall operate in a lead/standby fashion.
    - 1) The lead **primary** pump shall run first.
    - 2) On failure of the lead **primary** pump, the standby **primary** pump shall run and the lead **primary** pump shall turn off.
  - b. The designated lead **primary** pump shall rotate upon one of the following conditions (user selectable):
    - 1) manually through a software switch
    - 2) weekly
    - 3) monthly
  - c. Alarms shall be provided as follows:
    - 1) **Primary** Hot Water Pump 1
      - a. Failure: Commanded on, but the status is off.
      - b. Running in Hand: Commanded off, but the status is on.
    - 2) **Primary** Hot Water Pump 2
      - a. Failure: Commanded on, but the status is off.
      - b. Running in Hand: Commanded off, but the status is on.
  
- 5. **Boiler Circulation Pump 1:**
  - a. **Boiler** Circulation Pump 1 shall run anytime Boiler 1 is called to run and shall have a user definable delay (adj.) on stop.
  - b. Alarms shall be provided as follows:
    - 1) **Boiler** Circulation Pump 1 Failure: Commanded on, but the status is off.
    - 2) **Boiler** Circulation Pump 1 Running in Hand: Commanded off, but the status is on.
  
- 6. **Boiler Circulation Pump 2:**
  - a. **Boiler** Circulation Pump 2 shall run anytime Boiler 2 is called to run and shall have a user definable delay (adj.) on stop.
  - b. Alarms shall be provided as follows:
    - 1) **Boiler** Circulation Pump 2 Failure: Commanded on, but the status is off.
    - 2) **Boiler** Circulation Pump 2 Running in Hand: Commanded off, but the status is on.
  
- 7. **Boiler Lead/Standby Operation:**
  - a. The two boilers shall operate in a lead/standby fashion when called to run and flow is proven.
    - 1) The lead boiler shall run first.
    - 2) On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off.
  - b. The designated lead boiler shall rotate upon one of the following conditions: (user selectable):
    - 1) manually through a software switch
    - 2) weekly
    - 3) monthly

- c. Alarms shall be provided as follows:
    - 1) Boiler 1
      - a. Failure: Commanded on but the status is off.
      - b. Running in Hand: Commanded off but the status is on.
    - 2) Boiler 2
      - a. Failure: Commanded on but the status is off.
      - b. Running in Hand: Commanded off but the status is on.
      - c. Lead Boiler Failure: The lead boiler is in failure and the standby boiler is on.
  - 8. Hot Water Supply Temperature Setpoint Reset:
    - a. The hot water supply temperature setpoint shall reset only after the variable flow secondary hot water pumps are operating at minimum speed. Hot water supply temperature reset shall be a continuation of the control loop for the pump speed. Hot water supply and return temperatures shall be maintained above minimums per boiler manufacturer's recommendations. Further consideration should be given to high efficiency boiler systems to optimize system efficiency (reset water temp starting at higher pump speed to allow boiler to operate at optimum efficiency).
  - 9. Primary Hot Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Primary hot water supply.
      - 2) Primary hot water return.
    - b. Alarms shall be provided as follows:
      - 1) High Primary Hot Water Supply Temp: If greater than 200°F (adj.).
      - 2) Low Primary Hot Water Supply Temp: If less than 100°F (adj.).
  - 10. Boiler 1 Hot Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Boiler 1 hot water supply.
      - 2) Boiler 1 hot water return.
    - b. Alarms shall be provided as follows:
      - 1) High Hot Water Supply Temp: If greater than 200°F (adj.).
      - 2) Low Hot Water Supply Temp: If less than 100°F (adj.).
  - 11. Boiler 2 Hot Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Boiler 2 hot water supply.
      - 2) Boiler 2 hot water return.
    - b. Alarms shall be provided as follows:
      - 1) High Hot Water Supply Temp: If greater than 200°F (adj.).
      - 2) Low Hot Water Supply Temp: If less than 100°F (adj.).
- B. Secondary Hot Water Pumps
- 1. Secondary Hot Water Pump Run Conditions:
    - a. The secondary hot water pumps shall be enabled whenever outside air temperature is less than ***the unoccupied/occupied reset schedule.***
    - b. The secondary pumps shall run for freeze protection anytime outside air temperature is less than 38°F (adj.).

- c. To prevent short cycling, the secondary pumps shall run for and be off for minimum adjustable times (both user definable).
  - 2. Secondary Hot Water Pump Lead/Standby Operation:
    - a. The two secondary hot water pumps shall operate in a lead/standby fashion.
      - 1) The lead secondary pump shall run first.
      - 2) On failure of the lead secondary pump, the standby secondary pump shall run and the lead pump shall turn off.
    - b. The designated lead secondary pump shall rotate upon one of the following conditions (user selectable):
      - 1) manually through a software switch
      - 2) weekly
      - 3) monthly
    - c. Alarms shall be provided as follows:
      - 1) Secondary Hot Water Pump 1
        - a) Failure: Commanded on, but the status is off.
        - b) Running in Hand: Commanded off, but the status is on.
      - 2) Secondary Hot Water Pump 2
        - a) Failure: Commanded on, but the status is off.
        - b) Running in Hand: Commanded off, but the status is on.
  - 3. Secondary Hot Water Pump Volume Control:
    - a. A differential pressure sensor installed near the most remote heat exchanger shall monitor hot water system differential pressure.
    - b. The hot water system differential pressure shall be reset based on heating valve position.
    - c. The secondary hot water pump variable frequency drives shall be modulated to maintain hot water system differential pressure.
- C. Single Air Cooled Chiller System
- 1. Chiller - Run Conditions:
    - a. The chiller shall be enabled to run whenever the outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
    - b. To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
    - c. The chiller shall run subject to its own internal safeties and controls.
  - 2. Chilled Water Pump:
    - a. The chilled water pump shall run anytime the chiller is called to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).
    - b. The chilled water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The chilled water pump shall therefore have:
      - 1) A user adjustable delay on start.
      - 2) AND a user adjustable delay on stop.
    - c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

- d. Alarms shall be provided as follows:
    - 1) Chilled Water Pump Failure: Commanded on, but the status is off.
    - 2) Chilled Water Pump Running in Hand: Commanded off, but the status is on.
  3. Chiller:
    - a. The chiller shall be enabled a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.
    - b. The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
    - c. The chiller shall run subject to its own internal safeties and controls.
    - d. Alarms shall be provided as follows:
      - 1) Chiller Failure: Commanded on, but the status is off.
      - 2) Chiller Running in Hand: Commanded off, but the status is on.
  4. Chiller Chilled Water Supply Setpoint:
    - a. The chiller shall maintain a chilled water supply temperature setpoint as determined by its own internal controls (provided by others).
  5. Chilled Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Chilled water supply.
      - 2) Chilled water return.
    - b. Alarms shall be provided as follows:
      - 1) High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adj.).
      - 2) Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adj.).
- D. Single Water Cooled Chiller System
1. Chiller - Run Conditions:
    - a. The chiller shall be enabled to run whenever the outside air temperature is greater than ***the unoccupied/occupied reset schedule***.
    - b. To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.
    - c. The chiller shall run subject to its own internal safeties and controls.
  2. Refrigerant Detection:
    - a. The chiller shall shut down and an alarm generated upon receiving a refrigerant leak detection status.
  3. Chilled Water Pump:
    - a. The chilled water pump shall run anytime the chiller is called to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable setpoint (adj.).
    - b. The chilled water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The chilled water pump shall therefore have:
      - 1) A user adjustable delay on start.
      - 2) AND a user adjustable delay on stop.
    - c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

- d. Alarms shall be provided as follows:
  - 1) Chilled Water Pump Failure: Commanded on, but the status is off.
  - 2) Chilled Water Pump Running in Hand: Commanded off, but the status is on.
- 4. Condenser Water Pump:
  - a. The condenser water pump shall run anytime the chiller is called to run.
  - b. The condenser water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The condenser water pump shall therefore have:
    - 1) A user adjustable delay on start.
    - 2) AND a user adjustable delay on stop.
  - c. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
  - d. Alarms shall be provided as follows:
    - 1) Condenser Water Pump Failure: Commanded on, but the status is off.
    - 2) Condenser Water Pump Running in Hand: Commanded off, but the status is on.
- 5. Chiller:
  - a. The chiller shall be enabled a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.
  - b. The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.
  - c. The chiller shall run subject to its own internal safeties and controls.
  - d. Alarms shall be provided as follows:
    - 1) Chiller Failure: Commanded on, but the status is off.
    - 2) Chiller Running in Hand: Commanded off, but the status is on.
- 6. Chiller Chilled Water Supply Setpoint:
  - a. The chiller shall maintain a chilled water supply temperature setpoint as determined by its own internal controls (provided by others).
- 7. Cooling Tower VFD Fan - Condenser Water Temperature Control:
  - a. The controller shall measure the cooling tower condenser water supply (basin) temperature and modulate the bypass valve and fan VFD in sequence to maintain setpoints.
  - b. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
  - c. On rising supply temperature, the controller shall modulate the bypass valve to maintain setpoint of 78°F (adj.) and the fan VFD to maintain setpoint of 82°F (adj.).
  - d. Alarms shall be provided as follows:
    - 1) Fan
      - a) Failure: Commanded on, but the status is off.
      - b) Running in Hand: Commanded off, but the status is on.
      - c) VFD fault.
    - 2) High Cooling Tower Supply (Basin) Temp: If greater than 86°F (adj.).
    - 3) Low Cooling Tower Supply (Basin) Temp: If less than 38°F (adj.).

8. Chilled Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Chilled water supply.
      - 2) Chilled water return.
    - b. Alarms shall be provided as follows:
      - 1) High Chilled Water Supply Temp: If the chilled water supply temperature is greater than 55°F (adj.).
      - 2) Low Chilled Water Supply Temp: If the chilled water supply temperature is less than 38°F (adj.).
  9. Condenser Water Temperature Monitoring:
    - a. The following temperatures shall be monitored:
      - 1) Condenser water supply temperature.
      - 2) Condenser water return temperature.
    - b. Alarms shall be provided as follows:
      - 1) High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 86°F (adj.).
      - 2) Low Condenser Water Supply Temp: If the condenser water supply temperature is less than 65°F (adj.).
      - 3) High Condenser Water Return Temp: If the condenser water return temperature is greater than 100°F (adj.).
      - 4) Low Condenser Water Return Temp: If the condenser water return temperature is less than 75°F (adj.).
- E. Cabinet Heater
1. Run Conditions - Continuous:
    - a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
    - b. Alarms shall be provided as follows:
      - 1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
  2. Zone Setpoint Adjust:
    - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
  3. Fan:
    - a. The fan shall run anytime the zone temperature is below heating setpoint, unless shutdown on safeties.
  4. Heating Coil Valve:
    - a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
    - b. The heating shall be enabled whenever:
      - 1) Outside air temperature is less than **the unoccupied/occupied reset schedule**.
      - 2) AND the zone temperature is below heating setpoint.
      - 3) AND the fan is on.
- F. Unit Heater
1. Run Conditions - Continuous:
    - a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
    - b. Alarms shall be provided as follows:
      - 1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).

2. Zone Setpoint Adjust:
    - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
  3. Fan:
    - a. The fan shall run anytime the zone temperature drops below heating setpoint, unless shutdown on safeties.
  4. Heating Coil Valve:
    - a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
    - b. The heating shall be enabled whenever:
      - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
      - 2) AND the zone temperature is below heating setpoint.
      - 3) AND the fan is on.
- G. Convective / Fin Tube Heater
1. Run Conditions - Continuous:
    - a. The unit shall run continuously and shall maintain a heating setpoint of 70°F (adj.).
    - b. Alarms shall be provided as follows:
      - 1) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
  2. Heating Coil Valve:
    - a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
    - b. The heating shall be enabled whenever:
      - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
      - 2) AND the zone temperature is below heating setpoint.
- H. Exhaust Fan - Building Static
1. Run Conditions - Interlocked:
    - a. The unit(s) EF --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
  2. Control - Building Static Pressure:
    - a. The controller shall measure building static pressure and stage the exhaust fan on and off to maintain a building static pressure setpoint of 0.05in H<sub>2</sub>O (adj.). The fan shall have a user definable (adj.) minimum runtime.
    - b. Alarms shall be provided as follows:
      - 1) High Building Static Pressure: If the building static pressure is 25% (adj.) greater than setpoint.
      - 2) Low Building Static Pressure: If the building static pressure is 25% (adj.) less than setpoint.
  3. Exhaust Air Damper:
    - a. The exhaust air damper shall open anytime the unit runs and shall close anytime the unit stops. The exhaust air damper shall close 30 sec (adj.) after the fan stops.
  4. Fan Status:
    - a. The controller shall monitor the fan status.
    - b. Alarms shall be provided as follows:

- 1) Fan Failure: Commanded on, but the status is off.
  - 2) Fan in Hand: Commanded off, but the status is on.
- I. Variable Air Volume - AHU
1. Run Conditions - Scheduled:
    - a. The unit shall run based upon an operator adjustable schedule.
  2. Freeze Protection:
    - a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
  3. High Static Shutdown:
    - a. The unit shall shut down and generate an alarm upon receiving an high static shutdown signal.
  4. Supply Air Smoke Detection:
    - a. The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
  5. Supply Fan:
    - a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
    - b. Alarms shall be provided as follows:
      - 1) Supply Fan Failure: Commanded on, but the status is off.
      - 2) Supply Fan in Hand: Commanded off, but the status is on.
      - 3) Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
  6. Supply Air Duct Static Pressure Control:
    - a. The controller shall measure duct static pressure and shall modulate the supply fan VFD speed to maintain a duct static pressure setpoint of 1.5in H<sub>2</sub>O (adj.). The supply fan VFD speed shall not drop below 30% (adj.).
    - b. Alarms shall be provided as follows:
      - 1) High Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) greater than setpoint.
      - 2) Low Supply Air Static Pressure: If the supply air static pressure is 25% (adj.) less than setpoint.
      - 3) Supply Fan VFD Fault.
  7. Return Fan:
    - a. The return fan shall run whenever the supply fan runs.
    - b. Alarms shall be provided as follows:
      - 1) Return Fan Failure: Commanded on, but the status is off.
      - 2) Return Fan in Hand: Commanded off, but the status is on.
      - 3) Return Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
      - 4) Return Fan VFD Fault.
  8. Building Static Pressure Control:
    - a. The controller shall measure building static pressure and modulate the return fan VFD speed to maintain a building static pressure setpoint of 0.05in H<sub>2</sub>O (adj.). The return fan VFD speed shall not drop below 20% (adj.).
    - b. Alarms shall be provided as follows:
      - 1) High Building Static Pressure: If the building air static pressure is 25% (adj.) greater than setpoint.

- 2) Low Building Static Pressure: If the building air static pressure is 25% (adj.) less than setpoint.
9. Heat Recovery Wheel - Constant Speed:
- a. The controller shall run the heat recovery wheel for energy recovery as follows.
- 1) Cooling Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The heat wheel shall run for cool recovery whenever:
- The unit return air temperature is 5°F (adj.) or more below the outside air temperature.
  - AND the unit is in a cooling mode.
  - AND the economizer (if present) is off.
  - AND the supply fan is on.
- 2) Heating Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The heat wheel shall run for heat recovery whenever:
- The unit return air temperature is 5°F (adj.) or more above the outside air temperature.
  - AND the unit is in a heating mode.
  - AND the economizer (if present) is off.
  - AND the supply fan is on.
- b. Periodic Self-Cleaning:
- 1) The heat wheel shall run for 10sec (adj.) every 4hr (adj.) the unit runs.
- c. Frost Protection:
- 1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
- Outside air temperature drops below 15°F (adj.)
  - OR the exhaust air temperature drops below 20°F (adj.).
- d. The heat wheel bypass dampers will open whenever the heat wheel is disabled.
- e. Alarms shall be provided as follows:
- Heat Wheel Rotation Failure: Commanded on, but the status is off.
  - Heat Wheel in Hand: Commanded off, but the status is on.
  - Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
10. Preheating Coil Valve:
- a. The controller shall measure the mixed air temperature and modulate the preheating coil valve to maintain its setpoint 5°F (adj.) less than the supply air temperature setpoint.
- b. The preheating shall be enabled whenever:
- Outside air temperature is less than 60°F (adj.).
  - AND the economizer (if present) is disabled.
  - AND the supply fan status is on.

- c. The preheating coil valve shall open for freeze protection whenever:
- 1) Mixed air temperature drops from 40°F to 35°F (adj.).
  - 2) OR the freezestat (if present) is on.
11. Supply Air Temperature Setpoint - Optimized:
- a. The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint reset based on zone cooling and heating requirements
  - b. The supply air temperature setpoint shall be reset for cooling based on zone cooling requirements as follows:
    - 1) The initial supply air temperature setpoint shall be 55°F (adj.).
    - 2) As cooling demand increases, the setpoint shall incrementally reset down to a minimum of 53°F (adj.).
    - 3) As cooling demand decreases, the setpoint shall incrementally reset up to a maximum of 72°F (adj.) .
  - c. If more zones need heating than cooling, then the supply air temperature setpoint shall be reset for heating as follows:
    - 1) The initial supply air temperature setpoint shall be 82°F (adj.).
    - 2) As heating demand increases, the setpoint shall incrementally reset up to a maximum of 85°F (adj.).
    - 3) As heating demand decreases, the setpoint shall incrementally reset down to a minimum of 72°F (adj.).
12. Cooling Coil Valve:
- a. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
  - b. The cooling shall be enabled whenever:
    - 1) Outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
    - 2) AND the economizer (if present) is disabled or fully open.
    - 3) AND the supply fan status is on.
    - 4) AND the heating (if present) is not active.
  - c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat (if present) is on.
  - d. Alarms shall be provided as follows:
    - 1) High Supply Air Temp: If the supply air temperature is 5°F (adj.) greater than setpoint.
13. Heating Coil Valve:
- a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
  - b. The heating shall be enabled whenever:
    - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
    - 2) AND the supply fan status is on.
    - 3) AND the cooling (if present) is not active.
  - c. The heating coil valve shall open whenever:
    - 1) Supply air temperature drops from 40°F to 35°F (adj.).
    - 2) OR the freezestat (if present) is on.
  - d. Alarms shall be provided as follows:
    - 1) Low Supply Air Temp: If the supply air temperature is 5°F (adj.) less than setpoint.
14. Preheating Coil Pump:
- a. The recirculation pump shall run whenever:

- 1) The preheating coil valve is enabled.
  - 2) OR the freezestat (if present) is on.
  - b. Alarms shall be provided as follows:
    - 1) Preheating Coil Pump Failure: Commanded on, but the status is off.
    - 2) Preheating Coil Pump in Hand: Commanded off, but the status is on.
    - 3) Preheating Coil Pump Runtime Exceeded: Status runtime exceeds a user definable limit.
15. Economizer:
- a. The controller shall measure the mixed air temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F (adj.) less than the supply air temperature setpoint. The outside air dampers shall maintain a minimum adjustable position of 20% (adj.) open whenever occupied.
  - b. The economizer shall be enabled whenever:
    - 1) Outside air temperature is less than 65°F (adj.).
    - 2) AND the outside air enthalpy is less than 22Btu/lb (adj.)
    - 3) AND the outside air temperature is less than the return air temperature.
    - 4) AND the outside air enthalpy is less than the return air enthalpy.
    - 5) AND the supply fan status is on.
  - c. The economizer shall close whenever:
    - 1) Mixed air temperature drops from 40°F to 35°F (adj.)
    - 2) OR the freezestat (if present) is on.
    - 3) OR on loss of supply fan status.
  - d. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
16. Minimum Outside Air Ventilation:
- a. When in the occupied mode, the controller shall measure the outside airflow and modulate the outside air dampers to maintain the proper minimum outside air ventilation, overriding normal damper control. On dropping outside airflow, the controller shall modulate the outside air dampers open to maintain the outside airflow setpoint (adj.).
17. Dehumidification:
- a. The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.
18. Prefilter Status:
- a. The controller shall monitor the prefilter status.
  - b. Alarms shall be provided as follows:
    - 1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
19. Final Filter Status:
- a. The controller shall monitor the final filter status.

- b. Alarms shall be provided as follows:
          - 1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).
  - 20. Mixed Air Temperature:
    - a. The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
    - b. Alarms shall be provided as follows:
      - 1) High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
      - 2) Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
  - 21. Return Air Humidity:
    - a. The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
    - b. Alarms shall be provided as follows:
      - 1) High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
      - 2) Low Return Air Humidity: If the return air humidity is less than 35% (adj.).
  - 22. Return Air Temperature:
    - a. The controller shall monitor the return air temperature and use as required for setpoint control or economizer control (if present).
    - b. Alarms shall be provided as follows:
      - 1. High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
      - 2. Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
  - 23. Supply Air Temperature:
    - a. The controller shall monitor the supply air temperature.
    - b. Alarms shall be provided as follows:
      - 1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
      - 2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
  - 24. Zone Optimal Start:
    - a. The unit shall use an optimal start algorithm for morning startup. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
- J. Variable Air Volume - Terminal Unit
- 1. Run Conditions - Scheduled:
    - a. The unit shall run according to a user definable time schedule in the following modes:
      - 1) Occupied Mode: The unit shall maintain
        - a) A 75°F (adj.) cooling setpoint
        - b) A 70°F (adj.) heating setpoint.
      - 2) Unoccupied Mode (night setback): The unit shall maintain
        - a) A 85°F (adj.) cooling setpoint.

- b) A 55°F (adj.) heating setpoint.
  - b. Alarms shall be provided as follows:
    - 1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
    - 2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
- 2. Zone Setpoint Adjust:
  - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
- 3. Zone Unoccupied Override:
  - a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
- 4. Reversing Variable Volume Terminal Unit - Flow Control:
  - a. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
    - 1) Occupied:
      - a) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
      - b) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
      - c) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.
    - 2) Unoccupied:
      - a) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).
      - b) When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
      - c) When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.
- 5. Reheating Coil Valve:
  - a. The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.
- 6. Discharge Air Temperature:
  - a. The controller shall monitor the discharge air temperature.

- b. Alarms shall be provided as follows:
    - 1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
    - 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
- K. Fan Powered Variable Air Volume - Terminal Unit
1. Run Conditions - Scheduled:
    - a. The unit shall run according to a user definable time schedule in the following modes:
      - 1) Occupied Mode: The unit shall maintain
        - a) A 75°F (adj.) cooling setpoint
        - b) A 70°F (adj.) heating setpoint.
      - 2) Unoccupied Mode (night setback): The unit shall maintain
        - a) A 85°F (adj.) cooling setpoint.
        - b) A 55°F (adj.) heating setpoint.
    - b. Alarms shall be provided as follows:
      - 1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      - 2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
  2. Zone Setpoint Adjust:
    - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
  3. Zone Unoccupied Override:
    - a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
  4. Reversing Variable Volume Terminal Unit - Flow Control:
    - a. The unit shall maintain zone setpoints by controlling the airflow through one of the following:
      - 1) Occupied:
        - a) When zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
        - b) When the zone temperature is between the cooling setpoint and the heating setpoint, the zone damper shall maintain the minimum required zone ventilation (adj.).
        - c) When zone temperature is less than its heating setpoint, the controller shall enable heating to maintain the zone temperature at its heating setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum occupied airflow (adj.) and the maximum heating airflow (adj.) until the zone is satisfied.
      - 2) Unoccupied:
        - a) When the zone is unoccupied the zone damper shall control to its minimum unoccupied airflow (adj.).

- b) When the zone temperature is greater than its cooling setpoint, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the maximum cooling airflow (adj.) until the zone is satisfied.
    - c) When zone temperature is less than its unoccupied heating setpoint, the controller shall enable heating to maintain the zone temperature at the setpoint. Additionally, if warm air is available from the AHU, the zone damper shall modulate between the minimum unoccupied airflow (adj.) and the auxiliary heating airflow (adj.) until the zone is satisfied.
  - 5. Fan Control - Parallel:
    - a. The fan shall run whenever the zone controller calls for heat. The fan shall run for a minimum user definable time (adj.).
  - 6. Fan Control – Series:
    - a. The fan shall run whenever the system is in the occupied mode.
  - 7. Reheating Coil Valve:
    - a. The controller shall measure the zone temperature and modulate the reheating coil valve open on dropping temperature to maintain its heating setpoint.
  - 8. Discharge Air Temperature:
    - a. The controller shall monitor the discharge air temperature.
    - b. Alarms shall be provided as follows:
      - 1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
      - 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
- L. Single Zone Unit
  - 1. Run Conditions - Scheduled:
    - a. The unit shall run according to a user definable time schedule in the following modes:
      - 1) Occupied Mode: The unit shall maintain
        - a) A 75°F (adj.) cooling setpoint
        - b) A 70°F (adj.) heating setpoint.
      - 2) Unoccupied Mode (night setback): The unit shall maintain
        - a) A 85°F (adj.) cooling setpoint.
        - b) A 55°F (adj.) heating setpoint.
    - b. Alarms shall be provided as follows:
      - 1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      - 2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
  - 2. Zone Setpoint Adjust:
    - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
  - 3. Zone Optimal Start:
    - a. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.

4. Zone Unoccupied Override:
  - a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
5. Freeze Protection:
  - a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
6. Supply Air Smoke Detection:
  - a. The unit shall shut down and generate an alarm upon receiving a supply air smoke detector status.
7. Supply Fan:
  - a. The supply fan shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime.
  - b. Alarms shall be provided as follows:
    - 1) Supply Fan Failure: Commanded on, but the status is off.
    - 2) Supply Fan in Hand: Commanded off, but the status is on.
8. Heat Recovery Wheel - Constant Speed:
  - a. The controller shall run the heat recovery wheel for energy recovery as follows.
    - 1) Cooling Recovery Mode: The controller shall measure the zone temperature and run the heat recovery wheel to maintain a setpoint 2°F (adj.) less than the zone cooling setpoint. The heat wheel shall run for cool recovery whenever:
      - a) Return air temperature is 5°F (adj.) or more below the outside air temperature.
      - b) AND the zone temperature is above cooling setpoint.
      - c) AND the economizer (if present) is off.
      - d) AND the supply fan is on.
    - 2) Heating Recovery Mode: The controller shall measure the zone temperature and run the heat recovery wheel to maintain a setpoint 2°F (adj.) greater than the zone heating setpoint. The heat wheel shall run for heat recovery whenever:
      - a) Return air temperature is 5°F (adj.) or more above the outside air temperature.
      - b) AND the zone temperature is below heating setpoint.
      - c) AND the economizer (if present) is off.
      - d) AND the supply fan is on.
  - b. Periodic Self-Cleaning:
    - 1) The heat wheel shall run for 10sec (adj.) every 4hr (adj.) the unit runs.
  - c. Frost Protection:
    - 1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
      - a) Outside air temperature drops below 15°F (adj.)
      - b) OR the exhaust air temperature drops below 20°F (adj.).
  - d. The heat wheel bypass dampers will open whenever the heat wheel is disabled.

- e. Alarms shall be provided as follows:
  - 1) Heat Wheel Rotation Failure: Commanded on, but the status is off.
  - 2) Heat Wheel in Hand: Commanded off, but the status is on.
  - 3) Heat Wheel Runtime Exceeded: Status runtime exceeds a user definable limit (adj.).
- 9. Preheating Coil Valve:
  - a. The controller shall measure the mixed air temperature and modulate the preheating coil valve to maintain its setpoint 10°F (adj.) less than the zone heating setpoint.
  - b. The preheating shall be enabled whenever:
    - 1) Outside air temperature is less than 55°F (adj.).
    - 2) AND the economizer (if present) is disabled.
    - 3) AND the heating is active.
    - 4) AND cooling is not active.
    - 5) AND the supply fan status is on.
  - c. The preheating coil valve shall open for freeze protection whenever:
    - 1) Mixed air temperature drops from 40°F to 35°F (adj.).
    - 2) OR the freezestat (if present) is on.
- 10. Cooling Coil Valve:
  - a. The controller shall measure the zone temperature and modulate the cooling coil valve to maintain its cooling setpoint.
  - b. The cooling shall be enabled whenever:
    - 1) Outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
    - 2) AND the economizer (if present) is disabled or fully open.
    - 3) AND the zone temperature is above cooling setpoint.
    - 4) AND the supply fan status is on.
    - 5) AND the heating is not active.
  - c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat (if present) is on.
- 11. Heating Coil Valve:
  - a. The controller shall measure the zone temperature and modulate the heating coil valve to maintain its heating setpoint.
  - b. The heating shall be enabled whenever:
    - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
    - 2) AND the zone temperature is below heating setpoint.
    - 3) AND the supply fan status is on.
    - 4) AND the cooling is not active.
  - c. The heating coil valve shall open whenever the freezestat (if present) is on.
- 12. Economizer:
  - a. The controller shall measure the zone temperature and modulate the economizer dampers in sequence to maintain a setpoint 2°F less than the zone cooling setpoint. The outside air dampers shall maintain a minimum adjustable position of 20Btu/lb (adj.) open whenever occupied.
  - b. The economizer shall be enabled whenever:
    - 1) Outside air temperature is less than 65°F (adj.).
    - 2) AND the outside air enthalpy is less than 22Btu/lb (adj.).

- 3) AND the outside air temperature is less than the return air temperature.
  - 4) AND the outside air enthalpy is less than the return air enthalpy.
  - 5) AND the supply fan status is on.
  - c. The economizer shall close whenever:
    - 1) Mixed air temperature drops from 45°F to 40°F (adj.).
    - 2) OR on loss of supply fan status.
    - 3) OR freezestat (if present) is on.
  - d. The outside and exhaust air dampers shall close and the return air damper shall open when the unit is off. If Optimal Start Up is available, the mixed air damper shall operate as described in the occupied mode except that the outside air damper shall modulate to fully closed.
13. Minimum Outside Air Ventilation - Fixed Percentage:
- a. The outside air dampers shall maintain a minimum position (adj.) during building occupied hours and be closed during unoccupied hours.
14. Dehumidification:
- a. The controller shall measure the return air humidity and override the cooling sequence to maintain return air humidity at or below 60% rh (adj.). Dehumidification shall be enabled whenever the supply fan status is on.
15. Prefilter Status:
- a. The controller shall monitor the prefilter status.
  - b. Alarms shall be provided as follows:
    - 1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
16. Final Filter Status:
- a. The controller shall monitor the final filter status.
  - b. Alarms shall be provided as follows:
    - 1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).
17. Mixed Air Temperature:
- a. The controller shall monitor the mixed air temperature and use as required for economizer control (if present) or preheating control (if present).
  - b. Alarms shall be provided as follows:
    - 1) High Mixed Air Temp: If the mixed air temperature is greater than 90°F (adj.).
    - 2) Low Mixed Air Temp: If the mixed air temperature is less than 45°F (adj.).
18. Return Air Humidity:
- a. The controller shall monitor the return air humidity and use as required for economizer control (if present) or humidity control (if present).
  - b. Alarms shall be provided as follows:
    - 1) High Return Air Humidity: If the return air humidity is greater than 70% (adj.).
    - 2) Low Return Air Humidity: If the return air humidity is less than 35% (adj.).

19. Return Air Temperature:
- a. The controller shall monitor the return air temperature and use as required for economizer control (if present).
  - b. Alarms shall be provided as follows:
    - 1) High Return Air Temp: If the return air temperature is greater than 90°F (adj.).
    - 2) Low Return Air Temp: If the return air temperature is less than 45°F (adj.).
20. Supply Air Temperature:
- a. The controller shall monitor the supply air temperature.
  - b. Alarms shall be provided as follows:
    - 1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
    - 2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
- M. Makeup Air Unit - Supply Air Temp
1. Run Conditions - Interlocked:
    - a. The unit MAU --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
  2. Freeze Protection:
    - a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
  3. Outside Air Damper:
    - a. The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4sec (adj.) after the supply fan stops.
    - b. Alarms shall be provided as follows:
      - 1) Outside Air Damper Failure: Commanded open, but the status is closed.
      - 2) Outside Air Damper in Hand: Commanded closed, but the status is open.
  4. Supply Fan:
    - a. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties.
    - b. Alarms shall be provided as follows:
      - 1) Supply Fan Failure: Commanded on, but the status is off.
      - 2) Supply Fan in Hand: Commanded off, but the status is on.
  5. Exhaust Fan:
    - a. The exhaust fan shall run whenever the supply fan runs, unless shutdown on safeties.
    - b. Alarms shall be provided as follows:
      - 1) Exhaust Fan Failure: Commanded on, but the status is off.
      - 2) Exhaust Fan in Hand: Commanded off, but the status is on.
  6. Supply Air Temperature Setpoint - Fixed:
    - a. The controller shall monitor the supply air temperature and shall maintain a supply air temperature setpoint **based on a reset schedule.**
  7. Cooling Coil Valve:
    - a. The controller shall measure the supply air temperature and

- modulate the cooling coil valve to maintain its cooling setpoint.
- b. The cooling shall be enabled whenever:
    - 1) Outside air temperature is greater than ***the unoccupied/occupied reset schedule***.
    - 2) AND the supply air temperature is above cooling setpoint.
    - 3) AND the fan status is on.
  - c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat is on.
8. Heating Coil Valve:
- a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
  - b. The heating shall be enabled whenever:
    - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule***.
    - 2) AND the supply air temperature is below heating setpoint.
    - 3) AND the fan status is on.
  - c. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.
9. Prefilter Status:
- a. The controller shall monitor the prefilter status.
  - b. Alarms shall be provided as follows:
    - 1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
10. Supply Air Temperature:
- a. The controller shall monitor the supply air temperature.
  - b. Alarms shall be provided as follows:
    - 1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
    - 2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).
- N. Water Source Heat Pump (typical of 1)
1. Run Conditions - Scheduled:
    - a. The unit shall run according to a user definable time schedule in the following modes:
      - 1) Occupied Mode: The unit shall maintain
        - a) A 75°F (adj.) cooling setpoint
        - b) A 72°F (adj.) heating setpoint
      - 2) Unoccupied Mode (night setback): The unit shall maintain
        - a) A 85°F (adj.) cooling setpoint.
        - b) A 55°F (adj.) heating setpoint.
        - c) 60 – 65% RH zone space humidity
    - b. Alarms shall be provided as follows:
      - 1) High Zone Temp: If the zone temperature is greater than the cooling setpoint by a user definable amount (adj.).
      - 2) Low Zone Temp: If the zone temperature is less than the heating setpoint by a user definable amount (adj.).
  2. Freeze Protection:
    - a. The unit shall shut down and generate an alarm upon receiving a freezestat status.

3. Smoke Detection:
  - a. The unit shall shut down and generate an alarm upon receiving a smoke detector status.
4. Zone Setpoint Adjust:
  - a. The occupant shall be able to adjust the zone temperature heating and cooling setpoints at the zone sensor.
5. Zone Optimal Start:
  - a. The unit shall use an optimal start algorithm for morning start-up. This algorithm shall minimize the unoccupied warm-up or cool-down period while still achieving comfort conditions by the start of scheduled occupied period.
6. Zone Unoccupied Override:
  - a. A timed local override control shall allow an occupant to override the schedule and place the unit into an occupied mode for an adjustable period of time. At the expiration of this time, control of the unit shall automatically return to the schedule.
7. Fan:
  - a. The fan shall run anytime the unit is commanded to run, unless shutdown on safeties.
8. Heating and Cooling - 1 Compressor Stage:
  - a. The controller shall receive a signal from the loop water source monitor indicating that there is water flow and that the water temperature is within acceptable limits.
  - b. The controller shall measure the zone temperature and cycle the compressor to maintain its setpoint. To prevent short cycling, the stage shall have a user definable (adj.) minimum runtime. The compressor shall run subject to its own internal safeties and controls.
  - c. The heating shall be enabled whenever:
    - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
    - 2) AND the fan is on.
    - 3) AND the reversing valve is in heat mode.
  - d. The cooling shall be enabled whenever:
    - 1) Outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
    - 2) the fan is on.
    - 3) AND the reversing valve is in cool mode.
  - e. The compressor shall be disabled and remain off for 30sec (adj.) after the reversing valve has changed position.
  - f. Alarms shall be provided as follows:
    - 1) Compressor Runtime Exceeded: The compressor runtime exceeds a user definable limit (adj.).
9. Outside Air Dampers:
  - a. The outside air damper shall open to provide a fixed percentage outside air ventilation anytime the unit runs and shall close anytime the unit stops. The damper open position shall be set during testing and balancing. The outside air damper shall close 1sec (adj.) after the fan stops.
  - b. If Optimal Start Up is available the outside air damper shall close and the return air damper shall open.
10. Filter Status:
  - a. The controller shall monitor the filter status.

- b. Alarms shall be provided as follows:
    - 1) Filter Change Required: Filter differential pressure exceeds a user definable limit (adj.).
  - 11. Discharge Air Temperature:
    - a. The controller shall monitor the discharge air temperature. Alarms shall be provided as follows:
      - 1) High Discharge Air Temp: If the discharge air temperature is greater than 120°F (adj.).
      - 2) Low Discharge Air Temp: If the discharge air temperature is less than 40°F (adj.).
  - 12. Fan Status:
    - a. The controller shall monitor the fan status.
    - b. Alarms shall be provided as follows:
      - 1) Fan Failure: Commanded on, but the status is off.
      - 2) Fan in Hand: Commanded off, but the status is on.
- O. Loop Monitor and Pumps (typical of 1)
- 1. Water Source Heat Pump Loop Monitor - Run Conditions:
    - a. The loop monitor shall run whenever:
      - 1) Any zone is occupied.
      - 2) OR a definable number of unoccupied zones need heating or cooling.
    - b. The following loop water conditions shall be monitored:
      - 1) Flow status.
      - 2) Supply temperature.
      - 3) Return temperature.
    - c. Alarms and a heat pump shutdown signal shall be generated upon any of the following loop water conditions:
      - 1) No Loop Flow.
      - 2) High Loop Water Supply Temp Shutdown: If the loop water supply temperature is greater than 92°F (adj.).
      - 3) Low Loop Water Supply Temp Shutdown: If the loop water supply temperature is less than 58°F (adj.).
    - d. Alarms shall be provided as follows:
      - 1) High Loop Water Supply Temp: If the loop water supply temperature is greater than 90°F (adj.).
      - 2) Low Loop Water Supply Temp: If the loop water supply temperature is less than 60°F (adj.).
  - 2. Loop Water Pump Lead/Standby Operation:
    - a. The two loop water pumps shall operate in a lead/standby fashion.
      - 1) The lead pump shall run first.
      - 2) On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.
    - b. The designated lead pump shall rotate upon one of the following conditions (user selectable):
      - 1) manually through a software switch
      - 2) weekly
    - c. Alarms shall be provided as follows:
      - 1) Loop Water Pump 1
        - a) Failure: Commanded on, but the status is off.
        - b) Running in Hand: Commanded off, but the status is on.

- 2) Loop Water Pump 2
- a) Failure: Commanded on, but the status is off.
  - b) Running in Hand: Commanded off, but the status is on.
- P. Loop Cooling (typical of 1)
1. Water Source Heat Pump Cooling Tower System - Run Conditions:
    - a. The cooling tower system shall be enabled to run whenever:
      - 1) The loop control is enabled by zone requirements.
  2. Closed System Cooling Tower Loop Water Temperature Control:
    - a. The controller shall measure the loop water supply temperature and stage the damper, spray pump and fans on in sequence to maintain setpoints. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
    - b. On rising loop water supply temperature, the damper, pump and fan speeds shall stage on at the setpoints given below. When the loop water supply temperature drops back below the setpoints by the differentials listed, the fan speeds, pump and damper shall stage off. To prevent short cycling and back-emf in the fan motors, there shall be a minimum delay (adj.) between each stage.
 

| <u>Tower Damper</u>                              | <u>Spray Pump</u> | <u>Low Speed Fan</u> | <u>High Speed Fan</u> |
|--------------------------------------------------|-------------------|----------------------|-----------------------|
| Stage ON: If loop temp rises above setpoint of:  |                   |                      |                       |
| 80°F                                             | 83°F              | 85°F                 | 88°F                  |
| Stage OFF: If loop temp drops below setpoint by: |                   |                      |                       |
| 4°F                                              | 5°F               | 5°F                  | 5°F                   |
    - c. Alarms shall be provided as follows:
      - 1) Damper
        - a) Failure: Commanded open, but the status indicates closed.
        - b) Open in Hand: Commanded closed, but the status indicates open.
      - 2) Spray Pump
        - a) Failure: Commanded on, but the status is off.
        - b) Running in Hand: Commanded off, but the status is on.
      - 3) Fan Low Speed
        - a) Failure: Commanded on, but the status is off.
        - b) in Hand: Commanded off, but the status is on.
      - 4) Fan High Speed
        - a) Failure: Commanded on, but the status is off.
        - b) in Hand: Commanded off, but the status is on.
      - 5) High Condenser Water Supply Temp: If the condenser water supply temperature is greater than 90°F (adj.).
- Q. Loop Heating (typical of 1)
1. Water Source Heat Pump Boiler System - Run Conditions:
    - a. The boiler system shall run subject to its own internal safeties and controls. The boiler system shall be enabled to run whenever:
      1. The loop control is enabled by zone requirements.
      2. AND outside air temperature is less than ***the unoccupied/occupied reset schedule.***

- b. The boiler system shall also run for freeze protection whenever outside air temperature is less than 38°F (adj.).
2. Two Stage Boiler Loop Water Temperature Control:
- a. The controller shall measure the loop water supply temperature and stage the boiler, its circulation pump and heating stages on in sequence to maintain setpoints. The boiler system shall run subject to its own internal safeties and controls.
  - b. On dropping loop water supply temperature, the boiler and its circulation pump shall stage on at the setpoints given below. When the loop water supply temperature rises back above the setpoints by the differentials listed, the boiler shall then stage off. To prevent short cycling, there shall be a user definable (adj.) delay between stages, and each stage shall have a user definable (adj.) minimum runtime.
  - c. The following setpoints are recommended values. All setpoints shall be field adjusted during the commissioning period to meet the requirements of actual field conditions.
  - d. The boiler and circulation pump shall stage to maintain setpoints as follows:
 

| <u>Boiler &amp; Pump</u>                         | <u>Stage 1</u> | <u>Stage 2</u> |
|--------------------------------------------------|----------------|----------------|
| Stage ON: If loop temp drops below setpoint of:  |                |                |
| 70°F                                             | 68°F           | 66°F           |
| Stage OFF: If loop temp rises above setpoint by: |                |                |
| 4°F                                              | 4°F            | 4°F            |
  - e. Alarms shall be provided as follows:
    - 1) Boiler
      - a) Failure: Commanded on, but the status is off.
      - b) Running in Hand: Commanded off, but the status is on.
    - 2) Low Boiler Supply Temp: If the boiler supply temperature is less than 120°F (adj.).
- R. Makeup Air Unit - Supply Air Temp (typical of 1)
1. Run Conditions - Interlocked:
    - a. The unit MAU --- shall be interlocked to run whenever Air Handling Unit ---- runs unless shutdown on safeties.
  2. Freeze Protection:
    - a. The unit shall shut down and generate an alarm upon receiving a freezestat status.
  3. Outside Air Damper:
    - a. The outside air damper shall open anytime the unit runs and shall close anytime the unit stops. The supply fan shall start only after the damper status has proven the damper is open. The outside air damper shall close 4sec (adj.) after the supply fan stops.
    - b. Alarms shall be provided as follows:
      - 1) Outside Air Damper Failure: Commanded open, but the status is closed.
      - 2) Outside Air Damper in Hand: Commanded closed, but the status is open.

4. Heat Recovery Wheel - Constant Speed:
- a. The controller shall run the heat wheel for energy recovery as follows.
    - 1) Cooling Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the heat wheel to maintain a setpoint 2°F (adj.) less than the unit supply air temperature setpoint. The heat wheel shall run for cool recovery whenever:
      - a) The unit return air temperature is 5°F (adj.) or more below the outside air temperature.
      - b) AND the unit is in a cooling mode.
      - c) AND the supply fan is on.
    - 2) Heating Recovery Mode: The controller shall measure the heat wheel discharge air temperature and run the wheel to maintain a setpoint 2°F (adj.) greater than the unit supply air temperature setpoint. The heat wheel shall run for heat recovery whenever:
      - a) Unit return air temperature is 5°F (adj.) or more above the outside air temperature.
      - b) AND the unit is in a heating mode.
      - c) AND the supply fan is on.
  - b. Periodic Self-Cleaning:
    - 1) The heat wheel shall run for 10sec (adj.) every 4hrs (adj.) the unit runs.
  - c. Frost Protection:
    - 1) The heat wheel shall run for 10sec (adj.) every 600sec (adj.) whenever:
      - a) Outside air temperature drops below 15°F (adj.)
      - b) OR whenever exhaust air temperature drops below 20°F (adj.).
  - d. The bypass dampers will open whenever the heat wheel is disabled.
  - e. Alarms shall be provided as follows:
    - 1) Heat Wheel Rotation Failure: Commanded on, but the status is off.
    - 2) Heat Wheel in Hand: Commanded off, but the status is on.
5. Supply Fan:
- a. The supply fan shall run anytime the unit is commanded to run. To prevent short cycling, the supply fan shall have a user definable (adj.) minimum runtime, unless shutdown on safeties.
  - b. Alarms shall be provided as follows:
    - 1) Supply Fan Failure: Commanded on, but the status is off.
    - 2) Supply Fan in Hand: Commanded off, but the status is on.
6. Supply Air Temperature Setpoint - Fixed:
- a. The controller shall monitor the supply air temperature and shall maintain a fixed supply air temperature setpoint of 55°F (adj.) cooling, 70 °F (adj.) heating.
7. Cooling Coil Valve:
- a. The controller shall measure the supply air temperature and modulate the cooling coil valve to maintain its cooling setpoint.
  - b. The cooling shall be enabled whenever:

- 1) Outside air temperature is greater than ***the unoccupied/occupied reset schedule.***
  - 2) AND the supply air temperature is above cooling setpoint.
  - 3) AND the fan status is on.
  - c. The cooling coil valve shall open to 50% (adj.) whenever the freezestat is on.
8. Heating Coil Valve:
- a. The controller shall measure the supply air temperature and modulate the heating coil valve to maintain its heating setpoint.
  - b. The heating shall be enabled whenever:
    - 1) Outside air temperature is less than ***the unoccupied/occupied reset schedule.***
    - 2) AND the supply air temperature is below heating setpoint.
    - 3) AND the fan status is on.
  - c. The heating coil valve shall open to 100% (adj.) whenever the freezestat is on.
9. Prefilter Status:
- a. The controller shall monitor the prefilter status.
  - b. Alarms shall be provided as follows:
    - 1) Prefilter Change Required: Prefilter differential pressure exceeds a user definable limit (adj.).
10. Final Filter Status:
- a. The controller shall monitor the final filter status.
  - b. Alarms shall be provided as follows:
    - 1) Final Filter Change Required: Final filter differential pressure exceeds a user definable limit (adj.).
11. Supply Air Temperature:
- a. The controller shall monitor the supply air temperature.
  - b. Alarms shall be provided as follows:
    - 1) High Supply Air Temp: If the supply air temperature is greater than 120°F (adj.).
    - 2) Low Supply Air Temp: If the supply air temperature is less than 45°F (adj.).

END OF SECTION

## SECTION 231101

## LIQUID PETROLEUM GAS PIPING

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for interior LP gas piping, exterior LP gas piping, gas valves, gas regulators, LP gas tanks, and vaporizers.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, performance ratings, and installation instructions.

## 1.3 QUALITY ASSURANCE

- A. Material and installation requirements shall follow NFPA 58, state and local gas company codes.
- B. Material and installation requirements shall follow OBC-Plumbing Code 4101:2-67 and 4101:8-1 thru 19 of the Ohio Pressure Piping Systems Rules.
- C. Conformance to National Fuel Gas Code.

## 1.4 GAS PIPING

- A. Interior gas piping shall be schedule 40 black steel piping.
- B. Exterior gas piping shall be schedule 40 black steel piping with bituminous coating. Provide grounding anode(s). Review type of piping and depth of bury with local L.P. tank company.
- C. Option to 2.01,A: Gas piping for ½ to 2 inch shall be corrugated stainless steel tubing. Covering must meet ASTM 84 (25/50) requirements and ANSI/AGA LCI B2005.
- D. Copper tubing must meet ASTM B88 and NFPA 58.
- E. Copper press fittings may be used as an option to wrought copper fittings. Fitting must be specifically made for natural gas and LP gas.

## 1.5 GAS VALVES

- A. Gas valves 2 inches and smaller shall be full port all brass screwed gas service stops with lever handles and check.
- B. Gas valves 2-1/2 inches and larger shall be semi-steel, straightway flanged, 125 lbs. swp, square head wrench operated, lubricated plug valve.
- C. Kitchen Hood – Spring loaded (N.C.) gas valve.

**HVAC****CHAPTER 9: SPECIFICATIONS**

- D. In the science and art rooms, provide the following:
  - 1. A manual reset, solenoid operated shut-off valve with 120v operation with remote push button operation and fire alarm system activation.

**1.6 GAS REGULATORS**

- A. Gas regulators shall limit the pressure of gas from the inlet to the outlet feeding a gas appliance.

**1.7 LP GAS TANK**

- A. Tank shall be supplied by the local LP gas company, sized to match the gas usage of the school.

**1.8 LP GAS VAPORIZER**

- A. Provide vaporizer for delivery of gas to the building if a liquid LP source is used, sized for the total building load.

**1.9 INSTALLATION**

- A. Unions and valves are not permitted in the gas piping in a return air plenum.
- B. Piping 1-1/2 inch and smaller shall have threaded joints.
- C. Piping 2 inches and larger shall have welded joints.
- D. All regulators shall be separately vented full size to the exterior, with a turndown elbow and insect screen. Vent outlet shall not terminate next to a combustion or fresh air intake.
- E. Provide a valve, union and dirt leg at each appliance. Lubricate all valves before putting the valves into service.
- F. Provide 1/2 inch elastomeric insulation around all piping through walls and floors.
- G. Test all piping for 24 hours at 100 psi.
- H. All interior piping shall be exposed. Exposed piping shall not be located where students could hang from the piping.
- I. All exterior gas piping shall be buried a minimum of 30 inches.
- J. Provide 6 foot high fence around tank(s).
- K. Provide regulator on exterior wall of building, connected to the interior piping. Provide inlet and outlet shutoff valve.
- L. Provide vaporizer within LP tank fence.
- M. Science room auto shut-off valves can be located in teacher's demo unit, under sink, or exposed in storage room.

END OF SECTION

## SECTION 232113

## HVAC PIPING SPECIALITIES

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for piping expansion joints and piping guides, pressure reducing valves, ASME safety relief valves, manual and automatic air vents, ASME compression and expansion tanks, air separators with automatic air vent, and strainers.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Pressure piping shall meet ASME B31.9 Code.
- B. Safety relief valve requirements shall meet ASME Boiler and Pressure Vessel Code.

## 1.4 COMPONENTS

- A. Expansion Joint: Housed stainless steel bellows type. Provide with piping expansion guides.
- B. Pressure-Reducing Valves. Bronze or cast iron body with inlet strainer and noncorrosive valve seat and stem. Preset at 12 psig (adjustable).
- C. ASME Safety-Relief Valves: Brass or bronze body with brass and rubber wetted internal working parts. Size for the pressure and capacity of the system.
- D. Manual Air Vents: Provide 1/2 inch diameter piping loop with ball valve and standard hose end connection.
- E. Automatic Air Vents: High capacity with float operation. Constructed of cast iron body with stainless steel, brass and EPDM internal parts. Rated for 250 degrees F at 150 psig. Unit shall be designed not to allow air into the vent in cast of system pressure dropping below atmospheric pressure. Use for relieving air from the system at the air separator only.
- F. ASME expansion tanks with air-control tanks fittings, gauge glass and tank drain fittings.
- G. ASME diaphragm-type compression tanks.
- H. Air separators with high capacity automatic air vent.
- I. Y-Pattern Strainers: 125 psig working pressure cast iron or bronze body ASTM A126 Class B.

- J. Duplex basket strainers for open condenser water systems. Cast iron body with stainless steel basket strainer. Provide with isolation valves for cleaning each strainer while remaining in service.
- K. Corrosion coupons with associated holders in piping.

### 1.5 INSTALLATION

- A. Provide piping expansion joints with piping control guides to control the expansion of the heating water piping systems where piping expansion loops cannot be used because of space restrictions.
- B. Provide pressure reducing valves at the domestic cold water make-up connection to the closed loop heating water, chilled water piping systems, and heat pump.
- C. Provide ASME safety relief valve in all closed hydronic loop systems. Relief valves shall be sized for the proper relief capacity to protect each system.
- D. Provide manual air vent valves at all coils and at the high points of each system.
- E. Provide automatic air vent valves on the air separator for each system. Pipe this air relief discharge to the nearest floor drain.
- F. Provide either an ASME compression tank or an ASME bladder type expansion tank for each closed loop system.
- G. Provide a full size (same size as the main piping system) centrifugal air separator on the suction side of the closed loop pumping system. The capacity shall meet or exceed the flow requirements of the system.
- H. Provide basket strainer for all open loop condenser water systems.
- I. Provide corrosion coupons and holders for all open loop condenser water systems.
- J. Provide Y-pattern strainer at all coils including VAV reheat coils at inlet side of control valve and automatic flow controller.

END OF SECTION

## SECTION 232117

## GLYCOL HEAT TRANSFER FLUID

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for pre-mixed [ethylene] [propylene] glycol solution for the closed loop heating water systems and chilled water systems.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data, system capacity adjustments, MSDS sheets, and requirements for installation.

## 1.3 QUALITY ASSURANCE

- A. Chemical shall meet all state and local pollution control regulations.
- B. Heat transfer solution shall be inhibited and specifically for use in commercial HVAC systems.
- C. System shall have a minimum 8 inch by 10 inch metal system nameplate denoting the following:
  1. Date of original HTF charge.
  2. Description of heat transfer fluid.
  3. Manufacturer's name, address, and telephone.
  4. Percent ethylene glycol.
  5. Freeze point and burst point.
  6. Total system gallons.
  7. Reference to material safety sheet.
  8. Instruction for sampling of fluid.
  9. Month for annual sampling.
  10. Mailing instructions.

## 1.4 ETHYLENE GLYCOL-BASED PRODUCT

- A. Inhibited ethylene glycol containing inhibitors, buffers, and anti-foaming agents.
- B. Minimum 25 percent solution of heat transfer fluid and deionized water.

## 1.5 PROPYLENE GLYCOL-BASED PRODUCT

- A. Inhibited propylene glycol containing inhibitors, buffers, and anti-foaming agents.
- B. Minimum 30 percent solution of heat transfer fluid and deionized water. A 20 percent solution shall be acceptable in geothermal, ground-coupled systems where required for protection of equipment - not for freeze (burst) protection for exterior piping.

## 1.6 INSTALLATION

- A. Install fluid on suction side of system pump.

## 1.7 HYDRONIC SYSTEMS FLUSHING

- A. Hydronic systems shall be thoroughly flushed with approved pre-cleaning agent prior to being placed into service.

END OF SECTION

## SECTION 232119

## HVAC FLOW CONTROL

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for calibrated plug valves for manual system flow balancing and automatic flow balancing valves.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

## 1.3 COMPONENTS

- A. Calibrated plug valves
  - 1. 125 psig maximum working pressure 250 degrees Fahrenheit maximum operating temperature, bronze construction with calibrated orifice. Provide with pressure temperature taps. Two inches diameter and smaller shall have threaded connections. Two and one-half inches diameter and larger shall be flanged connections.
- B. Automatic flow balancing valves:
  - 1. 150 psig maximum working pressure, 250 degrees F maximum operating temperature. Brass or bronze housing for one and one-half inches diameter piping size and smaller and cast iron for two inches diameter and larger piping size with all stainless steel operating parts. Flow shall be controlled to plus or minus 5 percent of the required flow. Provide with threaded connections for two inches diameter and smaller. Provide flanged or grooved connections for two inches diameter and larger. Provide with pressure temperature taps on each side of the flow control cartridge. Provide the proper pressure control range for the system.

## 1.4 INSTALLATION

- A. Provide (calibrated manual) (automatic) flow control valves at each coil, heat pump, boiler or each chiller of a multiple chiller installation to properly balance the flow to each device.

END OF SECTION

## SECTION 232123

## HVAC HYDRONIC PUMPS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for in-line circulators, vertical in-line pumps, base-mount end-suction pumps, close-coupled end-suction pumps, coil circulating pumps, and double-suction, vertical split-case pumps.

## 1.2 SYSTEM DESCRIPTION

- A. Impellers shall be sized for a maximum diameter not to exceed 85 percent of the selected pump's largest diameter.
- B. Each pump shall be selected for non-overloading operation throughout its curve.
- C. Each pump shall be provided with high efficiency motors.
- D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.3 SUBMITTALS

- A. Submittals are required and shall include pump performance curves.

## 1.4 HORIZONTAL IN-LINE CIRCULATORS

- A. Each pump will be horizontal, centrifugal, single stage, design with cast iron casings and bronze impellers.
- B. Mechanical seals.
- C. Resiliently mounted motor.

## 1.5 VERTICAL IN-LINE PUMPS

- A. Each pump will be vertical, centrifugal, single stage, design with cast iron casings and bronze impellers.
- B. Mechanical seals.
- C. Direct-mounted motor with lifting and supporting lugs.

## 1.6 BASE-MOUNT END-SUCTION PUMPS

- A. Each pump will be single stage, base-mounted, end-suction design with cast iron casing, cast-bronze impeller, and bronze fitted construction.

- B. Mechanical seals.
- C. The pump and motor shall be mounted on a common baseplate of heavy structural steel.

#### 1.7 CLOSE-COUPLED END SUCTION PUMPS

- A. Each pump shall be closed-coupled, single-stage, end suction design with cast iron casing, cast-bronze impeller, and bronze-fitted construction.
- B. Mechanical seals.
- C. Direct-mounted motor.

#### 1.8 COIL CIRCULATING PUMPS

- A. Each pump will be horizontal, centrifugal, single stage, design with cast iron casings and nonmetallic impellers.
- B. Mechanical seals.
- C. Resiliently mounted motor.

#### 1.9 DOUBLE-SUCTION, VERTICAL SPLIT-CASE PUMPS

- A. Each pump will be single stage, double-suction, vertical split case design with cast iron casing, bronze impeller, and bronze fitted construction.
- B. Mechanical seals.
- C. The pump and motor shall be mounted on a common baseplate of heavy structural steel.

#### 1.10 INSTALLATION

- A. Install all pumps in accordance with manufacturer's requirements.
- B. Base mounted pumps shall be mounted on a concrete housekeeping pad. In-line pumps shall be supported from the structure or floor. Pumps may be provided as part of a packaged pumping system. Base mounted pumps shall be set on concrete inertia base when provided as part of packaged pumping systems.

END OF SECTION

## SECTION 232300

## REFRIGERANT PIPING

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for refrigerant piping and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. ASME B31.5 Refrigeration Piping latest edition.
- B. UL 207 Refrigerant Containing Components and Accessories.

## 1.4 COMPONENTS

- A. Piping: Type ACR hard copper tubing with wrought copper fittings and brazed joints.
- B. Valves
  1. Packed angle valve.
  2. Solenoid valve.
  3. Refrigerant check valve.
  4. Thermal expansion valve.
  5. Pressure relief valve.
  6. Pressure regulating valve.
  7. Hot gas bypass valve.
  8. Suction accumulator.
- C. Moisture indicators.
- D. Replaceable type filter/dryer assemblies with three valve by-pass.
- E. Flexible piping connectors.

## 1.5 INSTALLATION

- A. Provide filter/dryer assemblies, moisture indicators, thermal expansion valve and solenoid valves for each refrigeration circuit.
- B. Pressure test refrigerant piping system at 300 psi for high side and 150 psi for low side. Maintain pressure for a minimum of 24 hours.
- C. Leak test piping and joints with an electronic or halide leak detector.
- D. Evacuate entire system with an approved high vacuum pump system to 500 microns.

END OF SECTION

## SECTION 232500

## HVAC WATER TREATMENT

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for closed water treatment system for heating hot water, chilled water, and heat pump condenser water systems.
- B. Qualitative requirements for open water treatment system for cooling tower condenser water systems.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting catalog data, specification data, dimensional and operational data, wiring requirements with diagram, chemical specification data, and warranty data.

## 1.3 QUALITY ASSURANCE

- A. Chemical shall meet all state and local pollution control regulations.

## 1.4 WARRANTY

- A. Provide a 1 year chemical service program including testing and required materials and additives.

## 1.5 SYSTEM COMPONENTS

- A. Bypass Shot Feeders: Cast iron or steel, [1.8-gallon] [5-gallon] capacity, 125-psig working-pressure rating.
- B. Conductivity Probe: Provide complete with probe and flow switch and dual flat switch surface carbon elements. Maximum pressure shall not exceed 150 psi and maximum temperature shall not exceed 140 degrees F.
- C. Positive-displacement [diaphragm] [piston] pumps: Provide with ball type check valves, foot valves, and injection fittings.
- D. Chemical Solution Tanks: [30 gallon] [50 gallon].
- E. Packaged conductivity controller: Electronic operation with bleed and feed relays, feed timer, and digital display for control setting and adjustments.
- F. Cold-water meter: Provide complete with contacting register sized to meter twice the volume of maximum makeup water rate for system.
- G. Solenoid valves: Provide and wire as required.
- H. Electronic timers: Provide a biocide control timer and lockout control timer.

- I. Condenser water treatment control panel: Provide enclosed in a NEMA 4X, IP-65 rated enclosure with hinged lockable cover.
- J. Chemical treatment test equipment
  - 1. Water test kit with spare reagents.
  - 2. Conductivity meter that compensates for differences in temperatures and analog meter.
- K. Chemicals
  - 1. Provide a minimum of 1 years supply.
  - 2. Include all MSDS sheets for chemicals provided.
- L. Pre-cleaning and flushing materials: Provide chemicals produced specifically for use in cleaning piping systems after installation and prior to being placed into operation.

## 1.6 INSTALLATION

- A. Install shot feeder with 2 valve bypass.
- B. Mount conductivity monitor, chemical feed pumps, and biocide timer on 304 stainless steel shelf.
- C. Hydronic systems shall not be operated for any reason prior to complete flushing and charging with appropriate chemicals.

## 1.7 HYDRONIC SYSTEMS FLUSHING

- A. Hydronic systems shall be thoroughly flushed with approved pre-cleaning agent prior to being placed into service for temporary or permanent use.

## 1.8 WATER SERVICE PROGRAM

- A. The chemical treatment contractor shall provide chemical and consulting services for 1 year from date of acceptance of system by the Owner.

## 1.9 TRAINING

- A. Provide training for Owner's maintenance staff on testing of water samples.

END OF SECTION

## SECTION 233113

## LOW-PRESSURE DUCTWORK

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for low pressure supply (2-inch wg pressure class) sheetmetal ductwork; and low pressure return, relief and exhaust (2-inch wg pressure class negative) sheetmetal ductwork.
- C. Qualitative requirements for duct insulation liner. Application shall be limited; external wrapped insulation is preferred.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include 1/4 inch scale layout shop drawings showing duct location sizes, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect/Engineer upon request.

## 1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181.
- C. NAIMA AH124-94: Fibrous Glass Duct Liner Standard.
- D. NFPA 90A and 90B.
- E. ASHRAE Handbook, HVAC Systems and Equipment.
- F. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Supply air, return air, relief air and exhaust air (except shower rooms, kitchen exhaust hoods, dishwasher exhaust and fume hood exhaust) shall be galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.
  - 1. Provide Class B seals for all joints.
  - 2. Bolted-flange style duct connections shall be acceptable.

- B. Fume hood exhaust shall be **Type 304 stainless steel or** PVC -coated galvanized steel lock forming quality meeting UL 181, ASTM A 653/A 653/M, G90 (Z275) coating designation. Provide 4-mil PVC coating on the interior of the duct and fittings. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.
1. Provide Class **A** seals for all joints.
- C. Shower exhaust ductwork shall be aluminum construction conforming to ASTM B 209 Alloy 3003, Temper H14, Gauges shall be per the latest issue of SMACNA for listed pressure requirements. Seal all joints liquid-tight. **Pitch ductwork back toward grille.**
- D. Kitchen exhaust hood exhaust ductwork shall be 16 gauge steel with weld joints as required by the Ohio Basic Mechanical Code. All joints shall be welded liquid tight.
- E. Dishwasher exhaust ductwork shall be 16 gauge type 304 stainless steel with liquid tight welded joints all the way to the fan. **Pitch ductwork back toward dishwasher.**
- F. Flexible duct liner shall be a minimum of 1 inch thick and shall be applied in accordance with the latest addition of the SMACNA's Duct Liner Application Standard. All dimension shown on the plans are inside duct dimension and do not include the dimension of the duct liner.

END OF SECTION

## SECTION 233115

## MEDIUM-PRESSURE DUCTWORK

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for medium-pressure round or flat oval supply (3 inch wg pressure class) sheetmetal ductwork.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include 1/4 inch scale layout shop drawings showing duct location sizes, elevations and air flow quantities for each air terminal device. Electronic drawing files of floor plans and structural plans are available from the Architect/Engineer upon request.

## 1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181.
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Supply air shall be spiral seam round or flat oval duct work constructed of galvanized steel lock-forming quality ASTM A 653/A 653/M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view. Gauges shall be per the latest issue of SMACNA for listed pressure requirements.
- B. Minimum round duct sheet metal gauge shall be as follows:

| <u>Duct Diameter</u> | <u>Spiral Seam Gauge</u> | <u>Longitudinal Seam Gauge</u> |
|----------------------|--------------------------|--------------------------------|
| 3 through 14 inches  | 26                       | 24                             |
| 15 through 26 inches | 24                       | 22                             |
| 27 through 36 inches | 22                       | 20                             |
| 37 through 50 inches | 20                       | 20                             |
| 51 through 60 inches | 18                       | 18                             |
| 61 through 84 inches | 18                       | 16                             |

- C. Minimum flat oval duct gauges shall be as follows:

| <u>Major Dimension</u><br><u>Duct Width</u> | <u>Spiral Seam Gauge</u> | <u>Longitudinal Seam Gauge</u> |
|---------------------------------------------|--------------------------|--------------------------------|
| Up through 24 inches                        | 24                       | 20                             |
| 25 through 36 inches                        | 22                       | 20                             |
| 37 through 48 inches                        | 22                       | 18                             |
| 49 through 60 inches                        | 20                       | 18                             |
| 61 through 70 inches                        | 20                       | 16                             |
| 70 inches and up                            | 18                       | 16                             |

- D. Fittings for duct construction shall be of sheet metal gauges as follows:

| <u>Duct Diameter/<br/>Major Dimension</u> | <u>Round Fittings</u> | <u>Flat Oval Fittings</u> |
|-------------------------------------------|-----------------------|---------------------------|
| 3 through 14 inches                       | 24                    | 20                        |
| 15 through 26 inches                      | 22                    | 20                        |
| 27 through 36 inches                      | 20                    | 20                        |
| 37 through 50 inches                      | 20                    | 18                        |
| 51 through 60 inches                      | 18                    | 18                        |
| 61 through 84 inches                      | 16                    | 16                        |

- E. Provide with Class A seals for all duct joints.

END OF SECTION

## SECTION 233117

## FLEXIBLE DUCTWORK

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for flexible insulated HVAC ductwork and flexible ductwork joint connections.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include material pressure ratings and dimensions.

## 1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181 .
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. UL 191.
- F. Ductwork shall be sealed and leak tested as required by ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Low Pressure Flexible Duct
  - 1. Inner Core: Reinforced 3-ply aluminum foil with mechanically lock helix.
  - 2. Outer Covering: 1 inch thick, 3/4 pound density fiberglass with fire retardant jacket.
  - 3. Pressure Rating: 5 inches positive or negative.
- B. High Pressure Flexible Duct
  - 1. Inner Core: All metal, bend 3-ply laminated aluminum.
  - 2. Outer Covering: 1 inch thick, 3/4 pound density fiberglass with fire retardant jacket.
  - 3. Pressure Rating: 10 inch positive.
- C. Flexible Joints
  - 1. Minimum 30 ounce neoprene coated fabric secured by bolted angles or band iron.
  - 2. Metal to metal contact shall not be permitted.

## 1.5 INSTALLATION

- A. Provide the flexible connections at ductwork connections to vibrating or rotating equipment, including fans.

END OF SECTION

## SECTION 233300

## DUCTWORK ACCESSORIES

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for backdraft dampers, manual volume dampers, fire dampers, smoke dampers, duct silencers, turning vanes and duct access doors.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include material, sizes, quantities, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. SMACNA HVAC Duct Construction Standards-Metal and Flexible.
- B. UL181 .
- C. NFPA 90A and 90B.
- D. ASHRAE Handbook, HVAC Systems and Equipment.
- E. Dampers shall meet the requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Backdraft Dampers
  1. Frames: Galvanized steel.
  2. Blades: Extruded aluminum.
  3. Blade Seals: Neoprene.
  4. Blade Axles: Galvanized steel.
  5. Tie Bars and Brackets: Aluminum.
  6. Return Spring: Adjustable tension for motor operated dampers only.
  7. Dampers: Counter-balanced for building pressure activation.
- B. Manual Volume Dampers
  1. Frames: Galvanized steel.
  2. Blades: Galvanized steel or Extruded aluminum.
  3. Tie Bars and Brackets: Galvanized steel.
  4. Blade Seals: Neoprene.
  5. Dampers: Multiple, opposed blade design with linkage outside airstream.
- C. Fire Dampers
  1. UL listed and labeled for 1-1/2 hour or 3 hour.
  2. Frame: Galvanized steel.
  3. Blades: Mounted out of airstream.
  4. Fusible Link: Replaceable 165 degrees F.

- D. Smoke Dampers
  - 1. Actuators: Two-position with spring-return motors.
- E. Duct Silencers: Factory-fabricated and -tested, 25/50 flame-spread/smoke-developed rating, with performance ratings determined by ASTM E 477.
  - 1. Fill Material: fiberglass.
- F. Turning Vanes
  - 1. Installer fabricated or manufactured.
- G. Duct-Mounted Access Panels and Doors
  - 1. Frame: Galvanized steel
  - 2. Door: Double wall galvanized steel with 1 inch insulation fill and neoprene seal.
  - 3. Access panels shall be rated to seal at air pressure of associated duct.

### 1.5 INSTALLATION

- A. Provide backdraft dampers on all relief air and exhaust air outlets (except kitchen exhaust and fume hood exhaust).
- B. Provide manual volume dampers at each supply air outlet, exhaust air inlet, ducted relief air, and return air inlet.
- C. Provide fire dampers in all ducted and non-ducted openings in fire rated assemblies as required by the Ohio Basic Building.
- D. Provide smoke dampers in smoke barriers where required by the Ohio Basic Building Code.
- E. Provide duct silencers to control the air handling system discharge sound pressure level to acceptable levels.
- F. Provide turning vanes in all mitered ductwork 90 degree elbows.
- G. Provide duct mounted access doors and panels to all fire dampers, control damper, plenum housings.

END OF SECTION

## SECTION 233313

## EXTERIOR WALL LOUVERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for exterior wall louvers and soffit louvers.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include scheduled material, sizes, quantities, and finish.

## 1.3 QUALITY ASSURANCE

- A. AMCA Standard 511.

## 1.4 COMPONENTS

## A. Rectangular Drainable Wall Louvers

- 1. Stormproof, aluminum construction.
- 2. Aluminum bird screen suitably braced to prevent sagging.
- 3. Frame shall be constructed of 6063T5 extruded aluminum.
- 4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
- 5. Finish shall be factory applied baked enamel.

## B. Specialty Louvers-Polygon

- 1. Stormproof, aluminum construction.
- 2. Aluminum bird screen suitably braced to prevent sagging.
- 3. Frame shall be constructed of 6063T5 extruded aluminum.
- 4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
- 5. Finish shall be factory applied baked enamel.

## C. Specialty Louvers Semi-Round or Round

- 1. Stormproof, aluminum construction.
- 2. Aluminum bird screen suitably braced to prevent sagging.
- 3. Frame shall be constructed of 6063T5 extruded aluminum.
- 4. Blades shall be constructed of 6063T5 extruded aluminum. Blades shall be the drainable type, positioned at a minimum 35 degree angle.
- 5. Finish shall be factory applied baked enamel.

## D. Horizontal Soffit Louvers

- 1. Horizontal soffit louvers shall be of aluminum construction.
- 2. Frame to be of 6063T5 extruded aluminum.
- 3. Blades to be of 6063T5 extruded aluminum.
- 4. Aluminum bird screen suitably braced to prevent sagging.
- 5. Finish shall be factory applied baked enamel.

## 1.5 INSTALLATION

- A. Install wall louvers of the sizes and quantities as required.

END OF SECTION

## SECTION 233400

## HVAC FANS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for roof exhaust fans, in-line exhaust fans, utility fan sets, and ceiling exhaust fans.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include material capacities, quantities, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Sound Power Level Rating: AMCA 301.
- B. Performance Requirements: AMCA 210.
- C. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 COMPONENTS

## A. Utility Set Fans

1. Drive: Belt driven.
2. Housing: Steel, adjustable.
3. Fan Wheel: Centrifugal, single inlet, steel [backward inclined] [forward curved].
4. Fan Shaft: Steel.
5. Shaft Bearings: Prelubricated, self-aligning, pillow block type ball bearings with 200,000 hour rated life.
6. Belt Drives: Factory mounted, 1.4 service factor, adjustable pitch motor pulleys, oil-resistant non-sparking belts, and belt guards.
7. Motors: Heavy duty, ball bearing type with overload protection.
8. Accessories: [Gravity-actuated backdraft dampers] [Access doors] [Scroll dampers] [Spark-resistant construction] [Inlet screens] [Drain connection] [Weathershield hoods].

## B. Centrifugal Roof Ventilators

1. Drive: [Belt] [Direct].
2. Housing: Spun aluminum.
3. Fan Wheel: Aluminum hub and wheel, backward-inclined blades.
4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley, and fan motor isolated from airstream.
5. Motor: Heavy duty, ball bearing type with overload protection.
6. Accessories: [Variable speed controller] [Disconnect switch] [Bird screens] [Backdraft dampers].
7. Roof Curb Configuration: [Self-flashing without cant strip and with mounting flange] [Built-in cant and mounting flange] [Built-in raised cant and mounting flange].
8. Roof Curb Height: 12 inches standard above finished roof.

- C. Upblast Centrifugal Roof Exhaust Fans  
**Spec Writer Note: Accessories not to be used on greese duct exhaust system.**
1. Drive: Belt driven.
  2. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum.
  3. Housing: Spun aluminum.
  4. Fan Wheel: Aluminum construction, backward inclined centrifugal.
  5. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley with motor mounted outside the airstream.
  6. Motor: Heavy duty, ball bearing type with overload protection.
  7. **Accessories: [Variable speed controller][Disconnect switch][Bird screen][Back draft dampers]**
  8. Roof Curb Configuration: [Self-flashing without cant strip and with mounting flange] [Built-in cant and mounting flange] [Built-in raised cant and mounting flange].
  9. Roof Curb Height: 18 inches.
- D. Propeller Wall Ventilators
1. Drive: [Belt] [Direct].
  2. Housing: [Spun aluminum] [Painted steel].
  3. Fan Blade: Steel hub with steel propeller blades.
  4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, cast iron adjustable pitch pulley, and fan motor isolated from airstream.
  5. Motors: Shall be permanently lubricated, heavy duty type with overload protection.
  6. Accessories: [Variable speed controller] [Disconnect switch] [Bird screens] [Backdraft dampers].
- E. Ceiling Mounted Exhaust Fans
1. Drive: Direct.
  2. Housing: Galvanized steel.
  3. Fan Wheel: Centrifugal.
  4. Grilles: Plastic, louvered.
  5. Roof jack or wall cap and transition fittings.
  6. Provide with backdraft dampers.
  7. Provide with integral disconnect switch.
- F. In-Line Centrifugal Fans.
1. Drive: [Direct] [Belt].
  2. Housing: Galvanized sheet metal.
  3. Fan Wheel: Centrifugal, aluminum.
  4. Belt Drive Assembly: Steel shaft, permanently lubricated ball bearings, adjustable pitch motor pulleys, motor insulated from airstream, belt guards.
  5. Motors: Heavy duty, ball bearing type with overload protection.
  6. Accessories: [Variable speed controller] [Disconnect switch] [Backdraft dampers].

## 1.5 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION

## SECTION 233423

## ROOFTOP INTAKE, EXHAUST, AND RELIEF VENTILATORS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for rooftop intake and exhaust gravity ventilators.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include material and dimensions.

## 1.3 COMPONENTS

## A. Low Silhouette Roof Ventilators

- 1. Shall be constructed of heavy gauge aluminum.
- 2. Support members shall be constructed of galvanized steel.
- 3. Hood shall be removable from base or hinged.
- 4. Shall include 2 inch galvanized steel bird screens.
- 5. Underside of hood shall be insulated to reduce condensation.
- 6. Exterior finish shall be baked enamel.

## B. Louvered Penthouse Units

- 1. Shall be constructed of heavy gauge aluminum.
- 2. Support members shall be constructed of galvanized steel.
- 3. Hood shall be removable from base or hinged.
- 4. Shall include 2 inch galvanized steel bird screens.
- 5. Underside of hood shall be insulated to reduce condensation.
- 6. Exterior finish shall be baked enamel.

## 1.4 INSTALLATION

- A. Provide the number and type of ventilators as required.
- B. Mount units on roof curbs.

END OF SECTION

## SECTION 233513

## DUST COLLECTION SYSTEM

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for woodworking shop dust collection cyclone separator, after-filter, ductwork, equipment hoods, floor sweeps, blast gates, and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork layouts specific to each system.

## 1.3 QUALITY ASSURANCE

- A. Design and installation shall be in accordance with the Industrial Ventilation Manual of the American Conference of Governmental Industrial Hygienists and the American National Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems (ANSI/AIHA Standard Z9.2 – 2006).
- B. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 DUST COLLECTOR

- A. Primary collector shall be cyclone type for exterior installation.
- B. Dust shall be precipitated into 55 gallon drums, (one or two as required).
- C. Unit shall be constructed of heavy-gauge, cold rolled steel.
- D. Final finish of primer and enamel paint.
- E. Unit shall be factory assembled for final field assembly of major subassemblies.

## 1.5 AFTER-FILTER UNIT

- A. After-filter shall be cloth tube type.
- B. Dust removal shall be 100 percent down to 0.5 microns.
- C. Unit shall be provided with a manually operated, motorized shaker.
- D. Bottom of unit shall form a storage bin not less than 14 cubic feet for dust.
- E. Unit shall be factory assembled for placement in field.

**HVAC**

## CHAPTER 9: SPECIFICATIONS

**1.6 DUCTWORK AND ACCESSORIES**

- A. Ductwork shall be comprised of galvanized steel spiral pipe of not less than 22 gauge material.
- B. Elbows used in installation shall be a minimum of 2 gauges heavier construction than the straight pipe of equal diameter.
- C. Hoods shall be constructed of not less than 18 gauge galvanized steel material.
- D. Flexible duct connections shall be noncollapsible, flexible metallic hose.
- E. Blast gates shall allow for locking the gate in an open position or for removal of gate. Butterfly dampers are not permitted.
- F. Cleanouts shall include a piano hinged door with spring clamps, locking latches, and edge felting to prevent air leaks.

**1.7 INSTALLATION**

- A. Install in accordance with manufacturers requirements.
- B. Secure all duct and elbow joints with self-tapping screws and caulk or hardcast type sealer. Duct tape is not acceptable.
- C. Position cleanouts with hinged side at bottom center of ductwork.
- D. Blast gates shall be positioned within each reach of equipment operator.
- E. Manufacturer's service representative shall provide complete check, test, and start-up on the system.
- F. Construct hoods to suit actual equipment and site conditions.

END OF SECTION

## SECTION 233515

## WELDING EXHAUST SYSTEM

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for source capture devices, ductwork, flexible hoses and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork layouts.

## 1.3 QUALITY ASSURANCE

- A. Design and installation shall be in accordance with 1) ANSI/AIHA Standard Z9.2 – 2006: American National Standard for Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems and 2) Industrial Ventilation: A Manual of Recommended Practice, 4<sup>th</sup> Edition, American Conference of Governmental Industrial Hygienists (ACGIH).
- B. Flexible hoses shall meet UL-94 fire retardant requirements.

## 1.4 SOURCE CAPTURE DEVICES

- A. Constructed of reinforced fiberglass for fire retardance.
- B. Minimum 24 inches by 18 inches open face with an 8 inch diameter connection.
- C. Vertical support rail that allows for adjustment of capture device height, designed for wall mounting.
- D. Safety screen in throat.

## 1.5 DUCTWORK

- A. Round ductwork shall be manufactured of heavy gauge galvanized steel with a spiral lockseam.
- B. Fittings and couplings shall be constructed of 20 gauge galvanized steel.

## 1.6 FLEXIBLE HOSES

- A. Manufactured of polyvinyl chloride reinforced with a hard drawn steel spiral bead wire.
- B. Operating pressure of -7 psi to +5 psi.
- C. Operating temperature of -10 degrees Fahrenheit to +180 degrees Fahrenheit.

## 1.7 INSTALLATION

- A. Exhaust fans shall be as specified by Specification Section 233400 – HVAC Fans.
- B. Install in accordance with manufacturers requirements.
- C. Manufacturer's service representative shall provide complete check, test, and start-up on the system.

END OF SECTION

## SECTION 233600

## VARIABLE AIR VOLUME TERMINALS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for variable air volume reheat terminals and fan-powered variable air volume reheat terminals.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting the following:
  1. Product data indicating dimensions, weights, capacities, and materials.
  2. Static pressure requirements.
  3. Sound performance levels.
  4. Accessories.

## 1.3 QUALITY ASSURANCE

- A. Construction standard shall meet NFPA 90A.
- B. Product certification shall comply with ARI 880.
- C. Sound power level rating shall comply with AMCA 300, ASHRAE 68, and AMCA 301.
- D. Coil performance shall comply with ARI 410.
- E. Insulation standard shall comply with UL 181.

## 1.4 COMPONENTS

- A. Single-Duct Reheat Terminal Units
  1. Configuration: Volume-damper assembly inside unit casing.
  2. Casing: Zinc-coated steel
  3. Casing Lining: 1-inch thick, 1-1/2 pound density fiberglass insulation with erosion-resistant coating or 0.75 inch thick, 1-1/2 pound density closed cell foam insulation (fiber free).
  4. Air Inlets: Round or flat oval with air velocity sensor.
  5. Volume Damper: [Galvanized steel] [extruded aluminum] [cylindrical flow control device] with maximum airflow leakage of [2 percent at 1-inch wg] [2 percent at 3-inch wg] [3 percent at 3-inch wg] [3 percent at 6-inch wg].
  6. Damper Position: [Normally open] [Normally closed].
  7. Multi-outlet Discharge Section: Insulated plenum with ductwork discharge collars and locking balancing damper.
  8. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
  9. Velocity sensor: multi-point averaging type.
  10. Controls: Electronic DDC controls.
  11. Each unit shall include the following control accessories:
    - a. Control transformer and disconnect switch.
    - b. Mount controls in NEMA 250 Type 1 enclosure.

- B. Fan-Powered Reheat Terminal Units
1. Configuration: Volume-damper assembly inside unit casing.
  2. Casing: Zinc-coated steel
  3. Casing Lining: 1-inch thick, 1-1/2 pound density insulation with erosion-resistant coating.
  4. Air Inlets: Round or flat oval with air velocity sensor.
  5. Access: Removable panels with cam-lock fasteners.
  6. Volume Damper: [Galvanized steel] [extruded aluminum] [cylindrical flow control device] with maximum airflow leakage of [2 percent at 1-inch wg] [2 percent at 3-inch wg] [3 percent at 3-inch wg] [3 percent at 6-inch wg].
  7. Damper Position: [Normally open] [Normally closed].
  8. Fan: Series or parallel type unit located in acoustically lined plenum housing a direct-drive, forward-curved fan, and thermally protected PSC motor.
  9. Multi-outlet Discharge Section: Insulated plenum with ductwork discharge collars and locking balancing damper.
  10. Hot-Water Heating Coil: Copper tube and aluminum finned coil.
  11. Velocity sensor: multi-point averaging type.
  12. Filter: Attenuating air inlet section complete with 1 inch filter rack.
  13. Controls: Electronic DDC controls.
  14. Each unit shall include the following control accessories:
    - a. Control transformer and fused disconnect switch.
    - b. Fan solid state speed controller.
    - c. Fan relay switch.
    - d. Mount controls in NEMA 250 Type 1 enclosure.

## 1.5 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.
- C. Parallel fan-powered terminal units shall not be installed in classrooms or other acoustically sensitive spaces.

END OF SECTION

## SECTION 233713

## AIR OUTLETS AND INLETS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for supply air linear slot diffusers; return air linear diffusers; return air, exhaust air, and transfer air, grilles and registers; supply air registers; supply air diffusers; wall linear diffuser; egg crate return air or transfer air grilles; heavy duty wall return air grille or register; and above floor displacement type air devices.

## 1.2 SUBMITTALS

- A. Submittals are required and shall be scheduled by room number to include material, sizes, quantities, finishes, and accessories.

## 1.3 QUALITY ASSURANCE

- A. ASHRAE Standard 70 for performance testing.
- B. NFPA 90A for installation.

## 1.4 COMPONENTS

- A. Supply Air Linear Slot Diffusers
  1. 22 gauge aluminum or heavy gauge steel diffusers assembly with factory baked white enamel finish or powder paint white finish.
  2. 26 gauge zinc-coated steel inlet boot, maximum 12 inches high.
  3. Single/multiple slots with extruded or stamped vanes.
  4. Maximum 50 CFM/lineal ft./slot.
  5. Third band SPL 40 DB without room credit.
  6. 1/2 inch glass fiber acoustically insulated inlet plenum/boot.
- B. Return Slot Diffusers
  1. 22 gauge aluminum or heavy gauge steel diffuser assembly with factory baked white enamel finish or powder paint white finish.
  2. 26 gauge zinc-coated steel inlet boot, maximum 12 inches high.
  3. Single/multiple slots.
  4. Maximum 100 cfm/lineal ft./slot.
  5. 1/2 inch glass fiber insulated plenum/boot.
- C. Return Air, Exhaust and Air Transfer Grilles and Registers
  1. All aluminum construction.
  2. Angled louvers spaced 1/2 inch on center.
  3. One set of fixed louvers parallel to long dimension.
  4. Baked white enamel finish or powder paint white finish.

- D. Supply Air Registers
  - 1. All aluminum construction.
  - 2. Double deflection louvers.
  - 3. Front and rear louvers individually adjustable, horizontal to the front.
  - 4. Baked white enamel finish or powder paint white finish.
  
- E. Supply Air Diffuser
  - 1. All 18 gauge steel diffuser.
  - 2. Solid face panel with curved back pan designed for VAV usage.
  - 3. Opposed blade volume damper in inaccessible locations.
  - 4. Baked white enamel finish or powder paint white finish.
  - 5. Provide with equalizing grid.
  
- F. Wall Linear Diffuser
  - 1. All aluminum construction.
  - 2. Fixed bar type louvers.
  - 3. Provide with selected factory finish.
  
- G. Eggcrate Grille Return Air Grille or Transfer Grille
  - 1. 1/2 inch by 1/2 inch by 1/2 inch aluminum grid.
  - 2. Aluminum border if required.
  - 3. Provide frame for appropriate ceiling mounting.
  - 4. Baked white enamel finish or powder paint white finish.
  
- H. Heavy Duty Wall Return Air Grille (for use in gymnasiums and locker rooms)
  - 1. Heavy gauge steel construction.
  - 2. Angled louvers spaced 1/2 inch on center.
  - 3. Baked aluminum enamel or powder paint aluminum finish.
  
- I. Displacement Type Air Devices
  - 1. Heavy duty galvanized steel construction
  - 2. Powder coated finish
  - 3. Rubber lip seal

## 1.5 INSTALLATION

- A. Provide the number and type of air devices as required.

END OF SECTION

## SECTION 233716

## FABRIC AIR DISTRIBUTION DEVICES

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for fabric ductwork/air distribution devices and its suspension.

## 1.2 SUBMITTALS

- A. The fabric duct manufacturer shall study the floor plans and application and the design data noted on the floor plans, and shall provide engineered to scale drawings showing the supports layout, duct runs, orifice layout and performance data, including throws.
- B. Manufacturer shall have documented design support information including duct sizing, vent and orifice location, vent and orifice sizing, length and suspension. Parameters for design, including maximum air temperature, velocity, pressure and fabric permeability, shall be considered and documented in the shop drawing submittal.

## 1.3 QUALITY ASSURANCE

- A. Fabric ducts shall be classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A. All sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
- B. Fabric ducts shall be treated with an EPA registered antimicrobial agent.
- C. Manufacturer shall provide a 10-year warranty for products supplied for the fabric portion of this system.
- D. Installation shall be in strict accordance with the manufacturer's instructions.

## 1.4 CONSTRUCTION

- A. Fabric ducts shall be constructed of woven fire retardant fabric complying with the following physical characteristics:
  1. Fabric Construction: 100% Flame Retardant and treated with a machine wash-able anti-microbial agent from the manufacturer.
  2. Weight: 6.75 oz./yd<sup>2</sup> per ASTM D3776
  3. Air Permeability: 2 (+2/-1)cfm/ft<sup>2</sup> per ASTM D737, Frazier
  4. Temperature Range: 0 degrees F to 180 degrees F
  5. Fire Retardancy: Classified by Underwriters Laboratories in accordance with the flame spread/smoke developed requirements of NFPA 90-A and ICC AC167.
  6. Antimicrobial agent shall be proven 99% effective after 10 laundry cycles per AATCC Test Method 100.

### 1.5 SYSTEMS FABRICATION REQUIREMENTS

- A. Air dispersion accomplished by linear vent and permeable fabric, linear vent to consist of many 3/16" diameter open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents.
- B. Size of and location of linear vents to be specified and approved by manufacturer.
- C. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
- D. Inlet connection includes zipper for easy removal / maintenance.
- E. Lengths to include required zippers as specified by manufacturer.
- F. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
- G. End cap includes zipper for easy maintenance.
- H. Fabric system shall include connectors to accommodate suspension system listed below.
- I. Any deviation from a straight run shall be made using a gored elbow or an efficiency tee. Normal 90 degree elbows are 5 gores and the radius of the elbow is 1.5 times the diameter of the Fabric ductwork.

### 1.6 DESIGN PARAMETERS

- A. Fabric diffusers shall be designed from 0.25" water gage minimum to 3.0" maximum.
- B. Fabric air diffusers shall be limited to design temperatures between 0 degrees F. and 180 degrees F.
- C. Design CFM, static pressure and diffuser length shall be designed or approved by the manufacturer, in accordance with the plans and specs.

### 1.7 SUSPENSION HARDWARE

- A. Tension Cable: System shall be installed using a tension cable system including double strands (2 Row) of heavy weight stainless steel cable located 3" above the 10 and 2 o'clock locations of the Fabric ductwork system. Hardware to include cable, eye bolts, cable clamps and turnbuckle(s) as required. System attachment shall be made using nylon snap clips spaced 24 inches.

- B. Suspended H-Track: System shall include double (2 Row) runs of aluminum H-Track system located 1.5" above the 10 and 2 o'clock (2 Row) locations of Fabric ductwork system. Hardware to include 10' sections of track, splice connectors, track endcaps and vertical cable support kits – consisting of a length of cable with a locking stud end and quick cable connectors. Radius aluminum track must be included for all radius sections. Fabric / Track attachment shall be either a continuous supporting cord or snap tabs, a detachable sliding tab positioned every 24" along the length of the system.
- C. Surface mount ("D" shape): System shall include aluminum Flush-Mount system located flush with the top of the fabric duct system. Width between mounting points shall be 2" wider than the specified diameter of the D-Shape fabric ductwork. Hardware to include 12' sections of track, splice connections and end caps as required. System attachment shall be made by cord sewn into top side flaps of fabric ductwork system supported entire length.

#### 1.8 DELIVERY, STORAGE AND HANDLING

- A. Protect fabric air dispersion systems from damage during shipping, storage and handling.
- B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

#### 1.9 CLEANING AND PROTECTION

- A. Clean air handling unit and ductwork prior to the fabric ductwork system unit-by-unit as it is installed. Clean external surfaces of foreign substances that may cause corrosive deterioration of facing.
- B. Temporary Closure: At ends of ducts not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering that will keep the system clean until installation is completed.
- C. If fabric ductwork systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

## SECTION 233718

## UNDERFLOOR AIR DISTRIBUTION SYSTEM

## PART 1 GENERAL

## 1.01 SECTION INCLUDES

- A. The Contractor shall furnish and install a complete access floor air terminal system as shown on the drawings. All wiring, controls and other accessories required for a complete system shall be included. Contractor shall provide submittals, samples, and operation and maintenance documentation. Specific equipment includes: (List each type of terminal required on the project.)
1. Variable Volume Units
  2. Variable Volume Units with Duct Collar
  3. Perimeter Zone or Conference Room Heating/Cooling Units
  4. Fan-Powered Underfloor Hydronic Heating Units
  5. Power and Control Module for up to four (4) VAV units.
  6. Power and Control Module for up to fourteen (14) VAV units
  7. 25' Plug and Play Cable Set for Connection of VAV Actuators, power and control module, fan powered heating units, and/or cooling zones
  8. 50' Plug and Play Cable Set for Connection of Controller to Thermostat
  9. 25' Plug and Play Cable Set for Extension of Plug and Play Cable Sets
  10. 25' Plug and Play Cable Set for Connection of Auxiliary Sensor to heating zones
  11. PAP-E 5' Plug and Play Cable Set for Connection of fan powered heating units and heating zones
  12. PAP-F 10' Plug and Play Cable Set for Connection of Controller to Thermostat

## 1.02 RELATED WORK NOT INCLUDED

- A. The floor holes required for installation of floor air terminals shall be coordinated with the Access Floor Contractor. All floor openings shall be prepared by the Access Floor Contractor, as shown on the floor plan drawings. Required plenum barriers, sealing of plenum, structural supports, carpet cutouts and any other floor related appurtenances shall be prepared by the Access Floor Contractor as shown on the drawings.
- B. All electrical power needed for terminal operation shall be coordinated with the Electrical Contractor. The electrical power shall be furnished by the Electrical Contractor and installed as shown on the drawings.
- C. Control interfaces and/or integration with the Building Automation System (BAS) or other control system shall be furnished by the Controls Contractor.

## 1.03 QUALITY ASSURANCE

- A. All equipment and components shall be suitable for use in an environmental air plenum.

- B. All components within the air stream including under-floor terminals shall conform to the NFPA 90A Standard for Flame/Smoke/Fire contribution of 25/50/0.
- C. All units shall be the product of a manufacturer regularly engaged in the production of terminal units and all supplied units shall be from the same manufacturer.
- D. Units shall be specifically designed for an access floor installation and complete with all necessary controls and wiring as required to provide operation according to manufacturer's recommendations.
- E. Terminal operation shall be coordinated with air handling system and control system to assure complete compatibility.
- F. Equipment shall be listed under and conform to appropriate sections of U.L., CSA, E.T.L. and other testing laboratory requirements.

#### 1.04 SUBMITTALS

- A. Submit dimensioned drawings, performance and product data for approval. Include listing of discharge and radiated sound power level for each of second through sixth octave for fan-powered terminals. Data shall include all wiring diagrams, control sequences and power requirements as applicable to the product and coordination with other systems.

#### 1.05 OPERATION AND MAINTENANCE DATA

- A. Quantity: 3
- B. Content:
  1. Maintenance and Service Contracts: Provide a list, with each product, name, address and telephone number of:
    - a. Subcontractor or installer.
    - b. Maintenance contractor, as appropriate. Identify area of responsibility of each.
    - c. Local source of supply for parts and replacement.
  2. Table of Contents: List all products in the order in which they appear in the specifications and label accordingly.
  3. Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate specification section number. Provide the manufacturer's written installation and maintenance instructions for all items required.
  4. Routine Maintenance: Provide a list indicating all routine maintenance procedures based on recommended intervals.
  5. Contents: Include copies of approved submittal data, installation instructions, operation and maintenance instructions and parts lists.

#### 1.06 WARRANTY

- A. The air terminal materials and workmanship shall be guaranteed to be free from defects for a period of one year after Owner acceptance.

- B. Contractor and/or vendor shall maintain availability of replacement parts compatible with the terminals for no less than ten years after acceptance.

## 2.01 GENERAL DESCRIPTION

- A. The Contractor shall furnish a pre-engineered, prefabricated, access floor air terminal system that includes all necessary components from a single source of responsibility/manufacturer. All components including any controls and wiring shall be furnished as a “plug-and-play” system of modular and interchangeable components that are factory prepared to operate as a complete system. (Because some owners may want special controls this section may need to be modified to address this issue.)

## 2.02 FABRICATION

- A. VAV Terminal Units
  1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure.
  2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer’s standard color to be selected from submittal data. Trim ring shall be attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)
  3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heel penetration protection.
  4. Unit shall include an integral damper and damper operator. Damper shall be made of 20-gauge galvanized steel and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt-amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.
- B. Ducted Collar; VAV Terminal Units (These units provide control of the air flow for a ducted system.)
  1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure.

2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer's standard color to be selected from submittal data. Trim ring shall attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)
  3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heel penetration protection.
  4. Unit shall include an integral damper and damper operator. Damper shall be made of 20-gauge galvanized steel and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt-amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.
  5. The chassis design shall include a removable end panel for attachment of a supply air duct using standard duct size of 6 inches (152 mm) round for a 10 inch deep unit and 5 inches (127 mm) round for a 7 inch deep unit.
- C. Perimeter Zone Heating/Cooling VAV Terminal Units (These units provide control of the air flow from the plenum for cooling and from an attached duct for heating with a switchover mode of control.)
1. Unit chassis shall be minimum 18-gauge galvanized steel that shall enclose and support all components. The chassis design shall include an end panel for attachment of a supply air duct using standard duct size of 6 inches (152 mm) round for a 10 inch deep unit and 5 inches (127 mm) round for a 7 inch deep unit. Chassis construction shall admit plenum air from only one direction to provide a method of adjusting delivery volume for floor velocity pressure. Plenum air admittance openings shall be on opposite end of the chassis from the duct connection.
  2. Unit shall have a die cast aluminum trim ring that shall engage with the chassis and floor to provide complete support for the air grilles. Die cast aluminum ring color shall be as shown on the finish schedule or manufacturer's standard color to be selected from submittal data. Trim ring shall be attached to chassis and floor panel by means of concealed removable screws. (A round trim ring option is available at no additional cost. Special colors are available at additional cost.)

3. Unit shall have one or more removable grilles made of die cast aluminum material that matches the trim ring in color. Grilles shall include a means for adjusting air throw and pattern and shall fit securely within the trim ring and chassis without mechanical fasteners. Grilles shall be capable of supporting a load of 1250 pounds (565 kg) without permanent damage. No openings in the grilles shall be larger than .30 inches (7.6 mm) for shoe heel penetration protection.
  4. Unit shall include an integral damper and damper operator. Damper shall be made of die cast aluminum material and be sealed with felt or foam type gasket material. Damper operation shall provide a throttling of the airflow that produces a nominal constant velocity, variable volume flow from full shut-off to full open condition. The damper shall vary the active outlet area of the grilles while maintaining velocity of the supply air through the grille. Damper operator shall operate on 24VAC and use no more than 6 volt amperes per unit. Damper motor electrical connection shall be by means of a modular connector, polarized to prevent incorrect connection. Noise produced by damper motor shall not exceed 35 dB-A at a distance of 1 meter from the unit.
  5. Unit damper shall be sequenced to admit heating air from duct connection and cooling air from the plenum. In switchover mode, unit shall also act as a return air grille to remove air from the space and deliver it through the duct connection to a heating terminal under the floor.
- D. Fan Powered Underfloor Heating Terminal Unit – 150 CFM Nominal Size (These units are required when using terminals for perimeter heating. They include a power transformer to provide power to up to 14 VAV terminals and chaining ports for zones with up to 3 fan powered heating terminal units.)
1. Unit casing: 22-gauge minimum galvanized steel lined with 1/2 in. thick, 1-1/2 lb./ft.<sup>3</sup> density, dual thermal/acoustical fiberglass insulation meeting NFPA 90A requirements and U.L. 181 erosion control requirements. Insulation shall be protected with continuous vapor barrier. Casing shall have a removable side or top panel suitable for equipment service. Leakage not to exceed 2% of design flow at 2.0" w.g. Enclosure to have Plug and Play connectors for attachment of thermostat inputs, thermostat outputs, and outputs to VAV terminals in the zone.
  2. Fan assembly: Direct drive centrifugal with forward curved blades, internally suspended on rubber isolators. Motor to be permanent split capacitor with thermal overload protection and toggle disconnect.
  3. Return air filter frame and 1" throw-away filter.
  4. Discharge and radiated sound power levels shall not exceed those shown on the schedule.
  5. Hydronic Heating Coil
    - a. Heating coil shall be integral with the terminal unit, with coils having one row, same end connections. Tube-to-header joints shall be expanded and reinforced with brass bushing for pressure-tight joint. Maximum working ratings shall be 200 PSIG, 325°F. Plate-type aluminum fins with full fin collars for maximum fin-tube contact and accurate spacing, mechanically bonded to tubes for permanent fin-tube bond.
    - b. Galvanized steel casing with flanged or drive and slip connection.

6. Control transformers rated for specified line voltage input and 24VAC output at 40VA for thermostat operation and 100 VA for VAV operation (adequate power for up to 14 VAV units in zone.)
- E. Power and Control Module
1. 120 Volt, single-phase power input.
  2. Integral Transformer, 24VAC, 40 volt-ampere output rating.
  3. One modular output plug and play connector compatible with MIT Plug and Play wiring system.
  4. Modular input connector for thermostat connection using Plug and Play wiring system.
  5. Steel housing, minimum 24-gauge with knockouts.
- F. Power and Control Module
1. 120 or 277 Volt, single-phase power input.
  2. Integral Transformer, 24VAC, 90 volt-ampere rated output with 3-amp switching module.
  3. Two modular output plug and play connectors compatible with Plug and Play wiring system.
  4. One modular input connector for thermostat connection using Plug and Play wiring system (One is used for daisy-chaining zones larger than 14 terminals).
  5. One modular output connector for daisy-chaining units (up to 3 total) using a single controller for use in zones larger than 14 boxes.
  6. Steel housing, minimum 24-gauge with knockouts.
- G. Plug and Play Cable Set for VAV connection
1. Plenum rated, 4 conductor, 16-gauge, 25 feet (8 m) long, with Plug and Play wiring connectors attached on each end.
  2. Factory tested for continuity, shorts, opens and proper impedance.
- H. Plug and Play Cable Set for Thermostat Connection
1. Plenum rated, 4 conductor, 16-gauge, 50 feet (16 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
  2. Factory tested for continuity, shorts, opens and proper impedance.
- I. Plug and Play Extension Cable Set
1. Plenum rated, 4 conductor, 16-gauge, 25 feet (8 m) long, with male Plug and Play wiring connector attached on one end and female connection on the other end.
  2. Factory tested for continuity, shorts, opens and proper impedance.
- J. Plug and Play Cable Set for connection to auxiliary input sensor
1. Plenum rated, 2 conductor, 18-gauge, 25 feet (8 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
  2. Factory tested for continuity, shorts, opens and proper impedance.
- K. Plug and Play Cable Set for connection to fan powered terminals
1. Plenum rated, 4 conductor, 16-gauge, 5 feet (2 m) long, with Plug and Play wiring connectors attached on each end.
  2. Factory tested for continuity, shorts, opens and proper impedance.

- L. Plug and Play Cable Set for Thermostat connection
  - 1. Plenum rated, 4 conductor, 16-gauge, 10 feet (2 m) long, with Plug and Play wiring connector attached on one end and pig tail on the other.
  - 2. Factory tested for continuity, shorts, opens and proper impedance.
  
- M. Space Thermostat and DDC Controller (Required when using LON bus for local and remote setpoint adjustment and monitoring of a cooling only zone or cooling/heating zone with fan powered heating unit, 1 or 2 stage electric, or 2 position hot-water heat.)
  - 1. Plastic enclosure, UL 94-5V rated, suitable for wall mounting with control setpoint consisting of an adjustable setpoint knob. Size of enclosure shall be suitable for mounting on a single/double gang electrical box in either the horizontal orientation. Provide terminal block connection to wiring. Thermostat enclosure shall consist of a base and separate enclosure to permit attachment of wiring independently of the electronics.
  - 2. Device shall provide proportional-integral, PI, control and use an NTC thermistor with low drift and have compatible output/input with controller. Setpoint knob shall have optional range stops with maximum range of 55 to 90 degrees F. (12.8 to 32.2 C).
  - 3. Unit shall comply with FCC Part 15, NEC Class B, and be listed by UL.
  - 4. Device shall include an interface and jack for connection of LON bus.
  
- N. Space Thermostat and DDC Controller (Required when using bus for local and remote setpoint adjustment and monitoring of a cooling only zone or cooling/heating zone with modulating heat.)
  - 1. Plastic enclosure, UL 94-5V rated, suitable for wall mounting with control setpoint consisting of an adjustable setpoint knob. Size of enclosure shall be suitable for mounting on a single/double gang electrical box in either the horizontal orientation. Provide terminal block connection to wiring. Thermostat enclosure shall consist of a base and separate enclosure to permit attachment of wiring independently of the electronics.
  - 2. Device shall provide proportional-integral, PI, control and use an NTC thermistor with low drift and have compatible output/input with VAV controller. Setpoint knob shall have optional range stops with maximum range of 55 to 90 degrees F. (12.8 to 32.2 C).
  - 3. Unit shall comply with FCC Part 15, NEC Class B, and be listed by UL.
  - 4. Device shall include an interface and jack for connection of LON bus.

### 3.01 INSTALLATION

- A. Provide the number and type of components as required for complete and functional system.

END OF SECTION

## SECTION 233800

## KITCHEN HOOD VENTILATION SYSTEM

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for kitchen canopy hood exhaust and make-up air system complete with fans, heating equipment, roof curbs, ductwork, controls, fire suppression system, and related accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories and detailed ductwork and fire suppression layouts specific to each system.

## 1.3 QUALITY ASSURANCE

- A. Canopies shall be labeled and listed in accordance with UL 710.
  - 1. Listing shall be for installation without exhaust dampers.
- B. Fabrication shall be in accordance with NFPA 96.
- C. Assembly shall bear the National Sanitation Foundation (NSF) Seal of Approval.
- D. Fan performance rating shall comply with AMCA 210.
- E. Fan systems shall be UL listed and labeled for transfer of grease laddened vapors.
- F. Canopies shall comply with the requirements approved by BOCA, SBCC, and ICBO.
- G. Gas-fired system shall comply with AGA requirements.
- H. Rooftop, gas-fired make-up air handling units shall have the ETL label.
- I. Balance of air systems shall be by an independent air balancing firm certified as NEBB or AABC.
- J. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- K. Kitchen hood systems shall meet the requirements of ASHRAE Standard 90.1.

#### 1.4 CANOPY

- A. Canopy interior and exterior exposed surfaces shall be constructed of 18 gauge, type 304 stainless steel.
- B. Integral duct collars for exhaust without fire dampers.
- C. Liquid tight external welds at all joints and seams.
- D. Filter housing shall be constructed of 304 stainless steel complete with UL Classified aluminum baffle-type grease filters.
- E. [Incandescent] [fluorescent] vaporproof lights in quantity to provide a minimum of 50 footcandles on the lowest cooking surface.
- F. Insulated supply air plenum with minimum 1 inch, 3 pounds per cubic foot material.
- G. Integral supply air duct collar with 18 gauge steel fire damper having fusible link operation.

#### 1.5 EXHAUST FAN

- A. Upblast type arrangement and UL listed for operation in grease removal having built-in grease trough and isolated motor compartment.
- B. Bird screens **and dampers** are not permitted.
- C. Fan discharge shall be minimum 40 inches above roof surface.
- D. Unit shall include a hinged base for access to duct and blower.

#### 1.6 NO-HEAT SUPPLY AIR FAN

- A. Fan shall be a forward-curved, double-width, belt-driven, double-inlet blower, roof-mounted in a downblast configuration, statically and dynamically balanced.
- B. Fan motor shall include permanently lubricated ball bearings
- C. Housing shall be constructed of heavy gauge, galvanized steel, primed and painted with removable top for service access.
- D. Unit shall be provided with a minimum 12 inch high roof curb.
- E. Filters shall be 1 inch thick aluminum mesh and UL Classified.

**1.7 HEATED MAKE-UP AIR SYSTEM**

- A. Roof-mount makeup air system shall be factory assembled and tested.
- B. Fan and motor assembly shall be mounted on vibration isolators.
- C. Motors shall be permanently lubricated, heavy-duty, ball bearing-type.
- D. Fan wheels shall be forward-curved, double-width, double-inlet type, statically and dynamically balanced.
- E. Housing shall be constructed of heavy gauge, galvanized steel, primed and painted with removable panels for service access.
- F. A pre-wired control center shall include master disconnect switch, fuse blocks, magnetic motors starters, control circuit transformer, distribution terminal control strip, all UL Listed.
- G. Direct-fired gas heater section
  - 1. Burner shall be constructed of stainless steel having a gas valve control with capillary type sensor, main and pilot gas valves and pressure regulators, main and pilot shut off valves, airflow switch, high limit control, flame safeguard control, flame rod and electronic ignition pilot.
  - 2. Turndown range of 20 to 1.
  - 3. Piping and controls housed within the galvanized housing of the make-up air unit.
- H. Electric heater section
  - 1. Heater terminal box and frame shall be constructed of heavy-gauge galvanized steel.
  - 2. Heating elements shall be supported using ceramic insulators.
  - 3. Heating element shall be a UL Listed open coil type electric heater.
  - 4. Provide with a disc type automatic high limit switch and closed disc type manual reset switch.
  - 5. Unit shall include modulating step controller, airflow switch, circuit fusing, and door interlocking disconnect switch.
  - 6. Heater and controls housed within the galvanized housing of the make-up air unit.

**1.8 FIELD FABRICATED DUCTWORK AND ACCESSORIES**

- A. Exhaust ductwork shall be constructed of 16 gauge carbon steel, welded liquid tight.
- B. Supply ductwork shall be constructed of 18 gauge galvanized steel and installed with external duct insulation and vapor barrier.
- C. Cleanouts are required in changes of direction of exhaust ductwork.

**1.9 ELECTRICAL**

- A. Motor control panel enclosing motor contactors, overload relays, interface terminals for fire protection system and remote switch panel shall be located in the kitchen storage room.
- B. Remote switch panel shall be mounted on face of kitchen canopy and shall include the following:
  - 1. Lights on-off switch
  - 2. Exhaust/supply fan systems on-off switch with pilot light
  - 3. [Temperature setting for heating make-up air system]

**1.10 FIRE PROTECTION SYSTEM**

- A. Fire protection system shall be a wet chemical system and shall be installed to be in compliance with UL.
- B. System to be activated by fusible links connected to an automan release.
- C. Automan release shall trip 2 electric, double-pole, double-throw micro switches.
- D. Piping shall be concealed wherever possible. Exposed piping, fittings, and nozzles shall be constructed of stainless steel with chrome plated elbows.
- E. Supply fan shall shut down upon activation of fire suppression system. Exhaust fan shall remain running.
- F. Provide automatic, non-electric; or manual reset, electric, gas appliance shut off valves.
- G. Provide remote manual fire pull device.
- H. Provide storage tank and mounting hardware.

**1.11 INSTALLATION**

- A. Install in accordance with manufacturers requirements.
- B. Manufacturer's service representative shall provide complete check, test, and start-up on the system.
- C. Locate the manual pull station a minimum of 10'-0" from the kitchen canopy in the path of egress from the cooking area.

END OF SECTION

## SECTION 234323

## AIR CLEANING SYSTEM

**Spec Writer Note: If the project is to be LEED Certified, the IAQ procedure is not permitted in LEED Prereq. EQp1.**

GENERAL GUIDELINES

## 1.1 DESCRIPTION OF WORK

- A. Qualitative requirements for the design, performance and installation of an air purification system intended for use as part of the air handling units. For the purpose of compliance with the ventilation code using the indoor air quality procedure.

## 1.2 RELATED WORK PERTAINING TO OTHER SPECIFICATIONS

- A. Testing, balancing and inspection services
- B. Duct work
- C. Electrical Wiring
- D. Control Wiring

## 1.3 SUBMITTALS: The following information shall be submitted to the design professional prior to the release of any equipment for fabrication.

- A. Product performance data for filters, gauges and housings.
- B. Product drawings detailing all physical, electrical, duct work and control requirements.
- C. Manufacturer's Follow-up Service Program.

## 1.4 REFERENCE CODES AND STANDARDS

- A. ASHRAE Standards 62 & 52
- B. UL Standard 867
- C. CFR 39-75 Title 21 April 17, 1974
- D. National Electric Code NFPA 70, 1990

## 1.5 QUALITY ASSURANCE

- A. The Air Purification System shall be a product of an established manufacturer with installations in successful operation for a minimum of 10 years.
- B. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer's recommendation.

- C. The complete Air Purification System complete with power and control wiring, safety switches, airflow switches, controls, housing and filters shall be listed by either UL or ETL.
  - D. Provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62-01 to validate acceptable indoor air quality at the quantity of outside air scheduled.
- 1.6 DESIGN AND PERFORMANCE CRITERIA: The operation of the air purification system shall be through a combination of Catalytic, and Association / Disassociation processes.
- A. Each air handling unit shall contain an Air Purification System capable of:
    1. Effectively controlling microorganisms (mold, bacteria, etc.).
    2. Controlling gas phase contaminants generated from food, human occupants and the school building.
    3. High efficiency particulate filtration.
  - B. The Air Purification System shall operate in such a manner so that agglomeration or precipitation of airborne particulate shall not be permitted to collect on occupants, walls, floor or furnishings by virtue of its operation.
  - C. Air Exchange Rate: Air exchange rates may vary through the full operating range of a VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
  - D. Velocity Profile: The air velocity through the plenum approaching the air purification system shall not exceed 1,000 fpm (5 m/s).
  - E. Humidity: Electrodes or gas phase filters shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 99% shall not cause damage, deterioration or dangerous conditions within the air purification system.
  - F. Ozone Generation: The operation of the electrodes unit shall conform to ASHRAE Standard 62-01 and CFR 39-75 with respect to ozone generation.
- 1.7 EQUIPMENT REQUIREMENTS
- A. A schematic representation of the air purification system is indicated on the drawings. Each unit shall include mounting rack, electrodes, generator, safety switches, prefilters, primary filters, differential pressure gauge and accessories.
  - B. Electrode: Each unit shall include the required number of electrodes and power generators sized to the air handling unit capacity. Electrical power to the electrodes shall be interrupted when the airflow is less than 100 fpm or when access doors to the electrode plenum section are opened.
  - C. Plenum Specifications: Housings shall be of (horizontal / vertical) design with (single / double) wall construction. Refer to air handling unit specification for construction details.
  - D. Filter Gages: Differential pressure gages shall be provided to indicate filter status.

**1.8 FILTRATION REQUIREMENTS**

- A. Provide particulate and gas phase filtration equipment in order to achieve the performance detailed within the IAQ Model described in paragraph 1.5 D. Performance of fibrous filters shall conform to ASHRAE Standard 52.2 unless specified otherwise. Provide a fully assembled and tested system from a single manufacturer.

**1.9 ELECTRICAL REQUIREMENTS**

- A. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Electrical service shall be 115/208/230 volts, 1 phase, 50/60 Hz. In the event line voltage varies 10% or greater from nominal or when electrical spikes or transients are present power conditioning shall be provided.

**1.10 ASSEMBLY AND ERECTION**

- A. Assemble mounting racks within the air handling unit in accordance with manufacturer's recommendations and instructions.
- B. The air purification system manufacturer shall complete all interconnecting control and power wiring. The electrical contractor shall complete single point power connections.
- C. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and consulting engineer.
- D. Any material damaged by water or moisture shall be replaced at no cost to the owner.
- E. All equipment shall be protected from dust and damage on a daily basis throughout construction.
- F. Clean all components prior to commissioning.

**1.11 TESTING**

- A. Provide the manufacturer's recommended electrical and static pressure tests.

**1.12 COMMISSIONING & TRAINING**

- A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.
- B. Service
  - 1. A manufacturer's authorized service representative shall provide service support to insure satisfactory air purification system operation. The service program shall include at minimum, regular site visits, inspection of the air purification system and air handling unit, monitoring and validation, inspection of protected areas and the submission of a written report to the owner.
    - a. Submit the Manufacturer's Service Program with the shop drawing submittal.
  - 2. Provide one (1) year Factory Follow-up Service including repairs to the gas phase equipment, replacement of electrodes or removal of disposable modules, installation of new modules with fresh media, administration of hauling and disposal of spent media modules through the owner's normal channel of disposal and hauling.

3. Validate performance of the Air Purification System through accepted test procedures and independent testing.
4. Particulate filters are not covered by this service agreement and remain the responsibility of the Owner.

#### 1.13 WARRANTY

- A. The equipment shall be warranted against defects in material and workmanship for a period of 12 months from commissioning and acceptance.

END OF SECTION

## SECTION 235100

## BREECHING, CHIMNEYS, AND STACKS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for venting for fuel burning equipment.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions. Detailed shop drawings denoting layouts, specific to project for each vent is required.

## 1.3 QUALITY ASSURANCE

- A. Products and installation shall be in accordance with NFPA 211 and UL Listed.
- B. Each vent section/fitting shall be labeled for UL compliance.
- C. Installation shall be in conformance with OBC.

## 1.4 COMPONENTS

- A. Type B Gas Vents
  - 1. Round double-wall, with aluminized steel inner pipe and galvanized-steel outer pipe. Use for negative pressure venting systems
- B. Steel, Positive-Pressure, Double-Wall Vents
  - 1. Construction: Inner and outer shells separated by at least 1-inch air space, with positive sealing joints. The inner piping shall be stainless steel. The outer piping shall be aluminized steel construction. Use for all positive pressure systems including forced draft boilers and water heaters.
- C. Rain cap shall be of galvanized steel construction and attached firmly to stack top.
- D. Roof penetrations shall include an insulating thimble complete with proper flashing.
- E. Cleanouts shall be provided at all changes in direction.

## 1.5 INSTALLATION

- A. Provide independent or combined flues for each piece of gas burning equipment directly to the outside of the building.
- B. Each flue shall be support from the building structure, not from or on the equipment.

END OF SECTION

## SECTION 235213

## ELECTRIC BOILERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for electric resistance boilers.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section VIII.
- B. UL Listed.
- C. Constructed in accordance to the National Electric Code.
- D. Controls wired in accordance to ANSI/UL 834.
- E. Boiler shall have a minimum thermal efficiency of 95 percent.

## 1.4 COMPONENTS

- A. Pressure vessel: Constructed of carbon steel with ASME stamp.
- B. Pressure Rating: 60 psig, water.
- C. Heavy-steel mounting base frame.
- D. Removable access panels and doors for inspection and cleaning.
- E. Insulation and jacket.
- F. Hot-Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Water Connections: Internal thermal circulation to mix return water with boiler water.
  - 3. Dip tube.
  - 4. Low-water cutoff.
  - 5. Pressure and temperature gauges.
  - 6. Temperature controls.
  - 7. Boiler high-pressure-limit controller.

- G. Heating Elements:
  - 1. Replaceable sheathed heating elements.
  - 2. Minimum 75 watts/sq. in. heat transfer.
  - 3. Wire with UL Listed conductors.
  
- H. Power Panel:
  - 1. NEMA 1 enclosure with hinged door and key-locking handle.
  - 2. Mechanical lugs bolted to copper bus bars.
  - 3. NEMA Class J or K5 dual-element fuses.
  - 4. 3-pole magnetic contactors.
  - 5. Fused disconnect switch.

### 1.5 INSTALLATION

- A. Install boilers and accessories in accordance with manufacturers requirements.
- B. Startup shall be by a factory trained technician.
- C. Set boilers on four inches thick reinforced concrete pad.
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.

END OF SECTION

## SECTION 235216

## FLUE GAS CONDENSING BOILERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for flue gas condensing boilers.
- B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacities, accessories, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Gas trains shall comply with requirements of CSD-1.
- B. Boilers shall be National Board listed.
- C. Boiler shall have a minimum thermal efficiency of 88 percent at 120 degree Fahrenheit return water temperature.
- D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Heat Exchangers:
  - 1. Fire tube design that is self-supporting, baffle-free, and warranted to withstand thermal shock.
  - 2. Copper finned tube design, gasket-free, and warranted to withstand thermal shock.
- B. Pressure Rating: 160 psig, water.
- C. Exhaust manifold shall include condensate drain.
- D. Exhaust manifold shall be corrosion-resistant porcelain enameled cast iron or other corrosion resistant material.
- E. Exhaust gas vent.
- F. Insulation and jacket.

- G. Hot Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Low-water cutoff.
  - 3. Pressure and temperature gauges.
  - 4. Temperature controls.
  - 5. Boiler high-pressure-limit controller.
  
- H. Gas Burners: Power burner forced draft design.
  - 1. Fuel: [Natural gas] [Propane gas].
  - 2. Gas-pressure regulator.
  - 3. Gas valves.
  - 4. Manual shutoff.
  - 5. Thermistor flame-sensing device.
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Burner Firing: Modulating.
  - 8. Burner Ignition: Standing pilot or spark ignition.
  - 9. Safety controls.
  - 10. Flue-Gas Collector: Integral with boiler casing.
  - 11. Gas Piping Train: Factory Mutual approved.
  
- I. Factory-mounted control panel.
  - 1. Dry contacts for DDC signal.
  - 2. Alarm contacts for flame failure, low water cutoff, low temperature and high temperature alarms.
  
- J. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

## 1.5 INSTALLATION

- A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.
- B. Provide dual wall independent flues for each boiler.
- C. Pipe all gas pressure regulator vents to the outside of the building
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.
- E. Combustion air shall be directly connected or the boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

## SECTION 235223

## CAST IRON BOILERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for cast iron boilers.
- B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners, power or atmospheric.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with the ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.
- B. Gas trains shall comply with requirements of CSD-1.
- C. Boilers shall be UL 795 Listed.
- D. Boiler shall have a minimum thermal efficiency of 80 percent.
- E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Heat Exchangers: Cast iron sectional bolted together.
- B. Pressure Rating: 60 psig, water.
- C. Heavy-steel mounting base frame.
- D. Removable access panels and doors for inspection and cleaning.
- E. Observation ports.
- F. Exhaust gas vent.
- G. Insulation and jacket.
- H. Hot Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Dip tube.
  - 3. Low-water cutoff and auxiliary low-water cutoff.
  - 4. Pressure and temperature gauges.
  - 5. Temperature controls.
  - 6. Boiler high-pressure-limit controller.

- I. Gas Burners: Power burner, forced draft design.
  - 1. Fuel: [Natural gas] [Propane gas].
  - 2. Gas-pressure regulator.
  - 3. Gas valves.
  - 4. Manual shutoff.
  - 5. Thermistor flame-sensing device.
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Burner Firing: Modulating.
  - 8. Burner Ignition: Standing pilot
  - 9. Safety controls.
  - 10. Flue-Gas Collector and Draft Hood: Integral with boiler casing.
  - 11. Gas Piping Train: Factory Mutual approved.
  
- J. Oil Burners: Pressure-atomizing type.
  - 1. Fuel: No. 2 fuel oil.
  - 2. Operation and combustion-air controls.
  - 3. Oil pump.
  - 4. Oil-piping train.
  
- K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing burner.
  - 1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
  - 2. Burner operation and combustion-air controls.
  - 3. Gas pilot.
  - 4. Gas piping train.
  - 5. Oil pump.
  - 6. Oil-piping train.
  
- L. Gas Burners: Atmospheric Design
  - 1. Tubular alloy steel burners with natural draft.
  - 2. Electronic pilot and burner ignition.
  - 3. Gas pressure regulator.
  - 4. Gas valves.
  - 5. Manual shutoffs
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Safety controls.
  - 8. Flue-gas collector and draft hood.
  - 9. Factory Mutual approved gas train.
  
- M. Factory-mounted control panel.
  - 1. Dry contacts for DDC signal.
  - 2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.
  
- N. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

## 1.5 INSTALLATION

- A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.
- B. Provide dual wall independent flues for each boiler.

- C. Pipe all gas pressure regulator vents to the outside of the building
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.
- E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

## SECTION 235225

## STEEL FIREBOX BOILERS

## GENERAL

## 1.01 SECTION INCLUDES

- A. Qualitative requirements for steel firebox boilers.
- B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

## 1.02 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacities, accessories, and dimensions.

## 1.03 QUALITY ASSURANCE

- A. Gas trains shall comply with requirements of CSD-1.
- B. Units shall be constructed in accordance with the ASME Pressure Vessel Code Section IV and shall be National Board listed.
- C. Boiler shall have a minimum thermal efficiency of 80 percent.
- D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 2.01 COMPONENTS

- A. Heat Exchangers: 3 pass fire tube wet-back design with large fire box. 5 square feet of heating surface per boiler horsepower.
- B. Pressure Rating: 60 psig, water.
- C. Heavy-steel mounting base frame.
- D. Removable access panels and doors for inspection and cleaning.
- E. Observation ports.
- F. Exhaust gas vent.
- G. Insulation and jacket.
- H. Hot Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Water Connections: Internal thermal circulation to mix return water with boiler water.
  - 3. Dip tube.
  - 4. Low-water cutoff.
  - 5. Pressure and temperature gauges.
  - 6. Temperature controls.
  - 7. Boiler high-pressure-limit controller.

- I. Gas Burners: Power burner forced draft design.
  - 1. Fuel: [Natural gas] [Propane gas].
  - 2. Gas-pressure regulator.
  - 3. Gas valves.
  - 4. Manual shutoff.
  - 5. Thermistor flame-sensing device.
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Burner Firing: Modulating.
  - 8. Burner Ignition: Standing pilot
  - 9. Safety controls.
  - 10. Flue-Gas Collector: Integral with boiler casing.
  - 11. Gas Piping Train: Factory Mutual approved.
  
- J. Oil Burners: Pressure-atomizing type.
  - 1. Fuel: No. 2 fuel oil.
  - 2. Operation and combustion-air controls.
  - 3. Oil pump.
  - 4. Oil-piping train.
  
- K. Combination Gas/Oil Burners: Pressure-atomizing type.
  - 1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
  - 2. Burner operation and combustion-air controls.
  - 3. Gas pilot.
  - 4. Gas piping train.
  - 5. Oil pump.
  - 6. Oil-piping train.
  
- L. Factory-mounted control panel.
  - 1. Dry contacts for DDC signal.
  - 2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.
  
- M. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

### 3.01 INSTALLATION

- A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.
  
- B. Provide dual wall independent flues for each boiler.
  
- C. Pipe all gas pressure regulator vents to the outside of the building
  
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.
  
- E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

## SECTION 235233

## FLEXIBLE WATER TUBE BOILERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for flexible steel water tube boilers
- B. Qualitative requirements for gas fired, oil fired, or combination gas/oil fired burners, power or atmospheric.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with the ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.
- B. Gas trains shall comply with requirements of CSD-1.
- C. Boiler shall be UL 795 listed.
- D. Boiler shall have a minimum thermal efficiency of 80 percent.
- E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Heat Exchangers: Flexible bent steel tubes wedged into steel headers
- B. Pressure Rating: 160 psig, water.
- C. Heavy-steel mounting base frame.
- D. Removable access panels and doors for inspection and cleaning.
- E. Observation ports.
- F. Exhaust gas vent.
- G. Insulation and jacket.
- H. Hot Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Water Connections: Internal thermal circulation to mix return water with boiler water.
  - 3. Dip tube.
  - 4. Low-water cutoff and auxiliary low water cutoff.
  - 5. Pressure and temperature gauges.
  - 6. Temperature controls.
  - 7. Boiler high-pressure-limit controller.

- I. Gas Burners: Power burner, forced draft design.
  - 1. Fuel: [Natural gas] [Propane gas].
  - 2. Gas-pressure regulator.
  - 3. Gas valves.
  - 4. Manual shutoff.
  - 5. Thermistor flame-sensing device.
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Burner Firing: Modulating.
  - 8. Burner Ignition: Standing pilot
  - 9. Safety controls.
  - 10. Flue-Gas Collector and Draft Hood: Integral with boiler casing.
  - 11. Gas Piping Train: Factory Mutual approved.
  
- J. Oil Burners: Pressure-atomizing type.
  - 1. Fuel: No. 2 fuel oil.
  - 2. Operation and combustion-air controls.
  - 3. Oil pump.
  - 4. Oil-piping train.
  
- K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing oil burner.
  - 1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
  - 2. Burner operation and combustion-air controls.
  - 3. Gas pilot.
  - 4. Gas piping train.
  - 5. Oil pump.
  - 6. Oil-piping train.
  
- L. Gas Burners: Atmospheric Design
  - 1. Tubular alloy steel burners with natural draft.
  - 2. Electric pilot ignition.
  - 3. Gas pressure regulator.
  - 4. Gas valves.
  - 5. Manual shutoffs
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Safety controls.
  - 8. Flue-gas collector and draft hood.
  - 9. Factory Mutual approved gas train.
  
- M. Factory-mounted control panel.
  - 1. Dry contacts for DDC signal.
  - 2. Alarm contacts for low water cutoff, low temperature and high temperature alarms.
  
- N. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

## 1.5 INSTALLATION

- A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.
- B. Provide dual wall independent flues for each boiler.

**HVAC**

## CHAPTER 9: SPECIFICATIONS

- C. Pipe all gas pressure regulator vents to the outside of the building
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.
- E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

## SECTION 235239

## PACKAGED FIRETUBE BOILERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for package firetube boilers.
- B. Qualitative requirements for gas fired, oil fired, or combination gas/oil burners.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, capacity, accessories, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Unit shall be constructed in accordance with ASME Boiler and Pressure Vessel Code Section IV and shall be National Board listed.
- B. Gas trains shall comply with Factory Mutual Insurance (FM) requirements.
- C. Gas trains shall comply with the requirements of CSD-1.
- D. Boiler shall be UL 715 listed.
- E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- F. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Heat Exchangers: Horizontal- fire tube, multi-pass, dry-back or wet-back design.
- B. Pressure Rating: 125 psig, water.
- C. Heavy-steel mounting base frame.
- D. Removable access panels and doors for inspection and cleaning.
- E. Observation ports.
- F. Exhaust gas vent.
- G. Insulation and jacket.

- H. Hot Water Boiler Trim:
  - 1. Safety-Relief Valves: ASME rated.
  - 2. Water Connections: Internal thermal circulation to mix return water with boiler water.
  - 3. Dip tube.
  - 4. Low-water cutoff.
  - 5. Pressure and temperature gauges.
  - 6. Temperature controls.
  - 7. Boiler high-pressure-limit controller.
  
- I. Gas Burners: Power burner, forced draft design.
  - 1. Fuel: [Natural gas] [Propane gas].
  - 2. Gas-pressure regulator.
  - 3. Gas valves.
  - 4. Manual shutoff.
  - 5. Thermistor flame-sensing device.
  - 6. Automatic 100 percent safety gas shutoff.
  - 7. Burner Firing: Modulating.
  - 8. Burner Ignition: Standing pilot
  - 9. Safety controls.
  - 10. Flue-Gas Collector: Integral with boiler casing.
  - 11. Gas Piping Train: Factory Mutual approved.
  
- J. Oil Burners: Pressure-atomizing type.
  - 1. Fuel: No. 2 fuel oil.
  - 2. Operation and combustion-air controls.
  - 3. Oil pump.
  - 4. Oil-piping train.
  
- K. Combination Gas/Oil Burners: Power burner, forced draft design with pressure-atomizing oil burner.
  - 1. Fuel: [Natural gas] [Propane gas] and No. 2 fuel oil.
  - 2. Burner operation and combustion-air controls.
  - 3. Gas pilot.
  - 4. Gas piping train.
  - 5. Oil pump.
  - 6. Oil-piping train.
  
- L. Factory-mounted control panel.
  - 1. Dry contacts for DDC control.
  - 2. Alarm contacts for low water cutoff, low temperature and high temperature cutoffs.
  
- M. Motors: NEMA MG 1, general purpose, continuous duty, Design B, open-drip-proof type.

**1.5 INSTALLATION**

- A. Set boilers on minimum 3-1/2 inch thick reinforced concrete pad.
- B. Provide dual wall independent flues for each boiler.
- C. Pipe all gas pressure regulator vents to the outside of the building.
- D. Boil out all boilers per the manufacturer's recommendations before using the boilers to heat the building in a temporary or permanent basis. The water shall be tested by the chemical treatment subcontractor for acceptability. The heating water system shall have the proper water treatment chemicals installed immediately after the system has been flushed, boiled-out and refilled and before the system is used for temporary or permanent heating of the building.
- E. The boiler controls shall be interlocked with the combustion air system to operate the combustion air make-up system when the boiler is firing. The boiler shall not operate without the combustion make-up air system operating.

END OF SECTION

## SECTION 235700

## HEAT EXCHANGERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for shell and tube design; and plate and frame.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

## 1.4 WARRANTY

- A. Provide 1 year parts and labor warranty.

## 1.5 COMPONENTS

## A. Shell and Tube Exchangers

1. Shell shall be fabricated from steel, the head shall be cast iron.
2. Tube shall be constructed of seamless copper tubing
3. Piping connections shall be flanged or screwed connections.
4. Tube sheets shall be constructed of copper sheets.

## B. Plate and Frame Exchangers

1. The plates shall be constructed of type 304 or 316 stainless steel.
2. Gasket material shall be one of the following: Nitrile rubber, EPDM, Butyl or Viton.
3. Piping connections shall be flanged or screwed connections.
4. Unit shall include aluminum shroud.
5. Frame shall be constructed of steel.

## 1.6 INSTALLATION

- A. Install per the manufacturer's recommendations.
- B. Provide a safety pressure relief valve on both water sides of each plate and frame heat exchanger. The relief valve shall be properly sized for the system application.

END OF SECTION

## SECTION 236213

## REFRIGERANT CONDENSING UNITS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for air-cooled refrigerant condensing units with single compressors.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. ASHRAE Standard 15.
- B. Certified performance to ARI 210/270/340.
- C. UL construction.
- D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 WARRANTY

- A. Compressors shall include an extended 5 year parts warranty.

## 1.5 COMPONENTS

- A. Air-Cooled Units, single compressor 1 to 10 tons
  1. Compressor: Reciprocating or scroll type, hermetically sealed and isolated with single-speed or two-speed motor, crankcase heater, and internal temperature and motor overloads.
  2. Condenser: Copper-tube, aluminum-fin coil with integral liquid subcooler.
  3. Condenser Fan: Vertical discharge, direct-drive, propeller.
  4. Accessories: Suction and liquid line service valves with gauge ports, replaceable core filter driers, sightglass/moisture indicator, thermal expansion valve, automatic reset timer, and relief solder joints.
  5. Casing: Heavy-gauge, zinc-coated galvanized steel with baked enamel finish.
  6. Provide condenser coil protection.
  7. Refrigerant: Compressors shall utilize R-22 or R-134A refrigerant.
  8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.

## 1.6 INSTALLATION

- A. Install the unit per the manufacturer's recommendations.

END OF SECTION

## SECTION 236215

## MULTIPLE-COMPRESSOR REFRIGERANT CONDENSING UNITS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for air-cooled refrigerant condensing units with multiple compressors.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. ASHRAE Standard 15.
- B. Certified performance to ARI 340/360.
- C. UL construction.
- D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 WARRANTY

- A. Compressors shall include an extended 5 year parts warranty.

## 1.5 COMPONENTS

- A. Air-Cooled Units, multiple compressors
  1. Compressor: Reciprocating, rotary screw or scroll type. Semi-hermetic for the reciprocating or rotary screw. Hermetically sealed for the scroll type. Compressors shall be isolated from the unit frame for vibration control. Compressors shall include crankcase heaters, suction strainer, oil strainer, and oil charging connection. Motors shall have internal thermal protection.
  2. Condenser: Copper-tube, aluminum-fin coil with liquid subcooler.
  3. Condenser Fans: Minimum one fan per compressor. Vertical discharge, direct-drive, propeller.
  4. Accessories: Delay timer, automatic reset timer, suction and liquid line service valves with gauge ports, replaceable core filter driers, sightglass/moisture indicator, thermal expansion valve, automatic reset timer, suction accumulator, liquid receiver, and relief solder joints.
  5. Casing: Heavy-gauge, zinc-coated galvanized steel with baked enamel finish.
  6. Refrigerant: Compressors shall utilize R-22 or R-134a.
  7. Provide all required safeties including overcurrent, thermal overload, and single-phasing motor protection.

## 1.6 INSTALLATION

- A. Install the unit per the manufacturer's recommendations.

END OF SECTION

## SECTION 236416

## PACKAGED, CENTRIFUGAL WATER CHILLER

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged centrifugal compressor, water-cooled water chiller.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Capacity certified to ARI 590.
- B. Evaporator/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.
- C. ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.
- D. Conformance to ANSI/UI 465.
- E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 WARRANTY

- A. Compressors shall have an extended 5 year parts warranty.

## 1.5 COMPONENTS

- A. Packaged centrifugal compressor water-cooled water chiller:
  1. Compressor: Centrifugal design.
  2. Refrigerant: Shall be R-134a or R-123.
  3. Cooler: ASME vessel direct expansion, shell and tube design.
  4. Condenser: ASME shell and tube vessel.
  5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
  6. Starter: Unit mounted soft start design
  7. Control panel: Unit mounted with complete diagnostics, direct digital control.
  8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
  9. Provide complete charge of the selected refrigerant.
  10. Provide with "marine" water boxes for the cooler and condenser piping connections. Option: Detachable piping connections.
  11. Provide with safety flow switch for proof of flow.
  12. Provide unit with refrigerant purge unit for applicable refrigerant.
  13. Provide safety water flow switch.

**HVAC**

## 1.6 INSTALLATION

- A. Install per the manufacturer's requirements.
- B. Set the chiller on properly sized vibration isolation devices.
- C. Install the flow switch in the leaving water piping from the chiller and wire it into the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.
- D. Vent the refrigerant safety relief valve to the outside of the building.

END OF SECTION

## SECTION 236423

## PACKAGED, SCROLL WATER CHILLER

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged scroll compressor, air-cooled water chiller.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Capacity certified to ARI 590.
- B. Evaporator/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.
- C. ASHRAE Standard 15 "Safety Code for Mechanical Refrigeration".
- D. Conformance to ANSI/UI 465.
- E. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 WARRANTY

- A. Compressors shall have an extended 5 year parts warranty.

## 1.5 COMPONENTS

- A. Packaged air-cooled scroll water chiller:
  1. Compressor : Hermetic scroll design.
  2. Refrigerant: Shall be R-22 or R-134a
  3. Evaporator: ASME vessel direct expansion, shell and tube design. Provide with thermostatically controlled electric heat tracing.
  4. Condenser: Air-cooled condenser coils with integral sub-cooling circuit.
  5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
  6. Starter: Unit mounted soft start design
  7. Control panel: Unit mounted with complete diagnostics, direct digital control.
  8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
  9. Provide complete charge of the selected refrigerant.
  10. Provide with integral condenser fans
  11. Provide with safety flow switch for proof of flow.
  12. Condenser coil protection.
  13. Provide with safety water flow switch.

## 1.6 INSTALLATION

- A. Install per the manufacturer's requirements.
- B. Set the chiller on properly sized vibration isolation devices.
- C. Install the flow switch in the leaving water piping from the chiller and wire it into the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.

END OF SECTION

## SECTION 236426

## PACKAGED, ROTARY SCREW WATER CHILLER

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged rotary screw air-cooled or water-cooled, water chiller.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Capacity certified ARI 590.
- B. Evaporated/condenser shall be constructed to ASME Boiler and Pressure Vessel Code Section VIII.
- C. ASHRAE Standard 15 Safety Code for Mechanical Refrigeration.
- D. Conformance to ANSI/UL 465.
- E. Units must meet the minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 WARRANTY

- A. Compressors shall have an extended 5 year parts warranty.

## 1.5 COMPONENTS

- A. Water-cooled and air-cooled helical rotary screw chiller:
  1. Compressor: Semi-hermetic helical rotary screw design with double wall construction for sound attenuation.
  2. Refrigerant: Shall be R-22 or R-134a
  3. Cooler: ASME vessel direct expansion, shell and tube design. Provide thermostatically controlled electric heat tracing for exterior air-cooled chillers.
  4. Condenser: ASME vessel, shell and tube design for water-cooled design.
  5. Evaporator shell shall be wrapped with 3/4 inch thick elastomeric foam insulation.
  6. Starter: Unit mounted soft start design
  7. Control panel: Unit mounted with complete diagnostics, direct digital control.
  8. Provide all required safeties including: overcurrent, thermal overload, and single-phasing motor protection.
  9. Provide with "marine" water boxes for the cooler and condenser piping connections for water-cooled design.
  10. Provide complete charge of the select refrigerant.
  11. Provide integral multiple compressor fans for air-cooled design.
  12. Provide condenser coil protection on outdoor air-cooled units.
  13. Provide with water flow switch.

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**1.6 INSTALLATION**

- A. Install per the manufacturer's requirements.
- B. Minimize the number of daily starts as recommended by the manufacturer.
- C. Vent the refrigerant safety relief valve to the outside of the building.
- D. Set the chiller on properly sized vibration isolation devices.
- E. Mount the safety flow switch in the chilled water supply piping. Wire the flow switch to the chiller control panel. Chiller shall not start until proof of flow via the flow switch is established.

END OF SECTION

## SECTION 236440

## REFRIGERANT MONITORING SYSTEMS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for refrigerant monitoring equipment and breathing apparatus.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Products and installation shall comply with requirements of ASHRAE Standard 15.

## 1.4 COMPONENTS

## A. Gas Detection System

1. System shall be capable of detecting presence of any HCFC, CFC, or HFC refrigerant (R-22, R123, R-134a). Provide the appropriate sensors for the refrigerant being used.
2. The system shall indicate alarm and shut down the refrigeration equipment and start the refrigerant ventilation fan system.
3. Oxygen deprivation monitoring shall not be used in lieu of TLV-TWA monitoring for human safety exposure.
4. Sequential sampling and multi-point monitoring shall be required as defined in the latest issue of ASHRAE Standard 15.
5. The analyzer shall be microprocessor based and employ infrared (IR) sensor technology and shall accurately provide sensing down to 1 part per million.
6. Unit shall be factory calibrated for the refrigerant and sensors.
7. Sensors shall be capable of being installed up to 500 feet from the microprocessor.

## B. Breathing Apparatus

1. Self-contained with 30 minutes of air. Provide with full face mask, breathing tube, air tank, controls and harness. Provide with wall mounted storage cabinet.

## 1.5 INSTALLATION

- A. Provide refrigerant monitoring/alarm system for refrigeration equipment located inside the building.
- B. The monitoring system shall shut-down all refrigeration equipment in the room, start the refrigerant emergency exhaust system, and sound the alarm.
- C. Locate the breathing apparatus in a protective wall mounted enclosure immediately outside of the refrigeration room.
- D. Mount and wire the remote audible alarms inside the room containing the refrigeration equipment and immediately outside of the refrigeration room.

END OF SECTION

## SECTION 236500

## PACKAGED COOLING TOWERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for induced draft cross-flow package cooling towers, and forced-draft, counter-flow packaged cooling towers.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Certified for thermal performance to CTI 201.
- B. ASTM E84 for burning characteristics of building materials.
- C. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- D. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Induced-Draft, Cross-Flow Cooling Towers
  1. Fan Type: Propeller with cast-aluminum, fixed-pitch or galvanized-steel, fixed-pitch blades.
  2. Fan Drive: Gear, with speed reducer or belt drive.
  3. Fan Motor: Two-speed or suitable for variable-frequency drive control, totally enclosed, fan-cooled.
  4. Fan-vibration cutoff switch.
  5. Hot-water distribution system.
  6. Hot-Water Basin Control Valves: Globe.
  7. Casing: Galvanized steel with polymer coating or stainless steel.
  8. Collecting Basin: Galvanized steel with polymer coating or stainless steel.
  9. Fill Material: Formed PVC or CPVC.
  10. Drift Eliminator Material: Formed PVC.
  11. Louver Material: Galvanized steel with polymer coating.
  12. Water Level Control: Electric float switch with solenoid make-up valve.
  13. Basin Heaters: Electric immersion sized to maintain a minimum 40 degree F pan water temperature.
  14. Handrails, Ladders, and Safety Cage: Galvanized steel pipe.
  15. Vibration Controls: Manufacturer recommended. Rubber and glass-fiber pad isolators.
  16. Basin drain connection and overflow connections.
  17. Anti-vortex suction diffuser/screen constructed of stainless steel.

- B. Forced-Draft, Counter-Flow Cooling Towers
1. Fan Type: Propeller with cast-aluminum, fixed-pitch or galvanized steel, fixed-pitch blades. Centrifugal forward curved fans are also acceptable.
  2. Fan Drive: Gear, with speed reducer or belt drive.
  3. Fan Motor: Two speed or suitable for variable frequency drive control, totally enclosed, fan cooled.
  4. Fan vibration cutoff switch.
  5. Hot water distribution system.
  6. Hot Water Basin Control Valves: Globe.
  7. Casing: Galvanized steel with polymer coating or stainless steel.
  8. Collecting Basin: Galvanized steel with polymer coating or stainless steel.
  9. Fill Material: Formed PVC or CPVC.
  10. Drift Eliminator Material: Formed PVC.
  11. Louver Material: Galvanized steel with polymer coating.
  12. Water Level Control: Electric float switch with solenoid makeup valve.
  13. Basin Heaters: Electric immersion sized to maintain a minimum 40 degree F pan water temperature.
  14. Handrails, Ladders, and Safety Cage: Galvanized steel pipe.
  15. Vibration Controls: Manufacturer recommended. Rubber and glass fiber pad isolators.
  16. Basin drain connection and overflow connections.
  17. Anti-vortex suction diffuser/screen constructed of stainless steel.

## 1.5 INSTALLATION

- A. Install cooling towers to conform with the manufacturer's requirements

END OF SECTION

## SECTION 236533

## CLOSED CIRCUIT FLUID COOLERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for closed-circuit evaporative fluid coolers.

## 1.2 SUBMITTALS

- A. Provide submittals indicating capacity at the specified conditions, electrical requirements, construction material, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.

## 1.4 COMPONENTS

- A. Coil: Continuous serpentine, cleanable, galvanized tubes with removable cover plates on headers.
- B. Drift Eliminator Material: Hot-dip galvanized steel with polymer coating.
- C. Hot Water Distribution System: Schedule 40 PVC with removable branch pipes.
- D. Inlet Screens: Galvanized steel mesh with polymer coating mounted on removable frame.
- E. Basin Heaters: Electric.
- F. Circulating Pumps: Centrifugal, closed-coupled, bronze fitted with mechanical seals.
- G. Water Level Control: Electric float switch with solenoid makeup valve.
- H. Fan: Centrifugal
  - 1. Drive: Belt.
  - 2. Motor: Totally enclosed, fan-cooled energy-efficient type.
  - 3. Motor Speed: Single speed.
  - 4. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.
- I. Vibration cutout switch.
- J. Discharge dampers, inlet dampers, and controls.
- K. Casing Material: Galvanized steel with polymer coating or stainless steel.
- L. Collecting Basin: Galvanized steel with polymer coating or stainless steel.
- M. Vibration Controls: Manufacturer's recommended rubber and glass-fiber pads or restrained spring isolators.

## 1.5 INSTALLATION

- A. Mount fluid cooler on vibration isolators.
- B. Provide open circuit cooling tower chemical water treatment for control of scale, corrosion, and biological growth.

END OF SECTION

SECTION 237119  
ICE STORAGE SYSTEM

GENERAL GUIDELINES

1.1 SECTION INCLUDES

- A. Qualitative requirements for ice storage tanks.

1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

1.3 QUALITY ASSURANCE

- A. Unit controls shall be UL or ETL listed and labeled.

1.4 COMPONENTS

- A. Thermal ice storage tanks shall be constructed of galvanized steel or polyethylene.
- B. Heat exchangers shall be constructed of polyolefin, polyethylene or galvanized steel.
- C. The bottom, sides, and cover(s) of each ice storage tank shall be factory insulated to ensure standby losses do not exceed one percent of system capacity in 24 hours.
- D. Ice storage tanks that are to be buried shall be specifically designed for burial.
- E. An ice inventory measuring device shall be provided to interface with the HVAC Direct Digital Controls system.

1.5 Install per manufacturer's requirements.

1.6 Manufacturer shall check-test-start units.

END OF SECTION

## SECTION 237200

## AIR TO AIR ENERGY RECOVERY EQUIPMENT

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for total energy heat recovery wheels and energy recovery modules.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Recovery performance shall be tested in accordance with ASHRAE Standard 84.
- B. Units shall bear the ETL label and shall be ETL certified.
- C. Recovery performance at specified conditions shall be guaranteed by the manufacturer.

## 1.4 COMPONENTS

- A. Energy Recovery Wheel
  1. The energy recovery wheel shall have a heating net total effectiveness of 70% and a cooling net total effectiveness of 70%.
  2. The unit shall be constructed of structural steel tubular frame with epoxy primer and finish. The cabinet shall be of 16 gauge bright galvanized steel construction.
  3. The heat wheel transfer media shall be a coated aluminum or polymer media with air permeable matrix with laminar flow flutes coated with a renewable desiccant. The heat wheel media shall be driven by an electric motor.
  4. The face velocity across each side of the media (supply and exhaust) shall be less than 800 FPM and more than 350 FPM with a purge method that prevents exhaust air from being recirculated.
  5. Each unit shall include a frost control method. The control of the unit shall be provided by the DDC control system.
- B. Energy Recovery Module  
(This type of energy recovery does not meet the prescriptive path requirements of the energy code. If this type is to be used, compliance with the energy cost-budget method must be demonstrated – **ASHRAE 90.1-2007.**)
  1. The energy recovery module shall have a heating net total effectiveness of 62% and a cooling net total effectiveness of 41%.
  2. The module shall be constructed of 16 gauge galvanized steel with epoxy primer. **Access doors shall have gasket, hinge, and door latches to provide a tight seal.**
  3. The fixed plate exchange module shall be fixed plate cross-flow construction. Water vapor transfer shall be through molecular transport by hydroscopic resin.

**HVAC**

- C. Furnish a digital display for readout of both air stream temperatures and control settings.
- D. Provide filter racks and filters with a minimum MERV rating of 7 on both entering air sides of the wheel or energy recovery module.
- E. Each unit shall include a frost control method. The control for the unit shall be provided through the building DDC control system.
- F. Provide filter racks and minimum 30 percent efficiency filters on both entering air sides to the heat wheel.

**1.5 INSTALLATION**

- A. Install per manufacturers requirements.
- B. Manufacturer shall test-check-start units.

END OF SECTION

## SECTION 237313

## MODULAR INDOOR AIR HANDLING UNITS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for central station modular air handling units including fan sections hot water heating coils, chilled water cooling coils, filter sections, mixing boxes, face and bypass dampers, access modules, and other such equipment and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting the following:
  1. Product data indicating dimensions, weights, capacities, and materials.
  2. Fan performances including curves.
  3. Sound power levels.
  4. Filter data, mounting method, and performance.

## 1.3 QUALITY ASSURANCE

- A. Construction standard shall meet NFPA 90A.
- B. Product certification shall comply with ARI 430.
- C. Sound power level rating shall comply with AMCA 300, ASHRAE 68, and AMCA 301.
- D. Fan performance rating shall comply with AMCA 210.
- E. Damper leakage rating shall comply with AMCA 500.
- F. Coil performance shall comply with ARI 410.
- G. Safety code for mechanical refrigeration shall comply with ASHRAE 15.
- H. Filtration shall comply with ASHRAE 52.

## 1.4 COMPONENTS

- A. Unit Casing
  1. Galvanized steel framing on channel base with welding construction.
  2. Zinc coated steel with primer coat and final finish of protective enamel.
  3. Dual wall construction throughout.
  4. 2 inch thick insulation with minimum R-value of R-8.3 ft<sup>2</sup>•h•°F/Btu.
  5. Double wall, stainless steel drain pan, insulated and sloped to assure drainage.
  6. **Access doors shall be 2" thick dual wall construction with hinge and door latches to provide a tight seal. Bolted doors are not acceptable.**
- B. Water Coils
  1. Common or individual with minimum 16 gauge galvanized steel casings and intermediate supports for lengths over 60 inches.
  2. Constructed of seamless copper tubes with aluminum plate fins, cast iron or copper headers, with connections for drain valve and air vent.
  3. Drainable serpentine type.
  4. Tested at 300 psi under water.

**HVAC****CHAPTER 9: SPECIFICATIONS**

- C. DX Refrigerant Coils
  1. Constructed of seamless copper tubes with aluminum plate fins,
  2. Seamless copper suction header and distributor tube with low pressure drop distributors.
  3. Multi-circuited, fully intertwined, staggered row for full face cooling at variable air flows.
  4. Tested at 400 psi under water.
  
- D. Face and Bypass Dampers
  1. Dampers shall be opposed acting, with break-formed dampers having gaskets and edge seals.
  
- E. Access Section
  1. Section shall include an access door.
  2. Access sections shall be placed between coil sections to allow access for cleaning and repair.
  
- F. Mixing Box
  1. Section shall be provided with return air and economizer air connections.
  2. Dampers shall be provided and installed by the Temperature Control Contractor.
  
- G. Fans
  1. Fan type shall be (airfoil) (backward inclined) (forward curved) type.
    - a. Double width, double inlet multi-blade fan wheel.
    - b. Self aligning, grease lubricated ball bearings with lubrication fittings
    - c. Fan and motor assembly internally isolated from unit casing.
  2. Fan type shall be plug type.
    - a. Single width, single inlet, multi-blade fan wheel.
    - b. Self aligning, anti-friction pillow block bearings.
    - c. Fan and motor assembly internally isolated including spring-supported inertia pad.
  3. Fan assemblies shall be statically and dynamically balanced.
  4. Guards for belts and fans shall be provided to meet OSHA requirements.
  
- H. Motors/Drives
  1. Heavy-duty, high efficiency designed specifically for use with electronic variable frequency drives. Efficiency shall meet the minimum requirements of IEEE 112, Test Method B.
  2. Temperature rating shall be 50 deg C maximum rise at 40 deg C ambient.
  3. Service factor shall be 1.15 for polyphase motors and 1.35 for single-phase motors.
  4. Each motor shall be mounted on an adjustable base.
  5. Noise rating shall be quiet.
  6. Overload protection shall be built-in thermal with automatic-reset.
  7. Sheaves shall be cast iron with v-belt sized for 150 percent BHP.
  8. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

- I. Filter Section
  - 1. Filter section shall be a cartridge section separate from the mixing box.
  - 2. The pre-filters shall be 2 inch and have a minimum MERV rating of 7.
  - 3. The primary filters shall have a minimum **MERV rating of 13**, and be mounted just after the pre-filters.
  - 4. **Refer to “LEED For Schools” for additional requirements.**
- J. Vibration Isolation
  - 1. Each fan system shall be isolated from the cabinet with spring-type isolation.
  - 2. Fans shall include concrete-filled inertia bases where recommended by unit manufacturer.
  - 3. Thrust restraints shall be included for all fan types.
- K. Lighting and Convenience Outlet Circuit
  - 1. 1 vapor-proof service light and 1 convenience outlet shall be provided in each fan section and mixing box section. (optional for units less than 15,000 cfm)

## 1.5 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

## SECTION 237323

## CUSTOM INDOOR AIR HANDLING UNITS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Central station custom air handling units including fan sections, hot water heating coils, chilled water cooling coils, filter sections, mixing boxes, access modules, and other such equipment and accessories. Custom air handling units are intended only to be used to accommodate unusual mechanical room configurations where modular air handling units will not fit space allocated.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting the following:
  1. Product data indicating dimensions, weights, capacities, and materials.
  2. Fan performances including curves.
  3. Sound power levels.
  4. Filter data, mounting method, and performance.

## 1.3 QUALITY ASSURANCE

- A. Construction standard shall meet NFPA 90A.
- B. Product certification shall comply with ARI 430.
- C. Sound power level rating shall comply with AMCA 300, AMCA 301, and ASHRAE 68.
- D. Fan performance rating shall comply with AMCA 210.
- E. Damper leakage rating shall comply with AMCA 500.
- F. Coil performance shall comply with ARI 410.
- G. Safety code for mechanical refrigeration shall comply with ASHRAE 15.
- H. Filtration shall comply with ASHRAE 52.

## 1.4 COMPONENTS

- A. Unit Construction
  1. Unit base shall be constructed of structural steel channel with welded construction. Include lifting lugs and internal supports for spans over 96 inches.
  2. Exterior housing shall be dual wall constructed with minimum 16 gauge galvanized exterior skin and 20 gauge interior skin over 2 inch, 3 pounds per cubic foot insulation.
  3. Unit floor shall be minimum 16 gauge galvanized steel and shall be welded to the floor structural system.
  4. Access doors shall be dual wall, and installed in each fan section and mixing box section as a minimum. Each door shall be fully gasketed with heavy-duty hinges and adjustable latches. Insulation and panel construction shall match the rest of the unit sections.

5. Insulation shall be minimum 2 inch thick,  $R-8.3 \text{ ft}^2 \cdot \text{h} \cdot \text{°F}/\text{Btu}$  for all wall and door assemblies. Floor insulation shall be 2 inch,  $R-8.3 \text{ ft}^2 \cdot \text{h} \cdot \text{°F}/\text{Btu}$  and installed directly beneath floor surface.
  6. The finish for the unit shall include a painted exterior over galvanized steel having a minimum A-60 application.
- B. Water Coils
1. Common or individual with minimum 16 gauge galvanized steel casings and intermediate supports for lengths over 60 inches.
  2. Constructed of seamless copper tubes with aluminum plate fins, cast iron or copper headers, with connections for drain valve and air vent.
  3. Drainable serpentine type.
  4. Tested at 300 psi under water.
  5. Dual wall, insulated, stainless steel drain pan of IAQ design.
- C. Access Section
1. Section shall include an access door.
  2. Access sections shall be placed between coil sections to allow access for cleaning and repair.
- D. Mixing Box
1. Section shall be provided with return air and economizer air connections.
  2. Dampers shall be provided and installed by the Temperature Control Contractor.
- E. Fans
1. Fan type shall be (airfoil) (backward inclined) (forward curved) type.
    - a. Double width, double inlet multi-blade fan wheel.
    - b. Self aligning, grease lubricated ball bearings with lubrication fittings
    - c. Fan and motor assembly internally isolated from unit casing.
  2. Fan type shall be plug type.
    - a. Single width, single inlet, multi-blade fan wheel.
    - b. Self aligning, anti-friction pillow block bearings.
    - c. Fan and motor assembly internally isolated including spring-supported inertia pad.
  3. Fan assemblies shall be statically and dynamically balanced.
  4. Guards for belts and fans shall be provided to meet OSHA requirements.
- F. Motors/Drives
1. Heavy-duty, high efficiency designed specifically for use with electronic variable frequency drives. Efficiency shall meet the minimum requirements of IEEE 112, Test Method B.
  2. Temperature rating shall be 50 deg C maximum rise at 40 deg C ambient.
  3. Service factor shall be 1.15 for polyphase motors and 1.35 for single-phase motors.
  4. Each motor shall be mounted on an adjustable base.
  5. Noise rating shall be quiet.
  6. Overload protection shall be built-in thermal with automatic-reset.
  7. Sheaves shall be cast iron with v-belt sized for 150 percent BHP.
  8. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

- G. Filter Section
  - 1. Filter section shall be a cartridge section separate from the mixing box.
  - 2. The pre-filters shall be 2 inch and have a minimum MERV rating of 7.
  - 3. The primary filters shall have a minimum **MERV rating of 13** and be mounted just after the pre-filters.
  - 4. **Refer to “LEED for Schools” for additional requirements.**
- H. Vibration Isolation
  - 1. Each fan system shall be isolated from the cabinet with spring-type isolation.
  - 2. Fans shall include concrete-filled inertia bases where recommended by unit manufacturer.
  - 3. Thrust restraints shall be included for all fan types.
- I. Lighting and Convenience Outlet Circuit
  - 1. 1 vapor-proof service light and 1 convenience outlet shall be provided in each fan section, and mixing box section.

#### 1.5 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

## SECTION 238113

## UNITARY AIR CONDITIONING EQUIPMENT

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged through-the-wall terminal air conditioning equipment and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Refrigeration system shall meet ASHRAE 15.
- B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.
- C. Performance rating shall comply with ARI 310/380.
- D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 WARRANTY

- A. The unit compressor shall be warranted for 5 years.

## 1.5 COMPONENTS

- A. The cabinet shall be constructed of galvanized steel with removable front panel.
  1. Mounting: Wall installation with wall sleeve.
  2. Finish: Baked enamel over heavy, 18 gauge, phosphatized galvanized steel.
  3. Subbase: Enameled steel.
  4. Louvers: Extruded aluminum, architectural style grille with horizontal louvers and baked enamel finish.
  5. Discharge grille and access door: Extruded aluminum.
  6. Cabinet extensions matching cabinet construction.
- B. The refrigeration system shall be direct-expansion indoor coils with capillary restrictor and constant-pressure expansion valve, hermetically sealed compressor, outdoor coil and fan, and coaxial tube-in-tube condenser.
- C. The indoor air system shall include forward-curved centrifugal indoor fan and motor, and permanent filters. Motors shall be high efficiency, permanent split capacity type. A positive pressure ventilation damper with connection cable shall be included with each unit.

**HVAC**

## CHAPTER 9: SPECIFICATIONS

- D. The outdoor fan system shall include forward-curved centrifugal fan with separate motor from indoor system. Motors shall be high efficiency, permanent split capacity type.
- E. Heating coils shall be electric resistance type with fusible link and an overheat limit control.
- F. Condensate drain shall be provided for direct flow to the exterior of building.
- G. The control system shall include a unit mounted control panel for setting of fan speeds, heating/cooling mode and automatic control.
  - 1. A unit mounted thermostat shall sense the air temperature at the fan inlet for control. The setting shall be adjustable.

## 1.6 INSTALLATION

- A. Install in accordance with manufacturers requirements.

END OF SECTION

## SECTION 238123

## COMPUTER ROOM AIR CONDITIONERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for air conditioning units intended specifically for computer rooms including package unit, refrigerant piping and specialties, reheat control, valves, and unit control.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Refrigeration system shall meet ASHRAE 15.
- B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.
- C. Units shall be UL Listed and CSA Certified.
- D. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 WARRANTY

- A. The entire unit shall be warranted for 5 years.

## 1.5 COMPONENTS

- A. Cabinet and frame construction
  - 1. Welded, heavy gauge galvanized steel frame
  - 2. Zinc-coated steel with primer coat and baked enamel finish
  - 3. Minimum 2 inch, 2 pound density fiber insulation
  - 4. Hinged filter and grille for access
- B. Filters
  - 1. 1 inch thick, disposable and 20 percent efficiency.
  - 2. Provide extra set at completion of work
- C. Evaporator fan assembly
  - 1. Fan shall be direct-drive with double inlet blower.

**HVAC****CHAPTER 9: SPECIFICATIONS**

- D. Refrigeration system
  - 1. Direct expansion coil with aluminum fins, copper tubes, thermal expansion valve, liquid line filter-dryer, service shutoff valves, charging valves, and stainless-steel drain pan.
  - 2. Hermetic compressor with vibration mounts.
- E. Condenser section
  - 1. Air-cooled, copper tubes, aluminum fins, with refrigerant circuit of counterflow design including desuperheating section.
  - 2. Fan shall be double inlet, direct drive with a 3-speed motor and low limit ambient control to prevent evaporator freezeup.
- F. Reheat section
  - 1. Electric reheat coils shall be low-density, tubular type elements, with UL approved safety switches.
- G. Condensate drain system
  - 1. The condensate drain system shall include a condensate pump with integral float switch, pump/motor assembly, and reservoir.
- H. Control system
  - 1. The control system shall be solid state and shall include a remote thermostat and shutoff switch for field installation.

**1.6 INSTALLATION**

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

## SECTION 238146

## WATER SOURCE HEAT PUMPS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged horizontal or vertical water source heat pump air conditioning/heating unit, unit-mounted controls, and accessories. ***This section is NOT to be used on geothermal system where the EWT is below 45 degrees F, refer to section 238156.***

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Refrigeration system shall meet ASHRAE 15.
- B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.
- C. Performance rating shall comply with ARI/ASHRAE/ISO 13256-1.
- D. Safety requirements shall comply with UL 484/559.
- E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 WARRANTY

- A. Heat pump unit shall be warranted for ***one year for all parts including labor and a total of 5 years on compressor parts.***

## 1.5 COMPONENTS

- A. The cabinet shall be constructed of galvanized steel with **0.5** inch, 1-1/2 pound per cubic foot density insulation. Internal sheet metal parts shall be protected with a thermosetting, plastic coating.
- B. Heat pump shall include refrigeration circuit with single or dual capacity hermetic compressor.
  1. Refrigerant air-to-air copper-tube coil heat exchanger.
  2. ***Refrigerant shall be HFC***
  2. Water-to-refrigerant coaxial tube-in-tube heat exchanger.
  3. Refrigerant flow control using capillary tube or thermal expansion valve.
  4. High and low pressure safety cutoffs.
  5. Pilot controlled reversing valve.
  6. Thermal overload protection.
  7. External vibration isolation.

- 8. Internal compressor vibration isolation.
- 9. ***Insulate water-to-refrigerant heat exchanger and refrigerant suction lines.***
- C. Forward curved, centrifugal type evaporator fan with multi-speed, high-efficiency PSC ***or ECM*** type motor including integral mounting brackets and thermal overload protection.
- D. Galvanized steel ***insulated*** drain pan with external drain connection. ***Provide with solid-state liquid detection device in the drain pan to stop compressor if condensate accumulates.***
- E. Filter frame with 1 inch throwaway filter. ***Filter must be MERV 13 if designer is going after LEED EQ 5.0.***
- F. The control system shall include a unit-mounted ***microprocessor*** control panel design for interface to the building DDC electronic control system. ***Controller shall be capable of auto heating and cooling changeover and capacity control. Manufacturer shall provide all necessary control components (t-stats, humidistats, etc.) necessary for control of heat pump.***
- G. Units shall be finished with enamel paint to the manufacturer's standard color.
- H. ***Provide interior acoustical insulation to deaden fan and compressor noise.***

#### 1.6 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Hose kit and associated shutoff and flow control devices shall be field installed by the HVAC Contractor.

END OF SECTION

## SECTION 238156

## GROUND SOURCE HEAT PUMPS (GEOHERMAL)

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for packaged horizontal or vertical ground source heat pump air conditioning/heating unit, unit-mounted controls, and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Refrigeration system shall meet ASHRAE 15.
- B. Units must meet minimum efficiency of 16 EER cooling and 3.5 COP Heating under ARI/ISO Standard 13256-1 Ground Loop Conditions (ARI 330). Multiple or variable speed heat pumps shall achieve this rating at high speed.
- C. Performance rating shall comply with ARI/ASHRAE/ISO 13256-1.
- D. Safety requirements shall comply with UL 484/559.
- E. All three-phase motors shall be protected with phase loss protection. Protection shall be provided by the electrical system, by built-in protection, or by protection built into a variable frequency drive.

## 1.4 WARRANTY

- A. Heat pump unit shall be warranted for one year for all parts including labor and a total of 5 years on compressor parts.

## 1.5 COMPONENTS

- A. Unit shall be rated to operate with an entering water temperature from 25 degrees F. to 115 degrees F. Note that operating the ground loop below 40 degrees will require glycol freeze protection.
- B. The cabinet shall be constructed of galvanized steel with 0.5 inch, 1-1/2 pound per cubic foot density insulation. Internal sheet metal parts shall be protected with a thermosetting, plastic coating.
- C. Heat pump shall include refrigeration circuit with single or dual capacity hermetic compressor.
  - 1. Refrigerant air-to-air copper-tube coil heat exchanger.
  - 2. Refrigerant shall be HFC.
  - 2. Water-to-refrigerant coaxial tube-in-tube heat exchanger.

3. Refrigerant flow control using capillary tube or thermal expansion valve.
  4. High and low pressure safety cutoffs.
  5. Pilot controlled reversing valve.
  6. Thermal overload protection.
  7. External vibration isolation.
  8. Internal compressor vibration isolation.
  9. Insulate water-to-refrigerant heat exchanger and refrigerant suction lines.
- D. Forward curved, centrifugal type evaporator fan with multi-speed, high-efficiency ECM type motor including integral mounting brackets and thermal overload protection.
- E. Galvanized steel insulated drain pan with external drain connection. Provide with solid-state liquid detection device in the drain pan to stop compressor if condensate accumulates.
- F. Filter frame with 1 inch throwaway filter. Filter must be MERV 13 if designer is going after LEED EQ 5.0.
- G. The control system shall include a unit-mounted microprocessor control panel design for interface to the building DDC electronic control system. Controller shall be capable of auto heating and cooling changeover and capacity control. Manufacturer shall provide all necessary control components (t-stats, humidistats, etc.) necessary for control of heat pump.
- H. Units shall be finished with enamel paint to the manufacturer's standard color.
- I. Provide interior acoustical insulation to deaden fan and compressor noise.

## 1.6 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Hose kit and associated shutoff and flow control devices shall be field installed by the HVAC Contractor.

END OF SECTION

## SECTION 238219

## FAN COIL UNITS – FOUR PIPE

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for fan coil units and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.
- B. Performance rating shall conform to N.E.C requirements and shall be UL labeled.
- C. Unit capacities shall be certified in accordance with ARI Standard 440-98.

## 1.4 WARRANTY

- A. The entire unit shall be warranted for 5 years.

## 1.5 COMPONENTS

- A. Cabinet and frame construction
  - 1. Welded, heavy gauge galvanized steel frame
  - 2. Zinc-coated steel with primer coat and baked enamel finish
  - 3. Minimum 2 inch, 2 pound density fiber insulation
  - 4. Hinged filter and grille for access
- B. Filters
  - 1. 1 inch thick, disposable and MERV 6 efficiency.
  - 2. Provide extra set at completion of work.
- C. Centrifugal supply air fan
  - 1. Fan shall be forwardly curved double width-double inlet, with common shaft mounted on a removable fan board, driven by a three-speed permanent split capacitor motor having built-in overload protection.
- D. Chilled water cooling coil
  - 1. Coil shall consist of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p.
  - 2. A manual air vent shall be provided on each coil.
- E. Hot water heating coil
  - 1. Coil shall consist of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p.
  - 2. A manual air vent shall be provided on each coil.

**HVAC**

## CHAPTER 9: SPECIFICATIONS

- F. Condensate drain system
  - 1. The condensate drain system shall include a condensate drain pan under the cooling coil, pitched to drain, and an auxiliary drain pan under the coil connections. Provide auxiliary drain pan and/or condensate high limit fan cutoff as required by code.
  
- G. Control system
  - 1. The control system shall be a complete system of electronic direct digital controls.

## 1.6 INSTALLATION

- A. Install in accordance with manufacturers requirements.
- B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

## SECTION 238223

## UNIT VENTILATORS – FOUR PIPE

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for unit ventilator units and accessories.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacity, materials, controls, dimensions, and accessories.

## 1.3 QUALITY ASSURANCE

- A. Units shall be tested and performance certified in accordance with ARI 840-98.
- B. Units must meet minimum efficiency requirements of ASHRAE Standard 90.1.
- C. Units shall be UL or ETL listed.

## 1.4 WARRANTY

- A. The entire unit shall be warranted for 5 years.

## 1.5 COMPONENTS

- A. The cabinet shall be constructed of galvanized steel with removable front panel.
  1. Mounting: Wall installation with wall sleeve.
  2. Finish: Baked enamel over heavy, 18 gauge, phosphatized galvanized steel.
  3. Subbase: Enameled steel.
  4. Louvers: Extruded aluminum, architectural style grille with horizontal louvers and baked enamel finish.
  5. Discharge grille and access door: Extruded aluminum.
  6. Cabinet extensions matching cabinet construction.
- B. Centrifugal fans, forwardly curved double width-double inlet, with common shaft mounted on a removable fan board, driven by a single speed, permanent split capacitor motor having built-in overload protection and Class F winding insulation. The motor shall be factory wired to a solid state, single phase, variable speed controller with minimum turndown to 30% of total motor speed. A toggle type disconnect switch shall be furnished with each unit to provide electrical disconnect of power to all components.
- C. Chilled water cooling coil and separate hot water heating coil for a four-pipe system, each consisting of seamless copper tubes with bonded aluminum fins. Coils shall be designed for 300 psi w.p. A manual air vent shall be provided on each coil.
- D. Outside Air – Return air dampers with edge seals arranged for automatic operation modulating from zero to 100% outside air intake.

**HVAC**

## CHAPTER 9: SPECIFICATIONS

- E. Coil face and bypass modulating dampers with edge seals, arranged for automatic operation to regulate heat output.
  - F. Insulated drain pan under the cooling coil and insulated auxiliary drain pan under the coil connections shall be furnished.
  - G. Air filter, 1" pleated filter with cardboard frame. MERV value shall be 7.0.
  - H. Control system
    - 1. The control system shall be a complete system of electronic direct digital controls.
- 1.6 Outside air intake louver and protective lattice grille. Louver shall have vertical blades and bird screen. Louver and grilles shall be furnished in Kynar 500 with color selected by the Architect. Louvers and grilles shall be standard sizes except where otherwise noted on the drawings.
- 1.7 **INSTALLATION**
- A. Install in accordance with manufacturers requirements.
  - B. Startup and training to be provided by a factory-trained service technician.

END OF SECTION

## SECTION 238233

## CONVECTORS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for convectors and fin tube radiation.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Radiation pressure tested to 200 psig.

## 1.4 COMPONENTS

- A. Hydronic Finned-Tube Radiation and Enclosure
  - 1. Finned Tubes: Constructed of copper tube and aluminum fins
  - 2. Enclosure: Steel, sloped front with factory baked enamel finish.
  - 3. Provide with wall hang brackets for piping, finned tube element and enclosure support.

## 1.5 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION

## SECTION 238239

## CABINET UNIT HEATERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for ceiling mounted hydronic and electric cabinet unit heaters.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Capacity rated in accordance with ARI.
- B. Hydronic coils shall be pressure tested to 400 psig.
- C. Units shall be UL or ETI listed and labeled.

## 1.4 COMPONENTS

## A Hydronic Cabinet Unit Heaters

- 1. Cabinets shall be formed steel suitable for recessed ceiling mounting. Provide with stamped grilles for air inlet and outlet or ducted connections.
- 2. Coils shall be constructed of seamless copper tubing that is mechanically bonded to aluminum fins.
- 3. Fans shall be forward curved centrifugal direct drive.
- 4. Provide with disconnect switch, fused motor protection and fan speed controller switch.
- 5. Provide with 1 inch throw away fiberglass filter.
- 6. Provide with end pockets on both ends of the cabinet suitable in size for concealing piping and valving.
- 7. Provide factory enamel finish.

## B. Electric Cabinet Unit Heaters

- 1. Cabinets shall be formed steel suitable for wall mounting (surfaced or semi-recessed to 8 inches) or recessed ceiling mounting. Provide with stamped grilles for air inlet and outlet (location dependent on style selected).
- 2. Coils shall be constructed of nickel chromium wire in a metallic sheath with fins no closer than .16 inches and free from expansion noise and 60-Hz hum.
- 3. Fans shall be forward curved centrifugal direct drive.
- 4. Provide with disconnect switch, coil relay switches, and fan speed controller switch.
- 5. Provide with fan and electric coil circuit protection.
- 6. Provide factory enamel finish.

## 1.5 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION

## SECTION 238240

## PROPELLER UNIT HEATERS

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for horizontal or vertical hydronic and electric propeller unit heaters.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.

## 1.3 QUALITY ASSURANCE

- A. Capacity rated in accordance with ARI.
- B. Hydronic coils shall be pressure tested to 400 psig.
- C. Units shall be UL or ETI listed and labeled.

## 1.4 COMPONENTS

## A Hydronic Propeller Unit Heaters

- 1. Cabinets shall be formed steel. Provide with louvered adjustable grilles for air outlet.
- 2. Coils shall be constructed of seamless copper tubing that is mechanically bonded to aluminum fins.
- 3. Fans shall be propeller type direct drive.
- 4. Provide factory enamel finish.

## B. Electric Propeller Unit Heaters

- 1. Cabinets shall be formed steel. Provide with louvered adjustable grilles for air outlet.
- 2. Coils shall be constructed of nickel chromium wire in a metallic sheath with fins no closer than .16 inches and free from expansion noise and 60-Hz hum.
- 3. Fans shall be forward curved centrifugal direct drive.
- 4. Provide with fused fan and electric coil circuit protection.
- 5. Provide factory enamel finish.

## 1.5 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION

## SECTION 238316

## RADIANT HEATING HYDRONIC SYSTEM

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for hydronic ceiling radiation and enclosure.

## 1.2 SUBMITTALS

- A. Submittals are required and shall include product data noting capacities at the specified conditions, materials, sizes, and dimensions.
- B. Shop drawings are required denoting layout of each radiant panel.

## 1.3 QUALITY ASSURANCE

- A. Radiation pressure tested to 400 psig.

## 1.4 COMPONENTS

- A Hydronic ceiling radiation:
  - 1. Panels: Constructed of extruded ribbed aluminum with copper serpentine coil. The coil shall be mechanically bonded to the aluminum panel.
  - 2. Provide 2 inch thick fiberglass insulation on the top side of the radiant panel.
  - 3. Provide factory enamel finish.

## 1.5 INSTALLATION

- A. Install per manufacturers requirements.

END OF SECTION

**26**

**DIVISION**

**ELECTRICAL**

## TABLE OF CONTENTS

DIVISION 26: ELECTRICAL

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| 260513        | Medium Voltage Cables 2001 to 35,000 v                                  |
| 260519        | Low Voltage Electrical Power Conductors and Cables                      |
| 260526        | Grounding and Bonding of Electrical Systems                             |
| <b>260529</b> | <b><i>Hangers and Supporting Devices</i></b>                            |
| <b>260533</b> | <b><i>Raceway and Boxes for Electrical Systems</i></b>                  |
| <b>260536</b> | <b><i>Cable Tray for Electrical Systems</i></b>                         |
| 260543        | Underground Ducts and Raceways for Electric Systems                     |
| 260923        | Lighting Control Devices                                                |
| 261200        | Medium Voltage Transformers                                             |
| 261300        | Medium Voltage Switchgear                                               |
| 262200        | Low Voltage Transformers                                                |
| 262413        | Switchboards                                                            |
| 262416        | Panelboards                                                             |
| 262419        | Motor Control Centers                                                   |
| 262726        | Wiring Devices                                                          |
| 262813        | Fuses and Fuse Holders                                                  |
| 262816        | Enclosed Switches and Circuit Breakers                                  |
| 262913        | Enclosed Controllers                                                    |
| 263213        | Package Engine Generators                                               |
| 263600        | Transfer Switches                                                       |
| 264313        | Transient Voltage Suppressors for Low-Voltage Electrical Power Circuits |
| <b>265100</b> | <b><i>Interior Lighting</i></b>                                         |
| 265561        | Theatrical Dimming System                                               |
| 265600        | Exterior Lighting                                                       |

## SECTION 260513

## MEDIUM VOLTAGE CABLES 2,001 to 35,000 V

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for cables, related splices, and terminations.

**1.2 QUALITY ASSURANCE**

- A. IEEE C2
- B. NFPA 70 – National Electric Code
- C. Underwriter’s Laboratory
- D. Trained and Certified Cable Splicer – by material manufacturer

**1.3 CABLES**

- A. UL Cable Type MV 90
- B. UL 1072, AEIC CS 8, ICEA S-93-639, ICEA s-97-682 compliant
- C. Conductor material shall be copper
- D. Cross linked polyethylene 133 percent insulation
- E. Solid copper shielding wire

**1.4 SPLICE KITS**

- A. Comply with IEEE 404
- B. Type recommended by manufacturer

**1.5 TERMINATIONS**

- A. Comply with IEEE 48

**1.6 INSTALLATION**

- A. Install cables according to IEEE 576

END OF SECTION

## SECTION 260519

## LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for building wire and cable for wiring systems of 600V or less
- B. Qualitative requirements for connectors, splices, terminations, and accessories for electrical distribution systems rated 600 volt or less.

**1.2 QUALITY ASSURANCE – Copper Conductors**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory
- C. Copper Conductors NEMA WC 70.
- D. 600V Insulating Material NEMA WC 70.
- E. Armored Cable and Metal Clad Cable NEMA WC 70.
- F. Conductor Connection Torque Value UL 486A.

**1.3 QUALITY ASSURANCE – Aluminum Conductors**

- A. NFPA 70 – National Electrical Code
- B. Underwriter's Laboratory 1581 – table 10.1
- C. Aluminum Association 8000 series
- D. Conductor Connectors UL 486 B
- E. UL Standard 44
- F. ICEA S-95-658 NEMA WC 70

**1.4 COPPER CABLE AND WIRING - 600V OR LESS**

- A. Conductor material shall be copper.
- B. Wire and cable shall be rated 600V.
- C. Minimum conductor size shall be #12 AWG
- D. Type XHHW
- E. Type THHN/THWN

- F. Type AC, 3 conductor, 75C insulation, copper conductor, armored cable.
- G. Type MC, 3 conductor, 75C insulation, copper conductor, metal clad cable.

**1.5 ALUMINUM CABLE AND WIRING – 600v or less**

- A. Conductor material shall be aluminum
- B. Minimum size conductor shall be No. 6 AWG
- C. Type XHHW-2
- D. 90 degree Celsius temperature rating
- E. Cable rated for 600 volts

**1.5 MANUFACTURED WIRING SYSTEMS**

- A. Premanufactured, relocatable, integrated electrical branch wiring system for lighting in accessible ceilings.
- B. Minimum No. 12 AWG copper wire with 600-volt, 90 degree insulation.
- C. Minimum No. 12 AWG insulated copper ground wire.
- D. Pin and socket contacts connected to branch circuit conductor.
- E. Metal constructed cable heads with corrosion-resistant heads.
- F. Designed so no interconnection can occur between different electrical voltages.
- G. System shall be completely modular in construction incorporating conversion modules, prefabricated receptacles located in top of light fixtures, modular selector cables for connecting to light fixtures, and cable extenders.
- H. System shall be capable of being manufactured to conforming to light switching arrangements required.

**1.7 COPPER PERFORMANCES**

- A. Type THHN/THWN or XHHW in raceway for service entrance wiring.
- B. Type THHN/THWN in raceway for feeders and branch circuits.
- C. Type THHN/THWN for exterior branch circuits.
- D. Minimum conductor size shall be #12 AWG for power circuits, #14 AWG for controls.
- E. Feeders and branch circuits shall be concealed above accessible ceilings, in walls, chases, and below slab-on-grade.

**ELECTRICAL**

## CHAPTER 9: SPECIFICATIONS

- F. Manufactured wiring system installation shall be limited to wiring between light fixtures located in accessible acoustical tile ceilings and from junction box located above ceiling to fixtures. Conduit shall be provided from light fixture switch location to junction box located above ceiling.

**1.8 ALUMINUM PERFORMANCES**

- A. Type XHHW-2 in raceway for service entrance wiring, branch circuit feeders to panelboards, and distribution panels.
- B. Connectors shall be dual-rated (AL7CH or AL9CH).
- C. Aluminum conductor is not approved for branch circuits to receptacles, lighting fixtures, or mechanical/electrical motor circuits.
- D. Feeders and branch circuits shall be concealed above accessible ceilings, in walls, chases, and below slab-on-grade.
- E. Aluminum conductors shall be connected, terminated, and torque per manufacturer's recommendations.

END OF SECTION

## SECTION 260526

## GROUNDING and BONDING OF ELECTRICAL SYSTEMS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for grounding for low and medium voltage systems and equipment
- B. Qualitative requirements for basic requirements for grounding for protection of life, equipment, circuits, and systems
- C. Qualitative requirements for grounding of underground distribution components.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. UL 467
- C. Bare solid copper conductors ASTM B3.
- D. Bare stranded copper conductors ASTM B8.
- E. Underground distribution components IEEE C2.

**1.3 MATERIALS**

- A. Minimum No. 12 AWG 600V insulated copper equipment grounding conductor insulated with green colored insulation.
- B. Stranded cable grounding electrode conductors.
- C. Bare copper conductors.
- D. Grounding bus consisting of bare annealed ¼ inch by 2 inch copper bars of rectangular cross section.
- E. Braided No. 30 AWG bare copper wire bonding jumpers.
- F. Copper clad steel 3/4 inch grounding rods.

**1.4 PERFORMANCES**

- A. Conduit is not an allowable grounding means.
- B. Continuous grounding conductor carried throughout the power system.
- C. Grounding of voice, video and data systems.
- D. Provide grounding of circuits, equipment, conduits and etc. as required by the NEC.
- E. Ground manholes and handholes with grounding electrode and No. 1/0 AWG bare copper conductor.

END OF SECTION

## SECTION 260529

## HANGERS AND SUPPORTING DEVICES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Hangers and supporting devices for electrical components

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory

**1.3 MATERIALS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components:
  - 1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel
  - 2. Concrete Inserts: Steel or malleable-iron
  - 3. Clamps for Attachments to Steel Structural Elements
  - 4. Through Bolts: Structural type, hex head, and high strength
  - 5. Toggle Bolts: All-steel springhead type
  - 6. Hanger Rods: Threaded steel

- 1.4** Hangars, supports, and fastening methods used shall be suitable for the weight of the components being supported.

END OF SECTION

## SECTION 260533

## RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for raceways, boxes, wireways, raceway fittings, and technology raceways.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory
- C. Rigid Metal Conduit (RMC) ANSI C80.1.
- D. Intermediate Metal Conduit (IMC) ANSI C 80.6.
- E. Electrical Metallic Tubing (EMT) ANSI C 80.3.
- F. Liquidtight Flexible Metal Conduit (LFMC) UL 360.
- G. Underground Non-Metallic Conduit (RNC) NEMA TC 2, Type EPC-40-PVC.

**1.3 RACEWAY MATERIALS**

- A. Rigid Metal Conduit.
- B. Intermediate Metal Conduit.
- C. Electrical Metallic Tubing (EMT).
- D. Liquidtight Flexible Metal Conduit.
- E. Underground Non-Metallic Conduit.

**1.4 TECHNOLOGY RACEWAY**

- A. From technology outlet box provide two 1 inch conduits and extend the conduits to the associated telecommunications cable tray. Coordinate requirements with the Technology Designer.
- B. Utility Entrances
  - 1. Two 4 inch for telephone service from service pole to main technology equipment room.
  - 2. One 3 inch for cable television service from service pole to main technology equipment room.
  - 3. One 4 inch from service pole to main technology equipment room for wide area network (WAN).

**ELECTRICAL**

## CHAPTER 9: SPECIFICATIONS

**1.5 METAL WIREWAYS**

- A. Sheet metal sized for conductors.
- B. NEMA 250 Type 1.
- C. Screw-on covers.
- D. NEMA 1 general purpose rating at interior of building.
- E. NEMA 3R raintight rating at exterior applications.

**1.6 OUTLET C-D DEVICE BOXES**

- A. Metal boxes NEMA OS 1 compliant.
- B. Cast metal, fully adjustable, rectangular floor box.
- C. Metal pull boxes NEMA OS 1 compliant.
- D. Exposed boxes cast type FS or FSA.
- E. Outlet boxes for technology shall be minimum 3 ½ inch deep.

**1.7 FITTINGS**

- A. NEMA FB 1 listed.
- B. Hazardous (classified) location UL 886 compliant.
- C. EMT Fittings: Metal compression or set screw type.

**1.8 PERFORMANCES**

- A. RNC conduit may be used under building slab on grade for branch feeder and branch circuits. Conduit shall be installed in drainage fill.
- B. RNC conduit may be used for exterior branch circuits. Encase PVC conduit in concrete when under drives and parking areas.
- C. Raceway installation shall comply with NECA 1.

**ALLOWABLE CONDUIT USAGE**

| <b>CIRCUIT IDENTIFICATION</b>                                                                                       | <b>ALLOWABLE TYPE CONDUIT</b> |     |       |      |      |          |          |
|---------------------------------------------------------------------------------------------------------------------|-------------------------------|-----|-------|------|------|----------|----------|
|                                                                                                                     | GRC                           | IMC | EMT** | RNC* | Flex | W.P.Flex | MC Cable |
| Underground secondary service entrance conduit                                                                      | X                             |     |       | X    |      |          |          |
| Feeders to switchboards, panels, motors, transformers, exposed conduit                                              | X                             | X   | X     |      |      |          |          |
| Connections to interior light fixtures & transformers                                                               |                               |     |       |      | X    |          |          |
| Connections to motors & motorized equipment, interior & exterior                                                    |                               |     |       |      |      | X        |          |
| Underground interior feeder conduit                                                                                 | X                             | X   |       | X    |      |          |          |
| Branch circuit wiring from light fixture to light fixture                                                           |                               |     |       |      |      | X        | X        |
| Underground exterior branch conduit                                                                                 | X                             | X   |       | X    |      |          |          |
| Exposed conduits                                                                                                    | X                             | X   | X     |      |      |          |          |
| Conduits in metal stud partitions                                                                                   |                               |     | X     |      |      |          | X        |
| Conduits buried in block walls                                                                                      | X                             | X   | X     |      |      |          |          |
| Conduits above suspended ceilings                                                                                   | X                             | X   | X     |      |      |          |          |
| Misc. low voltage systems (fire alarm) up to 4" C size. (EMT not allowed underground or as otherwise limited above) | X                             | X   | X     |      |      |          |          |
| Interior above ceiling conduits 3 1/2" and larger except as otherwise permitted                                     | X                             | X   | X     |      |      |          |          |

\* With 3 inch concrete envelope under drives and sidewalks.

\*\* Not approved for exterior or exposed below 8 feet AFF.

END OF SECTION

## SECTION 260536

## CABLE TRAY FOR ELECTRICAL SYSTEMS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for cable tray.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. NEMA VE1 Cable Tray Systems.

**1.3 MATERIALS**

- A. Non-corrosive metal constructed center spine or wire baskets.
- B. Rungs at 9 inch on center.
- C. Wire mesh basket.
- D. Cold-rolled steel ventilated tray.
- E. Minimum size shall be 18 inches wide with 6 inch loading depth.
- F. Color coded rung caps.

**1.4 PERFORMANCES**

- A. Provide grounding per NFPA 70.
- B. Install per NEMA VE2.
- C. Install with ½ inch threaded rods.

END OF SECTION

## SECTION 260543

## UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRIC SYSTEMS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for conduits, ducts, handholes, and manholes.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 – National Electric Code.
- B. ANSI C2.

**1.3 NON-METALLIC CONDUITS**

- A. Rigid non-metallic conduit type EPC-40-PVC, NEMA TC2, UL 561.

**1.4 NON-METALLIC DUCTS**

- A. Rigid non-metallic Type EB-20-PVC, ASTM F 512, UL 651A.

**1.5 HANDHOLES**

- A. Reinforced – concrete complying with ASTM C 858.
- B. Cast-iron weatherproof frame.
- C. Cast-iron cover with “electric” or “communication” legend.

**1.6 MANHOLES**

- A. Reinforced concrete complying with ASTM C 858.
- B. Cast-iron weatherproof frame.
- C. Cast-iron cover with “electric” or “communication” legend.

**1.7 PERFORMANCE**

- A. Verify ductbank applications with local utility company.
- B. Verify loading requirements of manholes and handholes depending on locations.

END OF SECTION

## SECTION 260923

## LIGHTING CONTROL DEVICES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for time switches, outdoor photoelectric switches, indoor occupancy sensors, and lighting contactors.

**1.2 QUALITY ASSURANCE**

- A. Underwriter's Laboratory
- B. NFPA 70 – National Electric Code

**1.3 TIME SWITCHES**

- A. Contact configuration: SPST, DPST, SPDT, or DPDT.
- B. Comply with UL 917.
- C. 40-amp contact rating.
- D. Electromechanical or fully electronic.
- E. Skip-a-Day mode.
- F. Astronomic time dial.

**1.4 OUTDOOR PHOTOELECTRIC SWITCH**

- A. Solid State with SPDT or DPST contacts required for application.
- B. 1800 VA tungsten or 1000 VA inductive load.
- C. Comply with UL 773 A.
- D. Illumination monitoring range from 1.5 to 10 foot candles with turn "on" and "off" adjustments.
- E. 15 second minimum time delay.

**1.5 INDOOR OCCUPANCY SENSORS**

- A. Contacts rated to operate connected relay complying with UL 773 A.
- B. Dry contacts rated for 20 amp ballast load ct 120 and 277 voH.
- C. Power supply to server shall be 24-Vdc or 150-mA.

- D. Recessed and concealed time delay and sensitivity adjustments.
- E. LED indicator to show motion is being detected.
- F. Equipped with bypass sensor override switch in case of sensor failure.
- G. Passive infrared type.
- H. Ultrasonic type.
- I. Dual technology combination of infrared and ultrasonic.

**1.6 LIGHTING CONTACTORS**

- A. Electrically or mechanically held type complying with NEMA ICS 2 and UL 508.
- B. Two through 12 poles field convertible contacts.
- C. 20-A tungsten lighting rating or 30-A fluorescent lighting rating.
- D. NEMA 250 type I indoor enclosure.

**1.7 INSTALLATION**

- A. Install and aim sensors to achieve 90 percent of area.
- B. Verify operation of each lighting control device and adjust time delays.

END OF SECTION

## SECTION 261200

## MEDIUM VOLTAGE TRANSFORMERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for pad mounted, liquid filled transformers.

**1.2 QUALITY ASSURANCE**

- A. ANSI C57.12.26
- B. NFPA 70- National Electric Code
- C. IEEE C 57.12
- D. Underwriter's Laboratory
- E. ANSI C57.12.13.
- F. Mineral Oil ASTM D 3487

**1.3 MATERIALS**

- A. The mineral oil filled transformer shall be compartmental type, self-cooled and weather protected.
- B. Tap changing mechanism for accurate voltage adjustment without opening the tank.
- C. Compartments for medium and low voltage separated by a steel barrier.
- D. Surge arresters for each primary phases.
- E. Primary fuses complying with IEEE C 37.47.
- F. Arranged for radial or loop feed as required for application.
- G. Primary and secondary voltage as required.
- H. Mineral Oil tested according to ASTM D 117.
- I. Basic input level shall be standard value for primary equipment voltage per applicable IEEE standard.

END OF SECTION

## SECTION 261300

## MEDIUM VOLTAGE SWITCHGEAR

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for metal enclosed interruptor switchgear.

**1.2 QUALITY ASSURANCE**

- A. NFPA – National Electric Code
- B. Underwriter's Laboratory
- C. IEEE C2
- D. IEEE C37.20.3

**1.3 METAL-ENCLOSED INTERRUPTOR SWITCHGEAR**

- A. Suitable for application in 3-phase, 60 Hz, solidly grounded-neutral system.
- B. System Voltage: KV nominal to match utility voltage available.
- C. 600 amp main continuous bus rating.
- D. Power fuses to comply with NEMA SG-2.
- E. Outdoor enclosure of weatherproof steel construction.
- F. Surge arrestors to comply with NEMA LA1.
- G. Tin-plated copper or aluminum busing.

**1.4 INSTALLATION**

- A. Coordinate location and voltage with local electric utility and authority having jurisdiction.
- B. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

## SECTION 262200

## LOW VOLTAGE TRANSFORMERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for dry type distribution transformers rated 600V or less, buck-boost transformers, and energy efficient dry type transformers.

**1.2 QUALITY ASSURANCE**

- A. Dry Type Distribution Transformers: NEMA TP-1.
- B. High Efficiency Dry Type Distribution Transformers: Department of Energy CSL 3.**
- C. Buck-Boost Transformers NEMA ST 1, UL 506.
- D. Sound levels NEMA ST1-4 and ANSI C89.1.

**1.3 DRY TYPE TRANSFORMERS (NEMA TP-1)**

- A. Transformers shall be dry type gravity ventilated for wall or floor mounting.
- B. KVA rating shall be as denoted on the drawings.
- C. Transformers rated 7.5 kVA through 24 kVA shall have two -5 percent taps, below rated voltage.
- D. Transformers rated 25 kVA and larger shall have two 2-1/2 percent F.C.A.N. taps and four 2-1/2 percent F.C.B.N. taps, unless otherwise noted.
- E. Coils: continuous windings without splices except for taps.
- F. Insulation Class for Transformers 14 kVA and smaller: 180 degrees C, UL component recognized insulation system with a maximum of 115 degrees C rise above 25 degrees C ambient temperature.
- G. Insulation Class for Transformers 15 kVA and Larger: 220 degrees C, UL component recognized insulation system with a maximum of 150 degrees C rise above 40 degrees C ambient temperature.
- H. Cores shall be manufactured with non-ageing silicon steel.
- I. The core and coil assembly shall be mounted on vibration pads and bolted to the enclosure.
- J. Copper or aluminum windings to brace coil layers.

- K. Enclosure shall be heavy gauge steel.
- L. There shall be no metal to metal contact between the core, coil, and the enclosure.

#### **1.4 DRY TYPE TRANSFORMER (CSL 3)**

- A. *Transformer shall be dry type gravity ventilated.*
- B. *KVA rating shall be as shown as drawings.*
- C. *Transformers rated 30 KVA–300 KVA shall have two 2-1/2% F.C.A.N. and two 2-1/2% F.C.B.S. taps. Transformers rated 15 KVA–500 KVA shall have one 5% F.C.A.N. and one 5% F.C.B.N. tap.*
- D. *Copper-wound, 3-phase, common core insulation transformer built to NEMA ST20.*
- E. *200% rated neutral, 60 Hz, 10kV BIL.*
- F. *Insulation class 220 degrees C.*
- G. *Labeled K Rating: K-7.*
- H. *Maximum No loads losses and minimum efficiency shall comply with the following when tested per NEMA TP-2:*

| <b>Losses and Efficiencies</b> |                               |                               |
|--------------------------------|-------------------------------|-------------------------------|
| <b>KVA Size</b>                | <b>Maximum No Load Losses</b> | <b>Efficiency at 1/6 Load</b> |
| <b>15</b>                      | <b>60 watt</b>                | <b>97.3</b>                   |
| <b>30</b>                      | <b>100 watt</b>               | <b>97.6</b>                   |
| <b>45</b>                      | <b>130 watt</b>               | <b>97.9</b>                   |
| <b>75</b>                      | <b>180 watt</b>               | <b>98.2</b>                   |
| <b>112.5</b>                   | <b>265 watt</b>               | <b>98.4</b>                   |
| <b>150</b>                     | <b>340 watt</b>               | <b>98.5</b>                   |
| <b>225</b>                     | <b>460 watt</b>               | <b>98.6</b>                   |
| <b>300</b>                     | <b>565 watt</b>               | <b>98.7</b>                   |
| <b>500</b>                     | <b>860 watt</b>               | <b>98.8</b>                   |
| <b>750</b>                     | <b>1220 watt</b>              | <b>98.9</b>                   |

#### **1.5 BUCK-BOOST TRANSFORMER**

- A. Self-cooled dry type: continuous duty rating.
- B. Ventilated enclosure NEMA 250 Type 2.

END OF SECTION

## SECTION 262413

## SWITCHBOARDS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for switchboards and fusible bolted-pressure contact switch.

**1.2 QUALITY ASSURANCE**

- A. Switchboards 600 v or less: NEMA PB-2.
- B. NFPA 70 - National electrical Code
- C. Underwriter's Laboratory

**1.3 SWITCHBOARDS**

- A. Nominal system voltage, main bus continuous with uniform capacity for entire length of bus.
- B. Short circuit rating of 65K, 100K, or 200K to meet or exceed application.
- C. Low voltage circuit breakers to be continuous current, interrupting, and short-time current ratings for each circuit breaker suitable for use. Voltage and frequency ratings same as switchboard.
- D. Fusible switch branch units.
- E. Three-phase, four-wire configuration.
- F. Front connected, front accessible with fixed main device, panel-mounted branches and sections front and rear aligned.
- G. Tin plated copper or aluminum neutral and phase bussing.
- H. Minimum .25 by 2 inch full length ground buss.
- I. One hundred percent rated full length neutral buss.
- J. Utility Metering Compartment: Acceptable to local utility company.
- K. Integral fusible or circuit breaker type main switch.
- L. NEMA 1 enclosure.

**1.4 FUSIBLE BOLTED-PRESSURE CONTACT SWITCH**

- A. Labeled for use as service equipment.
- B. Manual handle operation for opening and closing.
- C. Contact interruption capability: twelve times switch rating.
- D. Ground fault relay: comply with UL 1053.
- E. Fused switch: NEMA KS 1 Type HD with clips to accommodate specified fuses.

**1.5 INSTALLATION**

- A. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

## SECTION 262416

## PANELBOARDS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for lighting and appliance branch circuit panelboards and distribution panelboards.

**1.2 QUALITY ASSURANCE**

- A. Lighting and appliance branch circuit panelboards – NEMA PB 1.
- B. Distribution Panelboards: NEMA PB.1.
- C. NFPA 70 - National Electrical Code
- D. Underwriter's Laboratory

**1.3 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS / DISTRIBUTION PANELBOARDS**

- A. Tin plated copper or aluminum phase and neutral bussing.
- B. Integral ground bus.
- C. Lighting and appliance branch circuit panelboards to be provided with circuit breaker type overcurrent protective devices with short circuit current available at terminals.
- D. Distribution panelboards to be provided with fusible or circuit breaker type overcurrent protective devices with short circuit current rating available at terminals.
- E. Mechanical type main and neutral lugs.
- F. Feed-through lugs suitable for use with conductor material. Locate at opposite end of incoming lugs on main device.
- G. Bus bars in lighting and appliance branch circuit panelboards and distribution panel assemblies shall be adequately braced to withstand the maximum short circuit current at the point of application.

**1.4 INSTALLATION**

- A. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

## SECTION 262419

## MOTOR CONTROL CENTERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for motor control centers rated 600 V or less.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory

**1.3 MOTOR CONTROL CENTER**

- A. NEMA 250 Type 1 indoor enclosure.
- B. Modular construction with individual doors.
- C. Compartments constructed to allow for removal of units without opening adjacent doors.
- D. Copper or tin plated aluminum bus.
- E. Full size neutral bus.
- F. Non-insulated equipment ground bus.
- G. Phase, neutral, and ground buses to have same capacity the entire length.
- H. Unit to have short circuit withstand rating shall as rating of section.
- I. NEMA size 3 and smaller controllers shall be constructed with drawout mountings.
- J. Equipment unit with controller to meet application as specified in specification section 262913.

**1.4 INSTALLATION**

- A. Provide arc flash hazard label on equipment per the National Electrical Code.

END OF SECTION

## SECTION 262726

## WIRING DEVICES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES QUALITATIVE REQUIREMENTS FOR:**

- A. High Capacity Floor Boxes
- B. Duplex Receptacles and Integral GFCI Receptacles
- C. Tamper-Resistant Duplex Receptacles
- D. Wall Switches
- E. Wall Switch Occupancy Sensors
- F. Dimmer Switches
- G. Poke Through Assemblies
- H. Device Coverplates

**1.2 QUALITY ASSURANCE**

- A. High Capacity Floor Boxes: Underwriter's Laboratory Listed.
- B. Duplex Receptacles and Integral GFCI Receptacles: Underwriter's Laboratory 498, NEMA WD 1.
- C. Tamper-Resistant Duplex Receptacles: NEMA WD 1, UL 498..
- D. Wall Switches: NEMA WD 1, UL 20.
- E. Wall Switch Occupancy Sensors: Underwriter's Laboratory.
- F. Dimmer Switches: UL 1472.
- G. Poke Through Assemblies: Underwriter's Laboratory.

**1.3 HIGH CAPACITY FLOOR BOXES**

- A. Stamped steel 8 gang 2 compartments units.
- B. Fully adjustable.
- C. Rectangular steel with carpet flange and carpet insert.
- D. Blank aluminum plate where floor finish is not carpet.

**1.4 DUPLEX RECEPTACLES AND INTEGRAL GFCI RECEPTACLES**

- A. 1-pole, 3 wire, grounding.
- B. 20 amp, 125 volt rated.
- C. Heavy Duty Specification grade, Duplex, back and side wired.
- D. Ground fault protection where required shall be built into receptacle. Trippins values shall conform: UL 1436 and UL 943.

**1.5 TAMPER-RESISTANT DUPLEX RECEPTACLES**

- A. 1-pole, 3 wire, grounding.
- B. 20 amp, 125 volt rated.
- C. Hospital grade.

**1.6 WALL SWITCHES**

- A. 20 amp, 120/277 volt rated with ground screw.
- B. Specification grade.

**1.7 WALL SWITCH OCCUPANY SENSORS**

- A. Adaptive technology with adjustable time delay.
- B. 180 degree field of view.
- C. 1800 watts at 120-volt.
- D. 4155 watts at 277-volt.
- E. Passive infrared.
- F. Push “on”-“off” occupant switch

**1.8 DIMMER SWITCHES**

- A. Architectural grade, rotary knob series.
- B. 120 volt, wattage as required by fixture wattage.

**1.9 POKE THROUGH ASSEMBLIES**

- A. Factory fabricated.
- B. Fire rated or non-fire rated assemblies.
- C. Flush with floor type.

**ELECTRICAL**CHAPTER 9: SPECIFICATIONS

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**1.10** DEVICE COVERPLATES

- A. Stainless steel jumbo size with U.S. 32D finish.
- B. Configuration of plates to match devices.
- C. Weatherproof type stainless steel with U.S. 32D finish on exterior mounted duplex receptacles.

**1.11** PERFORMANCES

- A. Provide receptacles on roof as required by National Electric Code.
- B. Toggle type in classrooms and key type in public areas.
- C. Provide tamper-resistant receptacles in pre-kindergarten and kindergarten classrooms.

END OF SECTION

## SECTION 262813

## FUSES AND FUSE HOLDERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for cartridge fuses rated 600 V and less and spare fuse cabinets.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory
- C. Cartridge Fuses: NEMA FU 1

**1.3 CARTRIDGE FUSES**

- A. Fuses shall be nonrenewable cartridge type, noninterchangeable type.
- B. Service entrance fuses shall be Class R or Class L rejection type, time delay, high interrupting, current limiting, dual element.
- C. Feeder fuses shall be Class L or J time delay.
- D. Motor branch circuit shall be NEMA Class "RK1" time delay.
- E. Other branch circuits Class J time delay.

**1.4 SPARE FUSE CABINET**

- A. Wall mounted steel constructed unit with hinged door and cam lock and pull.
- B. Three spare fuses for each type and size.

END OF SECTION

## SECTION 262816

## ENCLOSED SWITCHES AND CIRCUIT BREAKERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for molded case circuit breakers, fusible and non-fusible switches, bolted-pressure contact switches, enclosures.

**1.2 QUALITY ASSURANCE**

- A. Molded Case Circuit Breakers: UL 489, NEMA AB 1.
- B. Fusible and Non-Fusible Switches, NEMA KS 1.
- C. Bolted-Pressure Contact Switches UL 977.
- D. Enclosures, NEMA AB 1 and NEMA KS 1.
- E. NFPA 70 - National Electrical Code

**1.3 MOLDED CASE CIRCUIT BREAKER**

- A. Interrupting capacity to meet available fault current at point of application.
- B. Magnetic trip elements.
- C. Lugs: Suitable for number, size, trip ratings, and conductor material.
- D. GFCI Circuit Breakers: Single and two pole with 5mA trip sensitivity.
- E. Type SWD for switching fluorescent lights.
- F. Type HACR for heating, air conditioning, and refrigerant equipment.
- G. Shunt trip: 120 v coil energized from separate circuit.

**1.4 FUSIBLE AND NON-FUSIBLE SWITCHES**

- A. Fusible Switches, 1200 amp and Smaller: NEMA KS 1, Type HD (heavy duty) with lockable handle.
- B. Non-fusible Switches: NEMA KS 1, Type HD (heavy duty) with lockable handle.

**1.5 BOLTED-PRESSURE CONTACT SWITCHES**

- A. Labeled for use as service equipment.
- B. Manual handle operation for opening and closing.
- C. Contact interruptions capability: twelve times switch rating.
- D. Ground fault relay comply with UL 1053.

**1.6 ENCLOSURES**

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions.
  - 1. Outdoor locations: NEMA 250 Type 3R
  - 2. Kitchen areas: NEMA 250 Type 4X, stainless steel.

**1.7 INSTALLATION**

- A. Series rated circuit breaker not acceptable.

END OF SECTION

## SECTION 262913

## ENCLOSED CONTROLLERS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for across-the-line, manual, and magnetic controllers; and reduced-voltage controllers.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory

**1.3 ACROSS-THE-LINE MANUAL CONTROLLERS**

- A. Manual controller with quick make or quick break toggle switch or push button.
- B. General purpose Class A type.
- C. Equipped with heaters and sensors in each phase matched to nameplate full-load current of motor.

**1.4 ACROSS-THE-LINE MAGNETIC CONTROLLERS**

- A. Nonreversing across the line full voltage type.
- B. NEMA ICS 2 Class A full voltage.
- C. 120 volt control circuit obtained from integral control transformer.
- D. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.
- E. Equipped with under voltage and phase-failure relays.

**1.5 COMBINATION ACROSS-THE-LINE CONTROLLER / DISCONNECT**

- A. Nonreversing across-the-line full voltage type.
- B. NEMA ICS 2 Class A full voltage.
- C. 120 volt control circuit obtained from integral control transformer.
- D. Heavy duty, fusible switch with rejection type fuses. NEMA KS 1.
- E. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.
- F. Equipped with under voltage and phase-failure relays.

**1.6** REDUCED-VOLTAGE ENCLOSED CONTROLLERS

- A. Solid state controller suitable for use with polyphase induction motor.
- B. Adjustable acceleration rate and adjustable starting torque control.
- C. Surge suppressor in solid-state power circuit.
- D. LED indicators showing motor and control status.
- E. Heavy duty type, hand/off/auto selector switch with pilot light and test push button.
- F. Equipped with under voltage and phase-failure relays.

**1.7** ENCLOSURES

- A. NEMA 250 Type 1 for indoor applications.
- B. NEMA 250 Type 3R for outdoor applications.
- C. NEMA 250 Type 1 for kitchen areas.

END OF SECTION

## SECTION 263213

## PACKAGE ENGINE GENERATORS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for packaged engine generator system

**1.2 QUALITY ASSURANCE**

- A. Compliance with NFPA 110
- B. Factory testing
- C. Field testing
- D. NFPA 70 - National Electrical Code
- E. UL 2200 – Stationary generators  
UL 142 – Subbase fuel storage tanks
- F. Installation of stationary generator - NFPA 37

**1.3 PACKAGED GENERATOR SYSTEM CHARACTERISTICS**

- A. Type: Standby automatically started engine coupled to an AC generator unit.
- B. Ratings: Voltage, frequency, and power output ratings suitable for use.
- C. Maximum transfer time to assume full load: Per NEC.
- D. Fuel type: Diesel or natural gas dependent upon application and authorities having jurisdiction.
- E. Fuel supply: Minimum per NEC.

**1.4 PACKAGED GENERATOR SYSTEM COMPONENTS**

- A. Engine
- B. Cooling system: liquid-cooled unit mounted radiator.
- C. Subbase diesel double wall fuel storage tank with leak monitor or natural gas supply.
- D. For outdoor generator set provide weatherproof steel housing, louvers, and dampers.
- E. Provide vibration isolators.
- F. Critical type muffler/silencer.

END OF SECTION

## SECTION 263600

## TRANSFER SWITCHES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for automatic transfer switch for packaged engine generators.

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 – National Electric Code.
- B. NFPA 110 – Emergency and Standby Power Systems Level 1
- C. NEMA ICS 1

**1.3 AUTOMATIC TRANSFER SWITCH**

- A. Fault current and withstand ratings adequate for available fault currents.
- B. Solid state controls.
- C. Double-throw type, incapable of pauses or intermediate positions stops.
- D. 3 pole (phase) switching type.

END OF SECTION

## SECTION 264313

## TRANSIENT VOLTAGE SUPPRESSION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Transient Voltage Surge Suppressors

**1.2 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code. Including article 285, NEC 2002.
- B. Underwriter's Laboratory
- C. Transient Voltage Surge Suppressors: UL 1449 2<sup>nd</sup> Edition and UL 1283, ANSI/IEEE C62.41 Category A, B, C, and C62.45 testing.
- D. NEMA LS-1

**1.3 TRANSIENT VOLTAGE SURGE SUPPRESSORS**

- A. Individually fused Metal oxide varistors (MOVs) or each mode of protection is to be protected with surge rated fuses and thermal disconnects.
- B. Line protection
  - 1. Line to line
  - 2. Line to neutral
  - 3. Line to ground
  - 4. Neutral to ground
- C. UL 1449 Edition suppressed voltage rating:

| Voltage Configuration   | L-N  | L-G  | N-G  | L-L   |
|-------------------------|------|------|------|-------|
| 120/208 Three Phase Wye | 400v | 400v | 400v | 800v  |
| 277/480 Three Phase Wye | 800v | 800v | 800v | 1200v |

- D. One percent variation in metal oxide varistors.
- E. LED indicator light.
- F. Rated as a UL 1283 electromagnetic interference filter.
- G. NEMA 1 rated enclosure.

**1.4 SERVICE ENTRANCE**

- A. Integral or external mounting.
- B. Minimum single surge current rating of 120k per node.

**1.5 BRANCH PANELBOARD**

- A. Integral or external mounting.
- B. Minimum single surge current rating of 80k per node.

**1.6 INSTALLATION**

- A. Install transient voltage surge suppressors on the load side of the main disconnect at the main switchboard and each branch circuit panelboard serving duplex receptacles. Utilize a spare 30 to 60a two or three pole breaker for TVSS disconnect.

END OF SECTION

## SECTION 265100

## INTERIOR LIGHTING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for interior lighting fixtures, lamps and ballast, emergency lighting units, exit sign, and lighting fixture support.

**1.2 QUALITY ASSURANCE**

- A. Underwriter's Laboratory
- B. NFPA 70 - National Electrical Code
- C. Fluorescent fixtures UL 1598.
- D. High intensity discharge (HID) fixtures UL 1598.
- E. Incandescent fixtures UL 1598.
- F. Explosionproof fixtures UL 844.
- G. Track lighting UL 1574.
- H. Exit signs UL 924.
- I. Emergency lighting UL 924.
- J. High intensity discharge (HID) ballast UL 1029.

**1.3 FLUORESCENT INTERIOR LIGHTING FIXTURES**

- A. Fluorescent Troffers
  1. Static Recessed 2 by 4 foot, 2 by 2 foot, or 1 by 4 foot
  2. .125 inch Prismatic virgin acrylic A12 lens
  3. Flat steel door
  4. Number of lamps as required
  5. Steel construction
- B. Fluorescent Troffers – Specular Reflector
  1. Static recessed 2 foot by 4 foot, 2 foot by 2 foot, or 1 foot by 4 foot
  2. 0.125 inch prismatic virgin acrylic A12 lens
  3. Flat steel door
  4. 0.020 inch aluminum reflector, 92% specular, 3% diffuse
  5. Number of lamps as required
  6. Steel construction

**ELECTRICAL****CHAPTER 9: SPECIFICATIONS**

- C. Fluorescent Wraparound Fixtures
  - 1. One piece acrylic prismatic
  - 2. Number of lamps as required
  - 3. Four foot length
  - 4. Steel construction
  - 5. Surface or suspended mounting
  
- D. Fluorescent Strip Fixtures
  - 1. No lenses
  - 2. Four foot length
  - 3. Asymmetric or Symmetric reflectors as required.
  - 4. Steel construction
  
- E. Fluorescent Recessed Cans
  - 1. Minimum 6 inch diameter
  - 2. Clear alzak reflector
  - 3. Compact fluorescent
  - 4. Open lens unless required.
  
- F. Fluorescent Parabolic type
  - 1. Static Recessed 2 by 4 foot, 2 by 2 foot, or 1 by 4 foot
  - 2. Lens appropriate for insuring 80 percent visual comfort probability
  - 3. Number of lamps as required
  - 4. Steel construction
  
- G. Fluorescent Recessed Indirect/Direct
  - 1. Static recessed by 2 by 4 foot, 2 by 2 foot
  - 2. Perforated metal round shield
  - 3. Number of lamps as required
  - 4. Matte white aluminum reflector
  - 5. Steel housing construction
  
- H. Fluorescent Pendant High-Bays
  - 1. 15 inch minimum round
  - 2. Steel stem or aircraft cable support
  - 3. Open or enclosed bottom
  - 4. UV stabilized prismatic acrylic reflector
  - 5. Die-cast aluminum ballast housing
  - 6. Compact fluorescent lamps
  - 7. Number of lamps as required
  - 8. Safety chain
  - 9. Wireguard
  
- I. Interior Track Lighting
  - 1. Track
    - a. Surface or recessed track
    - b. Two circuit minimum
    - c. Standard lengths with all fittings
  - 2. Fixtures
    - a. Shape per Design Professional
    - b. Incandescent 120 volt type
    - c. Color selection by design professional

- J. High output Fluorescent High-Bay Industrial Fixtures
  - 1. Sizes
    - a. 16" x 4'
    - b. 2' x 4'
    - c. 16" x 8'
    - d. 2' x 8'
  - 2. Steel Construction
  - 3. No lens
  - 4. High output T5HO lamps
  - 5. 95% reflectance segmented specular aluminum reflector
  - 6. Full wireguard
- K. Labels and Miscellaneous
  - 1. Wet and damp location labels as required.
  - 2. Provide wireguards on fixtures, exit signs, and emergency lighting in gymnasiums.
- L. Installation
  - 1. Chain hang troffer type fixtures from structural steel independent of grid or screw attach fixtures to grid and grid support at each corner of grid.

**1.4 HIGH INTENSITY DISCHARGE INTERIOR LIGHTING**

- A. Pendant type
  - 1. 12 inch minimum round
  - 2. Steel stem or aircraft cable support
  - 3. Open or enclosed bottoms
  - 4. Clear alzak reflector
  - 5. Steel construction
  - 6. Porcelain socket
  - 7. Color selection by design professional
  - 8. 250 watt quartz restrike where appropriate
- B. Industrial Type (gymnasium)
  - 1. Totally enclosed fixture
  - 2. Glass reflector
  - 3. Hook and loop hanging (fixture swing ability)
  - 4. Porcelain sockets
  - 5. 250 watt quartz restrike
  - 6. Safety chain
  - 7. Wireguards
- C. Recessed Can Type
  - 1. 8 inch round minimum
  - 2. Open or glass lens bottom
  - 3. Clear alzak reflector
  - 4. Porcelain sockets
  - 5. 250 watt quartz restrike
- D. Labels and Miscellaneous
  - 1. Wet and damp location labels as required.
  - 2. Provide wireguards on fixtures, exit signs, and emergency lighting in gymnasiums.

**ELECTRICAL**

## CHAPTER 9: SPECIFICATIONS

**1.5 INCANDESCENT INTERIOR LIGHTING**

- A. Types
  - 1. Recessed type with open or fresnal type lens
  - 2. Round or square housing
  - 3. Wireguard on lampholder type
  - 4. Clear alzak reflector on open type
  - 5. Porcelain socket
  - 6. Interior mounted only

**1.6 EXPLOSIONPROOF FIXTURES**

- A. Types
  - 1. Comply with hazardous classification for its location per the National Electrical Code
  - 2. Lamp type suitable for condition.

**1.7 EMERGENCY LIGHTING UNITS**

- A. Type
  - 1. Provide from fixtures above connected to emergency generator.

**1.8 EXIT SIGNS**

- A. Type
  - 1. Cast aluminum construction
  - 2. Color by design professional
  - 3. LED lamp type
  - 4. Wireguards as required
  - 5. Red lettering
  - 6. Directional arrows

**1.9 LINEAR FLUORESCENT BALLAST**

- A. Electronic type with maximum 10 percent total harmonic distortion.
- B. Rapid start, instant start, or programmed start type.
- C. Suitable for T8, T5, or T5HO lamps.
- D. 95 percent minimum power factor.
- E. Class A sound rating.
- F. 85 percent or higher ballast factor.

**1.10 DIMMABLE LINEAR FLUORESCENT BALLAST**

- A. Electronic type.
- B. 100 percent to 5 percent dimming range.

**1.11 COMPACT FLUORESCENT BALLAST**

- A. Electronic type with maximum 20 percent total harmonic distortion.
- B. Programmed rapid start.
- C. 95 percent minimum power factor.
- D. 95 percent or higher ballast factor.
- E. Class A sound rating.

**1.12 DIMMABLE COMPACT FLUORESCENT BALLAST**

- A. Electronic type.
- B. 100 percent to 5 percent dimming range.

**1.13 DIGITAL ELECTRONIC DIMMING BALLAST**

- A. Provides a continuous 2-wire dimming signal.
- B. Internal circuitry to limit inrush current.
- C. Operating voltages of 120/240/277 volts at 50 or 60 Hz.
- D. Continuous flicker free dimming range from 100% to 10%.
- E. Capable of connecting one or multiple sensors.
- F. Capable of generating digital communication commands to digital bus.
- G. Capable of monitoring lamp and ballast conditions.
- H. Total harmonic distortion (THD) less than 20%.
- I. Power factor greater than 95%.
- J. Ballast factor greater than 85% for T8 lamps and equal to 1.0 for T5 and T5HO lamps.

**1.14 HIGH INTENSITY DISCHARGE BALLAST**

- A. Constant wattage autotransformer or high power factor regulator type.
- B. 104 degree Fahrenheit normal operating temperature.
- C. Cold weather type where required.
- D. Epoxy encapsulated for noise suppression on interior fixtures.
- E. Single lamp operation.

**1.15 HIGH INTENSITY DISCHARGE PULSE START BALLAST**

- A. Super constant wattage autotransformer.
- B. Dry-film capacitor.
- C. 60 hertz operation.
- D. Ignitor.
- E. 120-volt, 208-volt, and 277-volt operations.

**1.16 FLUORESCENT LAMPS**

- A. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.

**ELECTRICAL****CHAPTER 9: SPECIFICATIONS**

- B. T8 rapid-start low-mercury lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- C. T5 rapid-start low-mercury lamps, rated 28 W maximum, nominal length of 45.2 inches, 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- D. T5HO rapid-start high output low-mercury lamps, rated 54 W maximum, nominal length of 45.2 inches, 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 3500K, and average rated life 20,000 hours, unless otherwise indicated.
- E. Compact Fluorescent Lamps: 4-pin, low mercury, CRI 80 (minimum), color temperature 3500K, average rated life of 10,000 hours at 3 hours operation per start, and suitable for use with dimming ballasts, unless otherwise indicated.
  - 1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
  - 2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
  - 3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
  - 4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
  - 5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
  - 6. 55 W: T4, triple tube, rated 4300 initial lumens (minimum).

**1.17 HID LAMPS**

- A. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.

**1.18 LIGHT FIXTURES SUPPORT COMPONENTS**

- A. 1/4 inch minimum diameter thread steel rod hangers
- B. ½ inch steel tubing with swivel ball fittings and ceiling canopy.

END OF SECTION

## SECTION 265561

## THEATRICAL DIMMING SYSTEM

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Stage dimming and control.
- B. Stage lighting.

**1.2 QUALITY ASSURANCE**

- A. NFPA - National Electrical Code.
- B. Underwriter's Laboratory.
- C. Light Fixtures UL 1573.
- D. Main Control Console UL 508.

**1.3 MAIN CONTROL CONSOLE**

- A. Minimum 48 channel single scene microprocessor based.
- B. Non-volatile memory disk backup.
- C. Minimum 12 scene masters.
- D. Console receptacles located at stage managers panel, at rear of cafetorium and in booth (if one is provided).
- E. Minimum 10 foot cables for power and signal.
- F. Tabletop unit.

**1.4 DIMMER RACK**

- A. Dual 2400 watt dimmers.
- B. Free standing rack mounted with cooling fan(s).
- C. Primary circuit breaker with fault current rating for point of service.
- D. Capable of data transmission with USITT DMX 512.

**ELECTRICAL**

## CHAPTER 9: SPECIFICATIONS

**1.5 LIGHTING UNITS****A. Front Lighting (cafetorium ceiling)**

1. Connector Strips: Approximately 4 inch by 4 inch with flush receptacles, hangers, interior terminal strip.

| For School | Overall Dimmed Length Circuits | Number of Receptacles | Minimum Quantity |
|------------|--------------------------------|-----------------------|------------------|
| Middle 10' | Six each                       | Six each              | Two              |
| High 10'   | Six each                       | Six each              | Three            |

Locate at minimum the distance equal to proscenium height from the stage out onto the ceiling, centered on proscenium edges plus at proscenium center line for high school.

2. Lighting Instruments: Ellipsoidal spotlights, 6 inch by 20 degrees, 575 watt lamp, 36 inch leads, connector, color frame, safety cable, "C" Clamp.

| For School | Minimum Quantity | Initial Location           |
|------------|------------------|----------------------------|
| Middle     | Six              | Three each connector strip |
| High       | Nine             | Three each connector strip |

**E. Overstage Lighting (Electrics):** Should appear approximately 3 feet back, then at intervals of approximately eight feet.

1. Connector strips approximately 4 inch by 4 inch plus junction box, with receptacles on 18 inch pigtailed, double pipe hangers. Provide additional (\*) three receptacles at ends and center on a circuit switched at stage managers panel for worklights.

| For School | Minimum overall Length | Dimmed Circuits | Number of Receptacles | Minimum Quantity |
|------------|------------------------|-----------------|-----------------------|------------------|
| Middle     | 3/4 proscenium width   | Twelve          | Fifteen*              | Two              |
| High       | 3/4 proscenium width   | Eighteen        | Twenty-one*           | Two              |

2. Additional Overstage: Third Electric (fourth electric if stage is more than 25 foot deep). Four, 4 circuit/receptacle plug boxes on flexible cables capable of reaching a point 5 feet above the stage floor.

3. Spotlights: Fresnel Spotlights: 6 inches, 750 watt lamp, 36 inch leads, connector, color frame, safety cable, "C" Clamp.

| For School | Minimum Quantity | Initial Location          |
|------------|------------------|---------------------------|
| Middle     | Twelve           | Six each connector strip  |
| High       | Eighteen         | Nine each connector strip |

4. Striplights: 7'-6" x 4 circuit, with red, green, blue, and clear roundels, 200 watt lamps, 36 inch leads at each end with appropriate connectors.

| For School | Minimum Quantity | Initial Location           |
|------------|------------------|----------------------------|
| Middle     | Six              | Three each connector strip |
| High       | Six              | Three each connector strip |

5. Stage Worklights: Scoops: 10 inches, 150 watt lamp 36 inch leads, connector, color frame, safety cable, "C" Clamp.

| For School | Minimum Quantity | Initial Location           |
|------------|------------------|----------------------------|
| Middle     | Six              | Three each connector strip |
| High       | Six              | Three each connector strip |

- C. Backstage Worklights:
1. 200 watt incandescent in industrial reflectors to limit spill onto the stage.
  2. Minimum two each side of either type stage.

## 1.6 MISCELLANEOUS

- A. Provide stage managers panel to allow control of area lighting functions.
- B. Provide a minimum of two floor pockets, one each side of the stage, each with three dimmed circuits/receptacles and one constant duplex receptacle.

## 1.7 INSTALLATION

- A. Neutrals from system feed to be 130 percent of hot line size.
- B. All branch circuits are to be two wire no common neutrals.
- C. All strips and floor pockets shall be grounded per NEC.

END OF SECTION

## SECTION 265600

## EXTERIOR LIGHTING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for exterior luminaires with lamps and ballast; and poles.

**1.2 QUALITY ASSURANCE**

- A. Underwriter's Laboratory
- B. NFPA 70 - National Electrical Code
- C. Luminaires UL 1598.
- D. High intensity discharge (HID) ballast UL 1029.

**1.3 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION**

- A. Dead load weight of luminaire, supports, lowering devices as stated in AASHTO LTS-4.
- B. Fixtures and poles shall be designed for wind load pressures conforming to the Ohio Basic Code.

**1.4 LUMINAIRES**

- A. Listed and labeled for installation in wet location.
- B. Metal parts free of burrs, sharp corners, and edges.
- C. Constructed of corrosion-resistant aluminum.
- D. Rigidly formed housings that provide weathertight and lighttight enclosures.
- E. Stainless steel exposed hardware.
- F. Doors and frames shall prevent accidental falling during relamping or ballast replacement.
- G. Heat and aging-resistant resilient gasket to seal lenses to luminaire door.

**1.5 FLUORESCENT BALLAST AND LAMPS**

- A. Low temperature ballast for reliable starting and operation of lamps to minus 20 degrees Fahrenheit.
- B. Ballast to have less than 10 percent total harmonic distortion.
- C. Electromagnetic ballast to be high power factor Class P.

- D. Fluorescent lamps shall be low-mercury type and reliable starting and operation to minus 20 degrees Fahrenheit.

**1.6 BALLAST FOR HID LAMPS**

- A. Constant wattage autotransformer or high power factor type.
- B. Minimum starting temperature of minus 22 degrees Fahrenheit.
- C. High pressure sodium ballast shall be electro magnetic type with solid state igniter/starter and minimum starting temperature of minus 40 degrees Fahrenheit.

**1.7 HID LAMPS**

- A. High-Pressure Sodium Lamps: ANSI C78.42, CRI 21 (minimum), color temperature 1900K, and average rated life of 24,000 hours, minimum.
- B. Metal-Halide Lamps: ANSI C78.1372, with a minimum CRI 65, and color temperature 4000 K.
- C. Pulse-Start Metal-Halide Lamps: Minimum CRI 65, and color temperature 4000 K.
- D. Ceramic, Pulse-Start, Metal-Halide Lamps: Minimum CRI 80, and color temperature 4000 K.

**1.8 POLES**

- A. Adequate strength to withstand wind gust factor of 1.3.
- B. Steel poles complying with ASTM A 500 Grade B carbon steel with minimum yield of 46,000 psig.
- C. One piece construction.
- D. Weld ½ inch threaded lug for grounding conductor connections.
- E. Metal base covers.

END OF SECTION

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**27**

**DIVISION**

**COMMUNICATIONS**

## TABLE OF CONTENTS

DIVISION 27: COMMUNICATIONS

|               |                                                                                   |
|---------------|-----------------------------------------------------------------------------------|
| <b>270526</b> | <b><i>Grounding and Bonding for Communications Systems</i></b>                    |
| <b>271100</b> | <b><i>Communications Equipment Room Fittings</i></b>                              |
| <b>271313</b> | <b><i>Communications Copper Backbone Cabling</i></b>                              |
| <b>271323</b> | <b><i>Communications Optical Fiber Backbone Cabling</i></b>                       |
| <b>271333</b> | <b><i>Communications Coaxial Backbone Cabling</i></b>                             |
| <b>271513</b> | <b><i>Communications Copper Horizontal Cabling</i></b>                            |
| 271533        | Coaxial Communications Horizontal Cabling                                         |
| <b>271543</b> | <b><i>Audio-Video Communications Horizontal Cabling</i></b>                       |
| <b>272100</b> | <b><i>Data Communications Network Equipment</i></b>                               |
| <b>272133</b> | <b><i>Data Communications Wireless Access Points</i></b>                          |
| <b>273113</b> | <b><i>IP-Enabled PABX System</i></b>                                              |
| <b>273123</b> | <b><i>IP Only PABX System</i></b>                                                 |
| <b>274117</b> | <b><i>Broadband Video RF Distribution System</i></b>                              |
| <b>274119</b> | <b><i>Video Display Equipment</i></b>                                             |
| <b>274120</b> | <b><i>Interactive Audio-Video Equipment</i></b>                                   |
| <b>274125</b> | <b><i>Digital On-Demand Instruction Delivery System</i></b>                       |
| <b>275121</b> | <b><i>Student Dining / Auditoria Sound Reinforcement System – High School</i></b> |
| <b>275122</b> | <b><i>Student Dining / Cafeteria Sound Reinforcement System</i></b>               |
| <b>275123</b> | <b><i>Central Sound and Paging System</i></b>                                     |
| <b>275124</b> | <b><i>Gymnasium Sound Reinforcement System</i></b>                                |
| <b>275125</b> | <b><i>Music Room Audio Program Playback System - Middle School</i></b>            |
| <b>275126</b> | <b><i>Music Room Audio Recording/Playback System - High School</i></b>            |
| <b>275127</b> | <b><i>Classroom Sound Reinforcement System</i></b>                                |
| <b>275313</b> | <b><i>Clock Systems</i></b>                                                       |

## SECTION 270526

## GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

GENERAL GUIDELINES

## 1.1 SUMMARY

- A. This Section defines the general design requirements for a uniform Telecommunications Grounding and Bonding infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes the Telecommunications Bonding System
  - 2. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Telecommunications Main Grounding Busbar (TMGB)
- B. Telecommunications Grounding Busbar (TGB)
- C. Telecommunications Bonding Backbone (TBB) – **optional**.

## 1.3 QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment Installation Practices shall comply with the latest ANSI/TIA/EIA-758 Customer Owned Outside Plant Standard.
- E. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- F. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM).

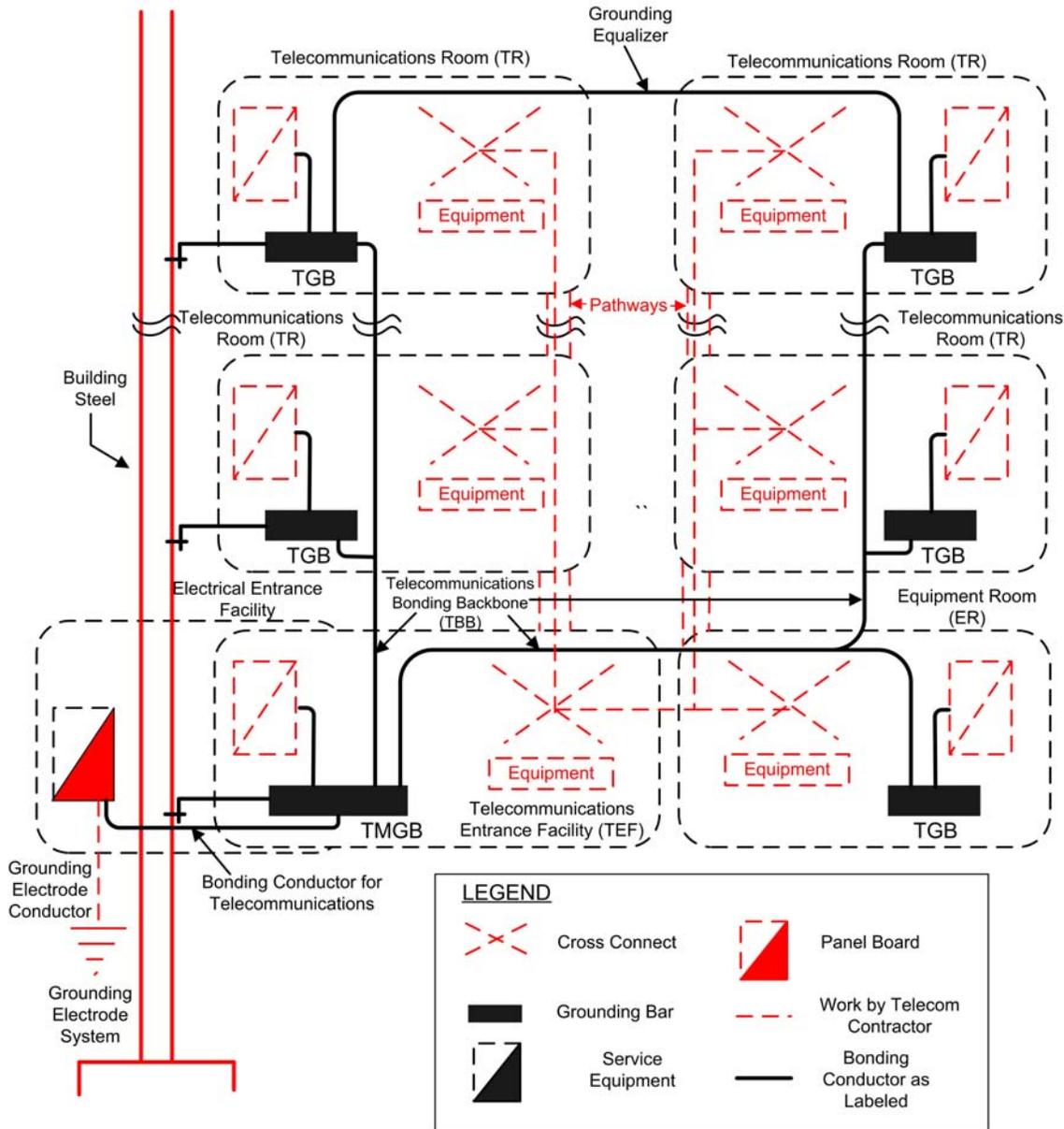


Figure 1 – Telecommunications Bonding System

#### 1.4 TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- A. Provide Telecommunications Main Grounding Busbar (TMGB) in Main Equipment Room (ER) and Telecommunications Room (TR).
- B. All TMGB Connections to be made with double-bolted, Compression style, Grounding Lugs.

## 1.5 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- A. Provide Telecommunications Grounding Busbar (TGB) in all Telecommunications Rooms (TRs) and AV Equipment Cabinets.
- B. All TGB Connections to be made with double-bolted, Compression style, Grounding Lugs.

1.6 TELECOMMUNICATIONS BONDING BACKBONE (TBB) - **OPTIONAL**

- A. Provide Telecommunications Bonding Backbone (TBB) between all TGBs and the TMGB.
- B. All TBB Connections to be made with double-bolted, Compression style, Grounding Lugs.
- C. The TBB shall be a minimum of No. 2 AWG insulated copper bonding conductor.

Sizing of TBB

| TBB Length in Feet | TBB Size (AWG) |
|--------------------|----------------|
| 0 -- 14            | 6              |
| 14 -- 20           | 4              |
| 21 -- 26           | 3              |
| 27 -- 33           | 2              |
| 34 -- 41           | 1              |
| 42 -- 52           | 1/0            |
| 53 -- 66           | 2/0            |
| 66 +               | 3/0            |

Figure 2 – Sizing of TBB

## 1.7 GROUNDING/BONDING CONDUCTORS

- A. All Grounding and bonding conductors shall be copper and may be insulated. When Conductors are insulated, they shall be listed for the application. The minimum bonding conductor shall be No. 6 AWG.

## 1.8 INSTALLATION

- A. As a minimum, Bond TMGB to following:
  1. Building Steel, (minimum No. 2 AWG insulated copper bonding conductor).  
CAD Weld Bonding Conductors to Building Steel.
  2. Main Electrical Service Grounding Electrode System (minimum No. 2 AWG insulated copper bonding conductor).
  3. Local Service Panel Ground (minimum No. 6 AWG insulated copper bonding conductor).
  4. Telecommunications Bonding Backbone (TBB) that connects TMGB to other TGBs (minimum No. 2 AWG insulated copper bonding conductor) – **optional**.
  5. Associated Telecommunications Cable Tray(s) (continuous No. 6 AWG bare copper bonding conductor connecting all Cable Tray Sections).

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

6. Telecommunications Conduit(s) Entering TR (minimum No. 6 AWG insulated copper bonding conductor).

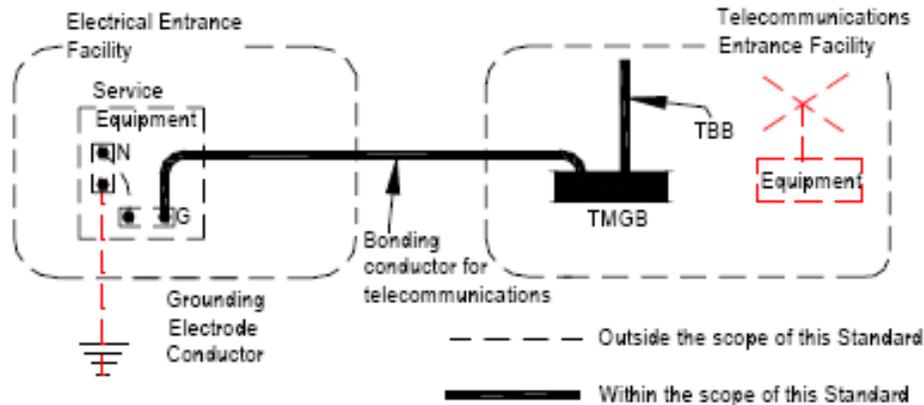


Figure 3 – Connection to Grounding Electrode

- B. As a minimum, Bond TGB to following:
1. Building Steel, (minimum No. 2 AWG insulated copper bonding conductor).  
CAD Weld Bonding Conductors to Building Steel.
  2. Local Service Panel Ground (minimum No. 6 AWG insulated copper bonding conductor).
  3. Telecommunications Bonding Backbone (TBB) that connects TGB to other TGBs and TMGB (minimum No. 2 AWG insulated copper bonding conductor) - **Optional**.
  4. Associated Telecommunications Cable Tray(s) (continuous No. 6 AWG bare copper bonding conductor connecting all Cable Tray Sections).
  5. Telecommunications Conduit(s) Entering TR (minimum No. 6 AWG insulated copper bonding conductor).
- C. As a minimum, the Technology Contractor shall bond the following devices to the associated TMGB and TGBs using a minimum No. 6 AWG insulated copper bonding conductor using compression style lugs:
1. Antenna Cable Shields
  2. Backbone Cable Shields
  3. CATV Equipment
  4. Coupled Bonding Conductors (CBCs)
  5. Equipment Racks and Cabinets
  6. Lightning and Surge Protectors
  7. PABX Equipment
  8. Raised Floors
  9. Telecommunication and Fiber Cable Shields
  10. Telecommunications Devices
  11. TR Cable Ladder and Tray

END OF SECTION

## SECTION 271100

## COMMUNICATIONS EQUIPMENT ROOM FITTINGS

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Communications Room Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Communications Rooms consist of:
    - a. Main Equipment Room (ER)
    - b. Telecommunication Rooms (TR)
  - 2. Figure 1 describes a typical Communications Room
  - 3. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. Equipment Room (ER)
- B. Telecommunication Rooms (TR)
- C. Equipment Backboards
- D. Equipment Racks and Cabinets
- E. Cable Ladder and Cable Tray

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment Racks and Cabinets shall comply with the latest ANSI/EIA-310 Cabinets, Racks, Panels and Associated Equipment Standard.

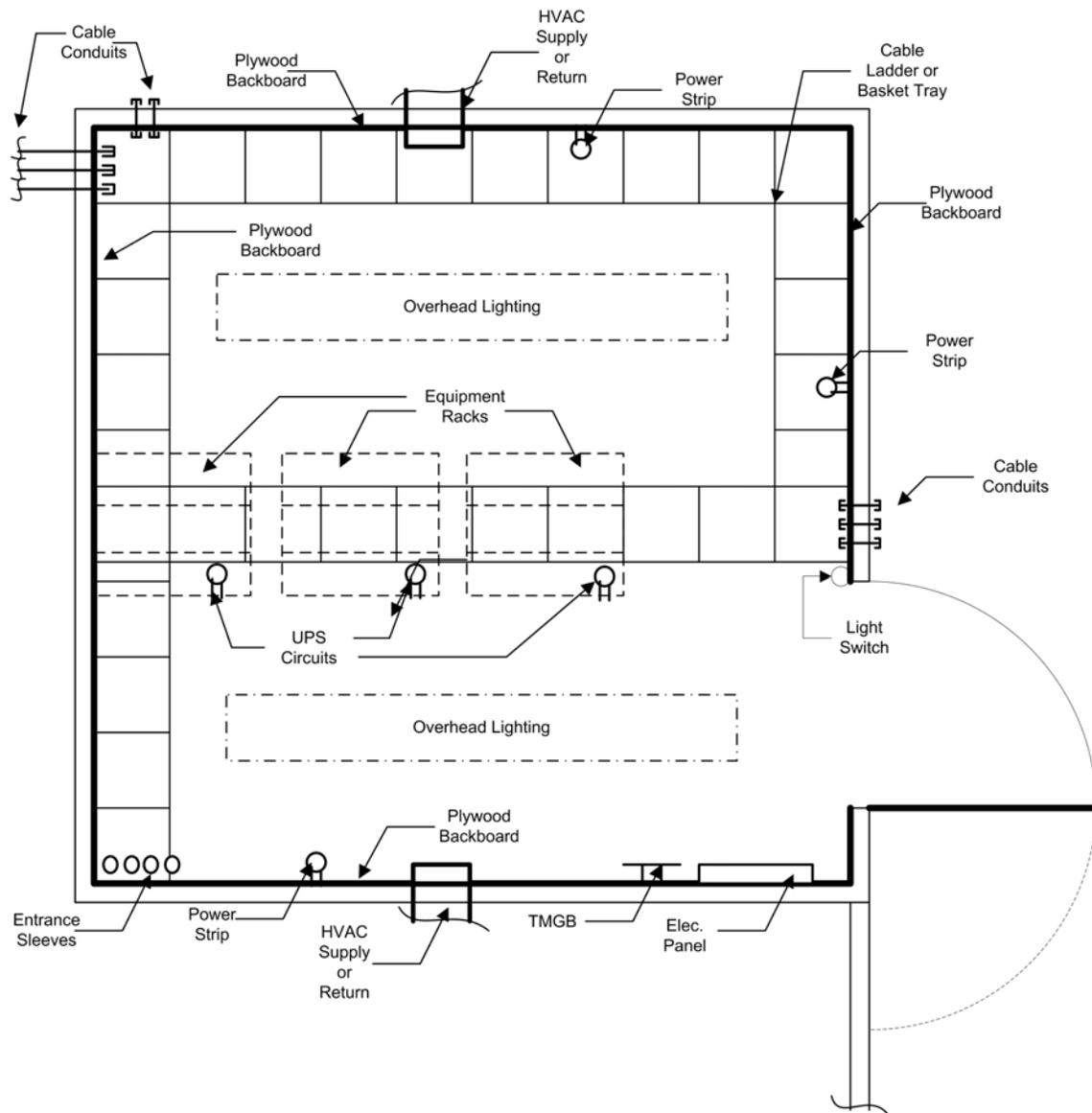


Figure 1 - Typical 10 ft x 10 ft Communications Room

#### 1.4 EQUIPMENT ROOM (ER) GENERAL

- A. Each Building shall be equipped with at least 1 ER
- B. Locate the ER in a Central area of the Building.
- C. For multiple story buildings, consider centrally locating the ER so it can serve multiple floors.
- D. Extend Service Entrance Conduits to the ER
- E. The ER typically contains the following equipment:

1. ACTIVE EQUIPMENT
  - a. Access Control Systems
  - b. CATV Systems
  - c. CCTV Systems
  - d. Clock Systems
  - e. Intercom Systems
  - f. Network Electronics
  - g. Paging Systems
  - h. PBX Equipment
  - i. Security Electronics
  - j. UPS Systems
  - k. Video Systems
  - l. Voice Mail Systems
  - m. Wireless Electronics
  
2. CROSS-CONNECT EQUIPMENT
  - a. Racks
  - b. Cabinets
  - c. Patch Panels
  - d. Backboards
  - e. 110 Blocks
  
3. BUILDING FACILITIES EQUIPMENT
  - a. Associated HVAC Equipment
  - b. Associated Electrical Equipment

#### **1.5 TELECOMMUNICATION ROOM (TR) GENERAL**

- A. When more than one Equipment Room (ER) is required, additional satellite Telecommunications Rooms (TRs) shall be provided.
  
- B. Centrally locate the TRs in the areas being served.
  
- C. For multiple story buildings, consider centrally locating the TRs so they can serve multiple floors.
  
- D. The TR typically contains the following equipment:
  1. ACTIVE EQUIPMENT
    - a. CATV Systems
    - b. Network Electronics
    - c. UPS Systems
  2. CROSS-CONNECT EQUIPMENT
    - a. Racks
    - b. Cabinets
    - c. Patch Panels
    - d. Backboards
    - e. 110 Blocks
  3. BUILDING FACILITIES EQUIPMENT
    - a. Associated HVAC Equipment
    - b. Associated Electrical Equipment
  
- E. Fiber and Copper Backbone cables shall be provided to interconnect the TR(s) with the ER.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

**1.6 ER AND TR REQUIREMENTS**

- A. The minimum ER and TR minimum ceiling heights shall be 8 feet (2.4 m) above finished floor (AFF). Consideration should be given to 10 ft (3 m) ceilings.
- B. The ER and TR shall be rectangular in shape.
- C. Consolidate multiple floors and serving areas into a single TR whenever possible. For example, a centrally located TR on the 2<sup>nd</sup> floor could also serve the 1<sup>st</sup> and 3<sup>rd</sup> floor.
- D. The minimum ER dimensions shall be 10 feet (3.0 m) x 15 feet (4.6 m).
- E. The minimum TR dimensions shall be 10 feet (3.0 m) x 10 feet (3.0 m).
- F. The ER and TR shall have tiled floors.
- G. The ER and TR shall have at least one lockable door that opens outward and has minimum dimensions of 3 feet (0.91 m) wide by 6.7 feet (2.0 m) tall.
- H. Provide each ER and TR with an HVAC system that maintains continuous environmental control 24 hours per day, 365 days per year.
- I. Maintain temperature between 64° F (18° C) to 75° F (24° C).
- J. Maintain relative humidity between 30% and 55% -- non-condensing.
- K. Provide Telecommunications Grounding Systems
- L. Provide the following minimum clearances:
  - 1. Minimum of 40 in. (1 m) between equipment racks and the front of cross-connect fields.
  - 2. Allow a minimum of 6 in. (150 mm) from the wall for wall-mounted equipment.
  - 3. Minimum of a 40 in. (1 m) aisle in front of and behind all equipment racks and cabinets.
  - 4. Minimum of 36 in. (0.91 m) floor area depth for equipment racks and cabinets.
- M. Provide sufficient Generator Electrical circuits to service the associated UPS units.
- N. Power all active devices from UPS units, which are connected to the Building generator.
- O. Provide a minimum of 500 lux (50-foot candles of uniform lighting when measured at 3 feet AFF.
- P. Use light colored walls to enhance lighting.

**1.7 EQUIPMENT BACKBOARDS**

- A. Cover at least two (2) walls with AC grade or better, void free ¾ in. (19 mm) plywood at least 8 feet (2.4 m) high.
- B. Place the grade C surface towards the wall and coat the plywood with two coats of fire-retardant white paint.

**1.8 EQUIPMENT RACKS**

- A. Place equipment racks or cabinets in a continuous row.
- B. Equipment racks shall be black, 84 inches high, have 19 inch EIA, pre-tapped, mounting rails and shall have integral, 5 inch minimum, vertical cable organizers on both the left and right of the rack.
- C. Equipment racks shall be provided with rear vertical cable organizers on both the left and right side of the rack.
- D. Provide at least one 4-posted rack or equipment cabinet in the ER for placing file servers and other equipment requiring four-corner mounting.
- E. Equipment racks are the preferred equipment-mounting device.
- F. When equipment cabinets are furnished, they shall be black, have vented side panels and lockable front and back doors. Cabinets shall be a minimum of 22-1/2 inches (572 mm) wide by a minimum of 27 in. (686 mm) deep and 84 in. (2.15 m) high.
- G. All equipment racks and cabinets shall be of the same manufacturer and model type.

**1.9 CABLE LADDER AND CABLE TRAY**

- A. Line the walls of the ER and TR with a minimum of 12 in (305 mm) wide cable ladder or wire basket cable tray for cable management.
- B. Provide a minimum of 12 in (305 mm) wide cable ladder or wire basket cable tray over the tops of racks and cabinets for cable management.



Figure 2 -- Typical Communications Room Cable Conduits



Figure 3 -- Typical Communications Room Overhead Cable Ladder and Backboard

### 1.10 GENERAL

- A. All racks, patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. Coordinate the location of lighting equipment so that fully loaded cable trays and ladder do not impede or obstruct the lighting.

END OF SECTION

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**SECTION 271313****COMMUNICATIONS COPPER BACKBONE CABLING****GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Intra and Inter-Building Communications Copper Backbone Cabling Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figures 1, 2 and 3 describe a typical Intra-Building Communications Copper Backbone Cabling Systems
  - 2. Figure 4 describes a typical Inter-Building Communications Copper Backbone Cabling System
  - 3. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. INTRA-BUILDING COPPER BACKBONE CABLE SYSTEMS
  - 1. Main Equipment Room (ER) to Telecommunication Rooms (TR) Voice Backbone Cable System.
  - 2. Main Equipment Room (ER) to Telecommunication Rooms (TR) Data Backbone Cable System.
  - 3. Entrance Facility (EF) to Main Equipment Room (ER) Voice Backbone Cable System.
  - 4. Entrance Facility (EF) to Main Equipment Room (ER) Data Circuit Backbone Cable System.
- B. INTER-BUILDING COPPER BACKBONE CABLE SYSTEMS
  - 1. Main Equipment Room (ER) to Main Equipment Room (ER) Voice Backbone Cable System.

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.

**COMMUNICATIONS**

CHAPTER 9: SPECIFICATIONS

- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM) and BICSI<sup>®</sup> Customer-Owned Outside Plant Design Manual.
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, Standards.
- G. All Inter-Building cabling shall comply with the latest ANSI/TIA/EIA-758. Customer-Owned Outside Plant Telecommunications Cabling, Standard, as applicable.
- H. All Inter-Building cabling shall comply with the latest ANSI/ICEA S-98-688. Broadband Twisted-Pair, Telecommunications Cable Aircore, Polyolefin Insulated Copper Conductors, Standard, as applicable.
- I. All Inter-Building cabling shall comply with the latest ANSI/ICEA S-99-689. Broadband Twisted-Pair, Telecommunications Cable Filled, Polyolefin Insulated Copper Conductors, Standard, as applicable.

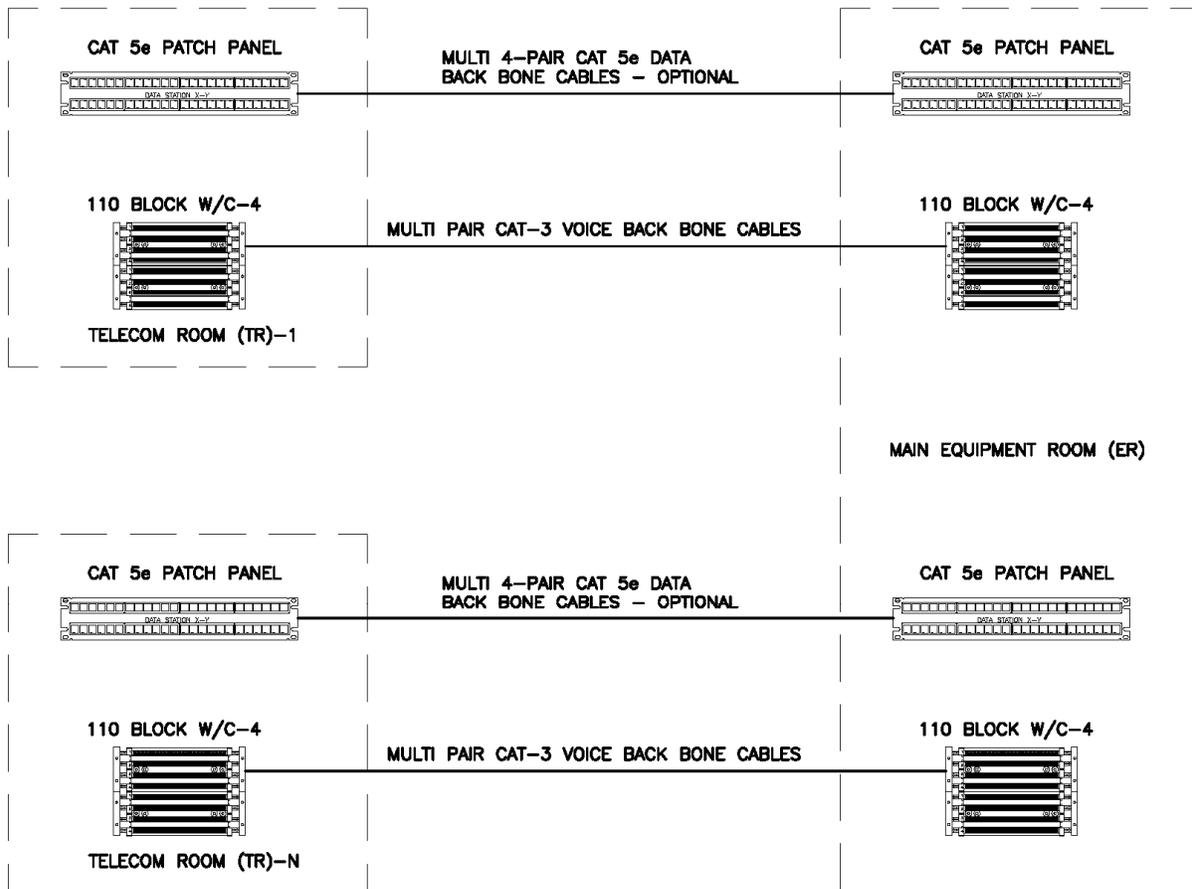


Figure 1 – Main Equipment Room (ER) to Telecommunication Rooms (TRs) Data and Voice Backbone Cable System, Option - 1

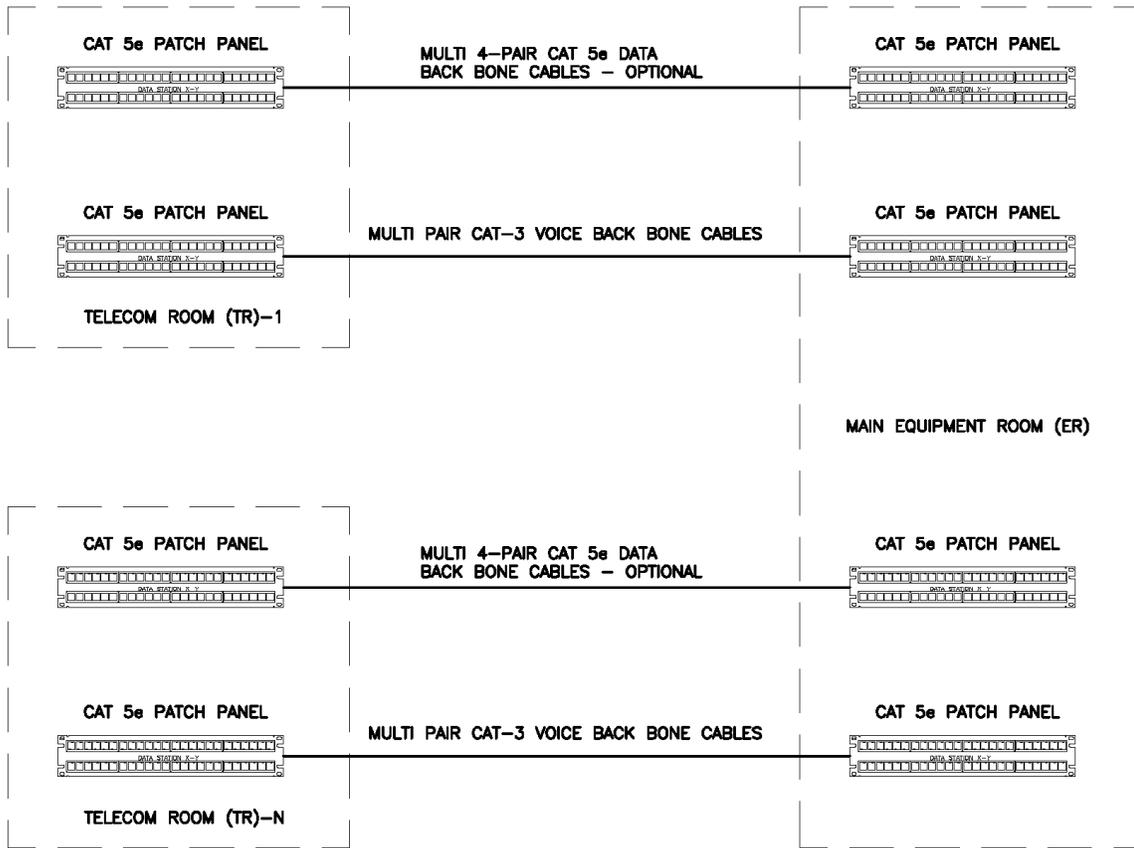


Figure 2 – Main Equipment Room (ER) to Telecommunication Rooms (TRs) Data and Voice Backbone Cable System, Option – 2

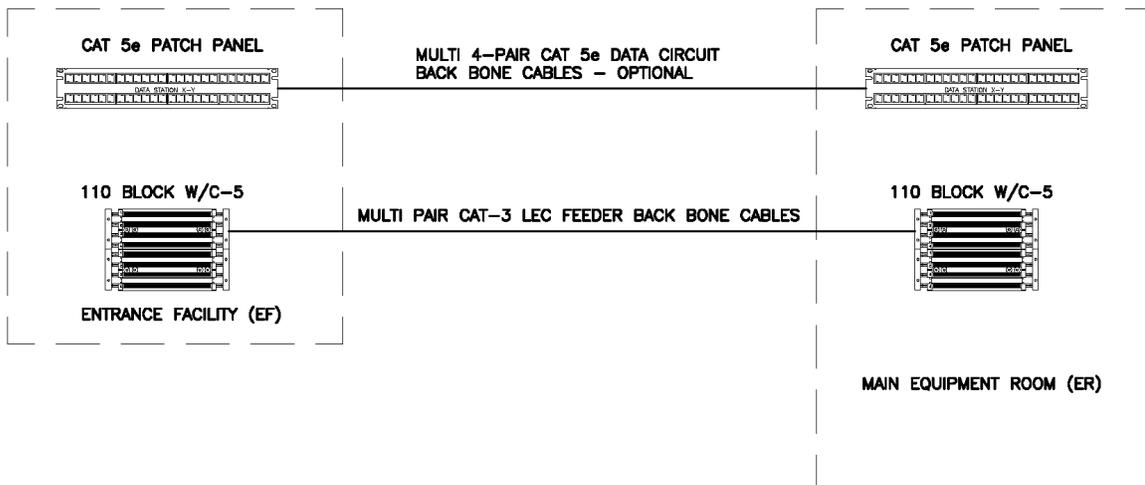


Figure 3 – Entrance Facility (EF) to Main Equipment Room (ER) Data Circuit and Voice Backbone Cable System

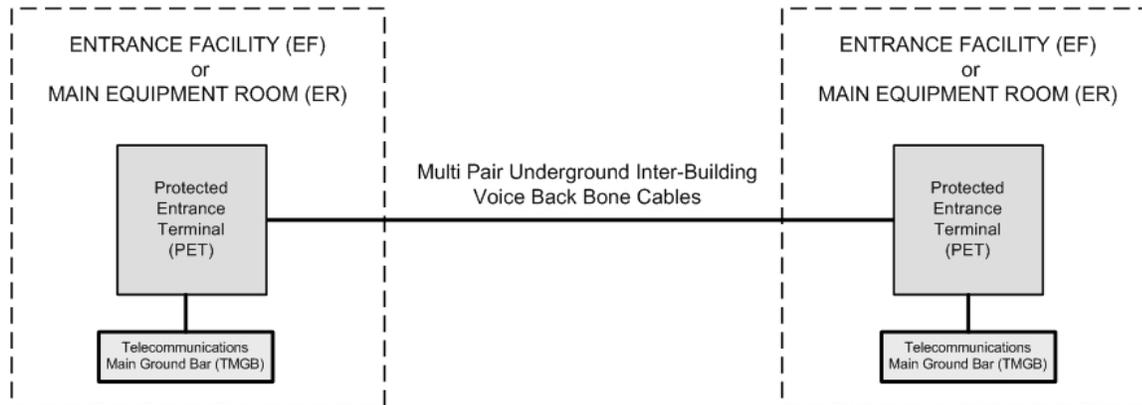


Figure 4 – Main Equipment Room (ER) to Main Equipment Room (ER) Inter-Building Voice Backbone Cable System

#### 1.4 INTRA-BUILDING COPPER BACKBONE CABLE SYSTEMS

##### A. MAIN EQUIPMENT ROOM (ER) TO TELECOMMUNICATION ROOMS (TR) VOICE BACKBONE CABLE SYSTEM

1. When the School has a Traditional IP-Enabled PBX Phone System, provide a multi-pair CAT-3 Voice Backbone system between the ER and the associated TRs, sufficient to serve all voice stations with 2 pairs in the backbone.
2. When the School has an all-IP Phone System, a minimal 25-pair CAT-3 Voice Backbone is recommended by not required.
3. Provide a minimum of one (1) 100-pair cable between the ER and each associated TR. Equip cables in increments of 100 pairs. **For TE/TR serving less than 24 users, provide a minimum 50 pair cable.**
4. Provide a minimum of **one (1) pair** per associated TR telephone outlet **with 50% spare capacity**.
5. Terminate 100-pair cables on 110 Blocks using C-4 Clips or Cat-5e, rack-mounted, patch panels as minimum 2-pair circuits – See figures 1 and 2 above.

##### B. MAIN EQUIPMENT ROOM (ER) TO TELECOMMUNICATION ROOMS (TR) DATA CIRCUIT BACKBONE CABLE SYSTEM - **OPTIONAL**

1. Provide a minimum of six (6) four-pair, Cat-5e/6 cables to match category rating of data cables between the ER and each associated TR.
2. Terminate the cables on Cat-5e/6, rack-mounted, Patch panels at each end. – See figures 1 and 2 above.

C. ENTRANCE FACILITY (EF) TO MAIN EQUIPMENT ROOM (ER) VOICE BACKBONE CABLE SYSTEM

1. Separate Entrance Facilities (EF) are generally encountered during renovations to existing buildings and are not recommended for new construction. For new construction, co-locate the Entrance Facility (EF) in the Main Equipment Room (ER).
2. When the Entrance Facility is not co-located in the Main Equipment Room (ER), provide a multi-pair CAT-3 Voice Backbone system between the EF and the ER, for the extension of voice, FAX and alarm circuits provided by the Service Provider (SP).
3. Provide a minimum of one (1) 100-pair cable between the EF and each associated ER. Equip cables in increments of 100 pairs.
4. Terminate LEC Feeder, 100-pair cables on 110 Blocks using C-5 Clips at both ends. – See figure 3 above.

D. ENTRANCE FACILITY (EF) TO MAIN EQUIPMENT ROOM (ER) DATA CIRCUIT BACKBONE CABLE SYSTEM

1. When the Entrance Facility is not co-located in the Main Equipment Room (ER) provide a minimum of six (6) four-pair, Cat-5e cables between the EF and the ER for the extension of special circuits (T-1, PRI, etc.) provided by the Service Provider (SP) - **Optional**.
2. Terminate the cables on a Cat-5e, wall-mounted, Patch panel at the EF end and on a Cat-5e, wall-mounted or rack-mounted patch panel at the ER end. – See figure 3 above.
3. Terminate LEC Feeder, 100-pair cables on 110 Blocks using C-5 Clips at both ends. – See figure 4 above.

1.5 INTER-BUILDING COPPER BACKBONE CABLE SYSTEMS

A. MAIN EQUIPMENT ROOM (ER) TO MAIN EQUIPMENT ROOM (ER) VOICE BACKBONE CABLE SYSTEM

1. When multiple School Buildings are located on the same campus, and served by a common IP-Enabled Phone System, provide a multi-pair, underground or aerial telecommunications cable between the ER or EF of the building containing the common Phone System and the ER or EF of each of the associated satellite buildings.
2. Provide a minimum of 25 pairs.
3. Provide a minimum of one pair for each active telephone outlet in the associated satellite building.
4. Provide a minimum of 25 % spare pairs for growth.

**COMMUNICATIONS****CHAPTER 9: SPECIFICATIONS**

5. When the School has an all-IP Phone System, the multi-pair inter-building Voice Backbone is optional. In cases where only one Service Provider DEMARC is provided per campus, provide an inter-building Voice Backbone cable for 911 backup and alarm circuits.
6. Terminate the inter-building cables on Protected Entrance Terminals (PETs) at both ends. – See figure 4 above.
7. Provide Gas-Tube Protector Modules for all pairs at both ends.
8. Ground the Cable sheath and the PET to the associated Telecommunications Main Grounding Bus (TMGB) at both ends.
9. Depending on the application, provide metal protective sheaths and appropriate rodent protection devices for aerially installed Telecommunications cables.

**1.6 INSTALLATION**

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and BISC1 standards.
- B. All Cat-5e cabling shall be terminated on Cat-5e (minimum) patch panels and jacks as noted above.
- C. All system multi-pair voice backbone cabling shall be terminated on Cat-5e (minimum) patch panels or 110 style punch blocks as noted above.
- D. Provide designated space on Telecommunications Backboard for location of Access Provider's (AP's) Service Entrance Cable Termination and Protection Point.

**1.7 LABELING**

- A. All racks, patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.
- C. All Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.

**1.8 TESTING**

- A. All Cat-5e (or Cat-6) backbone cables shall be tested to Cat-5e (or Cat-6) performance levels in accordance with ANSI/TIA/EIA-568-B.2 (or latest) specifications, using a Level III compliant tester.
- B. All multi-pair, backbone cables shall be tested to Cat-3 (minimum) performance levels in accordance with ANSI/TIA/EIA-568-B.2 (or latest) specifications, using a Level III compliant tester.

- C. All multi-pair, inter-building backbone cables shall be tested to Cat-3 (minimum) performance levels in accordance with ANSI/TIA/EIA-568-B.2 (or latest) specifications, using a Level III compliant tester.
- D. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- E. All Cable Tester record designations shall match the associated cable label, and associated patch panel or 110-block label designation.

END OF SECTION

## SECTION 271323

## COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Intra and Inter-Building Communications Optical Fiber Backbone Cabling Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a typical Intra-Building Communications Optical Fiber Backbone Cabling System
  - 2. Figure 2 describes a typical Inter-Building Communications Copper Backbone Cabling System
  - 3. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. INTRA-BUILDING OPTICAL FIBER BACKBONE CABLE SYSTEMS
  - 1. Main Equipment Room (ER) to Telecommunication Rooms (TR) Fiber Optic Backbone Cable System
- B. INTER-BUILDING OPTICAL FIBER BACKBONE CABLE SYSTEMS
  - 1. Main Equipment Room (ER) to Main Equipment Room (ER) Fiber-Optic Backbone Cable System
- C. OPTICAL FIBER PATCH PANEL SYSTEMS
  - 1. Fiber-Optic Patch Panels
  - 2. Fiber-Optic Connectors
  - 3. Fiber-Optic Splice Trays

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment installation practices shall comply with the local electric code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM) and BICSI<sup>®</sup> Customer-Owned Outside Plant Design Manual.

- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, standards.
- G. All 62.5 micron, multi-mode fiber equipment shall comply with the latest American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance Specification ANSI/TIA/EIA-492AAAA. Detail Specification for 62.5- $\mu$ m Core Diameter/125- $\mu$ m Cladding Diameter Class 1a Graded-Index Multimode Optical Fibers.
- H. All 50 micron, multi-mode equipment shall comply with the latest American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance Specification ANSI/TIA/EIA-492AAAB. Detail Specification for 50- $\mu$ m Core Diameter/ 125- $\mu$ m Cladding Diameter Class 1a Multimode Graded-Index Optical Waveguide Fibers. 50 micron fiber shall be laser optimized with support for 10 GB serial at 500m.
- I. All single-mode equipment shall comply with the latest American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance Specification ANSI/TIA/EIA-492CAA. Detail Specification for Class IVa Dispersion—Unshifted Single-Mode Optical Fibers.

#### 1.4 SYSTEM WARRANTY

- A. System shall carry an industry standard, performance based warranty, by the manufacturer and contractor, for a period of at least 20 years on the fiber-optic cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

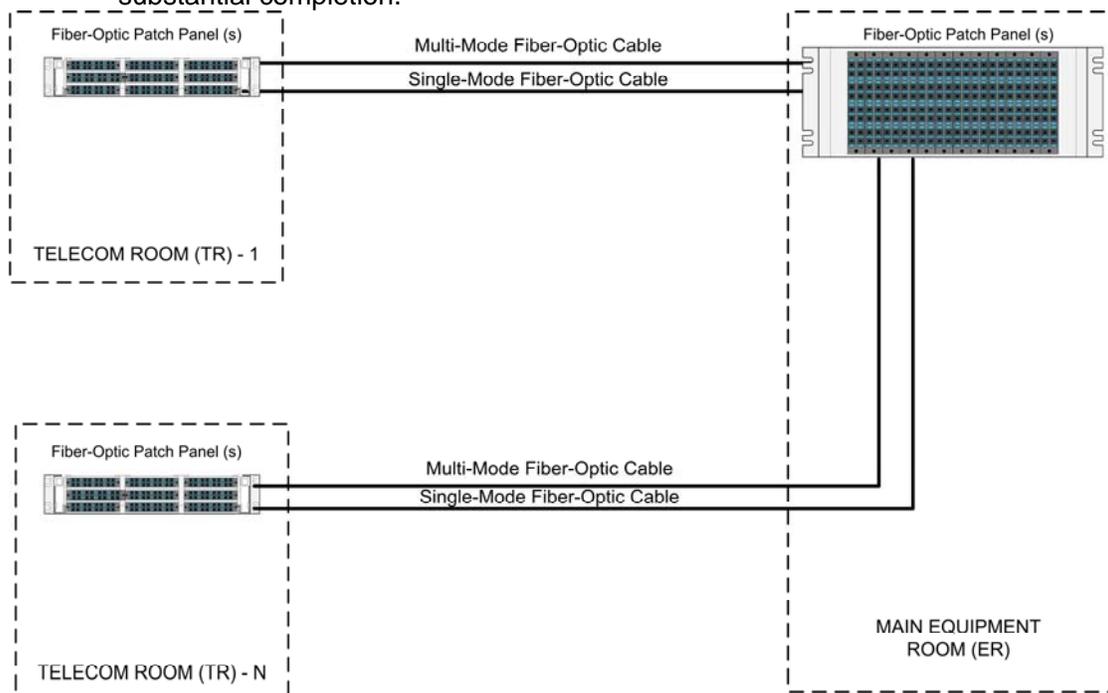


Figure 1 – Main Equipment Room (ER) to Telecommunication Rooms (TRs) Fiber-Optic Backbone Cable System

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

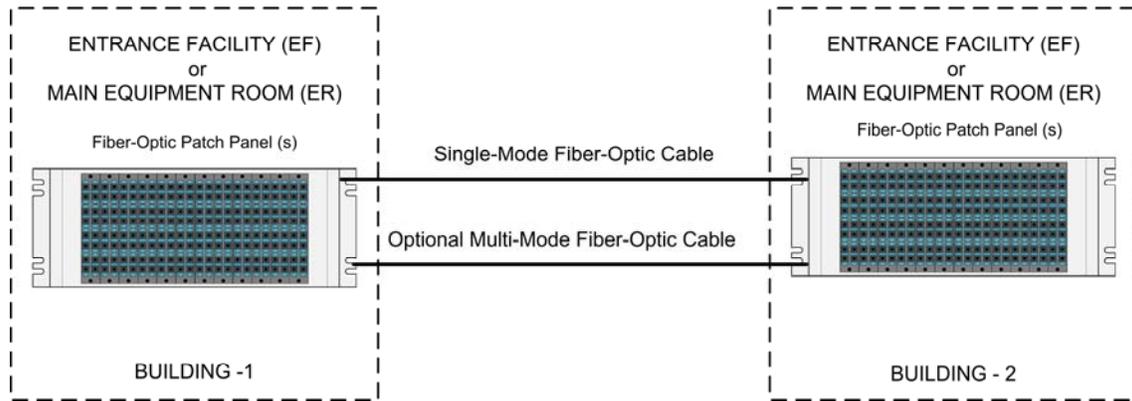


Figure 2 – Main Equipment Room (ER) to Main Equipment Room (ER) Inter-Building Fiber-Optic Backbone Cable System

### 1.5 INTRA-BUILDING OPTICAL FIBER BACKBONE CABLE SYSTEMS

#### A. MAIN EQUIPMENT ROOM (ER) TO TELECOMMUNICATION ROOMS (TR) FIBER-OPTIC BACKBONE CABLE SYSTEM

##### 1. GENERAL

- a. Provide a multi-mode and single-mode Optical Fiber Backbone System for all new and renovated Buildings when the building contains more than one (1) Telecommunications Closet.
- b. Upgrade existing Optical Fiber Backbone Systems to the following requirements.
- c. Ground the Cable sheath of aerial fiber-optic cables to the associated Telecommunications Main Grounding Bus (TMGB) at both ends.
- d. Depending on the application, provide metal protective sheaths and appropriate rodent protection devices for aerially installed fiber-optic cables.

##### 2. MULTI-MODE FIBER-OPTIC CABLE

- a. Provide a Multi-Mode, Fiber-Optic Cable between the Main Equipment Room and each associated Telecommunications Room (TR).
- b. The Multi-Mode, Fiber-Optic cable shall be 50/125 micron **laser optimized fiber. (62.5/125 is acceptable for legacy systems)**
- c. The entire District must utilize either 62.5/125 OR 50/125 micron fibers. A combination of both types is not **recommended**.
- d. The Multi-Mode, Fiber Optic cable shall be OFNP rated, tight-buffered and installed in plenum rated inner-duct.
- e. The Multi-Mode, Fiber-Optic cable shall be a minimum 24 strands per TR to ER. **TE/TR serving less than 96 users shall be minimum 12 strands.**
- f. When the TR serves more than 240 users, add 2 additional multi-mode strands per 24 users and round up to the nearest 6 count (24, 30, 36, etc.).
- g. Provide a minimum of 25% spare fibers after initial Network Configuration Design.
- h. The Multi-Mode fibers shall be terminated with fusion-spliced, factory-polished, SC or LC Pigtails.

- i. Classroom fibers are not supplied for new construction; however, for existing construction (renovations), the fibers may be terminated with epoxy cured, field-terminated, SC **or** LC Connectors.
3. SINGLE-MODE FIBER-OPTIC CABLE
- a. Provide a Single-Mode, Fiber-optic Cable between the Main Equipment Room (ER) and each associated Telecommunications Room (TR).
  - b. The Single-Mode, Fiber Optic cable shall be 8.7/125 micron fiber.
  - c. The Single-Mode, Fiber Optic cable shall be OFNP rated, tight-buffered and installed in plenum rated inner-duct.
  - d. The Single-Mode, Fiber Optic cable shall be a minimum 12 strands per TR to MC. **TE/TR serving less than 96 users shall be a minimum 6 strands.**
  - e. The Single-mode fibers shall be terminated with fusion-spliced, factory-polished, SC **or** LC Pigtails capable of 10 Gbps operation.
  - f. Angle-Polished Connectors (APC) shall be utilized on all Single-mode fibers used to support AM Video (CATV, etc.) applications.

#### 1.6 INTER-BUILDING OPTICAL FIBER BACKBONE CABLE SYSTEMS

##### A. MAIN EQUIPMENT ROOM (ER) TO MAIN EQUIPMENT ROOM (ER) INTER-BUILDING FIBER-OPTIC BACKBONE CABLE SYSTEM

1. GENERAL
- a. Provide a single-mode Optical Fiber Backbone System between all buildings on the same campus.
  - b. Provide an optional, multi-mode Optical Fiber Backbone System between all buildings on the same campus that are less than 250 meters between building ERs.
  - c. Upgrade existing Optical Fiber Backbone Systems to the following requirements.
2. MULTI-MODE FIBER-OPTIC CABLE - OPTIONAL
- a. Provide an optional Multi-Mode, Fiber-Optic Cable between the Main Equipment Room (ER) of the Network Center and each associated Building's Main Equipment Room (ER).
  - b. The Multi-Mode, Fiber-Optic cable shall be 50/125 micron **laser optimized fiber. (62.5/125 is acceptable for legacy systems.)**
  - c. The entire District must utilize either 62.5/125 OR 50/125 micron fibers. A combination of both types is not **recommended**.
  - d. The Multi-Mode, Fiber Optic cable shall be gel-filled or indoor/outdoor rated, tight-buffered cable installed in underground duct banks or aerially between buildings.
  - e. If the fiber-optic cable shares the duct bank with other cables, install an inner-duct.
  - f. The Multi-Mode, Fiber-Optic cable shall be a minimum 12 strands between buildings -- ER to ER.
  - g. Provide a minimum of 25% spare fibers after initial Network Configuration Design.
  - h. The Multi-Mode fibers shall be terminated with fusion-spliced, factory-polished, SC **or** LC Pigtails.

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

3. SINGLE-MODE FIBER-OPTIC CABLE
  - a. Provide a Single-Mode, Fiber-optic Cable between the Main Equipment Room (ER) of the Network Center and each associated Building's Main Equipment Room (ER).
  - b. The Single-Mode, Fiber Optic cable shall be an 8.7/125 micron fiber.
  - c. The Single-Mode, Fiber Optic cable shall be gel-filled or indoor/outdoor rated, tight-buffered cable installed in underground duct banks or aerially between buildings.
  - d. If the fiber-optic cable shares the duct bank with other cables, install an inner-duct.
  - e. The Single-Mode, Fiber-Optic cable shall be a minimum 12 strands between buildings -- ER to ER.
  - f. The Single-mode fibers shall be terminated with fusion-spliced, factory-polished, SC **or** LC Pigtails capable of 10 Gbps operation.
  - g. Angle-Polished Connectors (APC) shall be utilized on all Single-mode fibers used to support AM Video (CATV, etc.) applications.

### 1.7 OPTICAL FIBER PATCH PANEL SYSTEMS

- A. FIBER-OPTIC PATCH PANELS
  1. Fiber-Optic patch panels shall be mounted in equipment racks.
  2. Fiber-Optic patch panels shall be rack-mounted and shall be 24/48/72/144 port, or as required.
  3. Provide "Dual SC **or** LC" type couplers for multi-mode and single-mode cables.
- B. FIBER-OPTIC CONNECTORS
  1. Terminate Multi-Mode fibers with factory-terminated SC **or** LC multi-mode pigtails. Match fiber cable type provided.
  2. Terminate Single-Mode fibers with factory-terminated SC **or** LC single-mode pigtails. Match fiber cable type provided.
- C. FIBER-OPTIC SPLICE TRAYS
  1. Provide Fiber-Optic Fusion Splice Trays for connecting the factory-terminated, SC **or** LC pigtails to the associated Multi-Mode and Single-Mode fibers.

### 1.8 INSTALLATION

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and BISC standards.
- B. All fiber-optic cabling shall be terminated on rack-mounted patch panels using fusion-spliced, pigtails, as noted above.
- C. Provide space in rack (min 3 units) for possible District or DA-Site-provided, inter-building Fiber-Optic Cable Patch Panel.

### 1.9 LABELING

- A. All racks, patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.

- B. All Fiber-Optic cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.
- C. All Fiber-Optic Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.

**1.10 TESTING**

- A. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- B. All Cable Tester, Record designations shall match the associated cable label, and associated patch panel label designation.
- C. All Fiber-Optic Cables shall be tested with both a power meter and an OTDR.

END OF SECTION

## SECTION 271333

## COMMUNICATIONS COAXIAL BACKBONE CABLING

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Intra-Building Coaxial CATV Backbone Cabling Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a typical Intra-Building Coaxial Backbone Cabling Systems.
  - 2. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. INTRA-BUILDING COAXIAL CABLE BACKBONE CABLE SYSTEMS
  - 1. Main Equipment Room (ER) to Telecommunication Rooms (TR) Coaxial Backbone Cable System.
- B. COAXIAL CABLE PATCH PANEL SYSTEMS
  - 1. Coaxial Backbone Cable
  - 2. Coaxial Cable Connectors
  - 3. Coaxial Cable Patch Panels

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM) and BICSI<sup>®</sup> Customer-Owned Outside Plant Design Manual.
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, standards.

### 1.4 SYSTEM WARRANTY

- A. System shall carry an industry standard, performance based warranty, by the manufacturer and contractor, for a period of at least 20 years on the cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

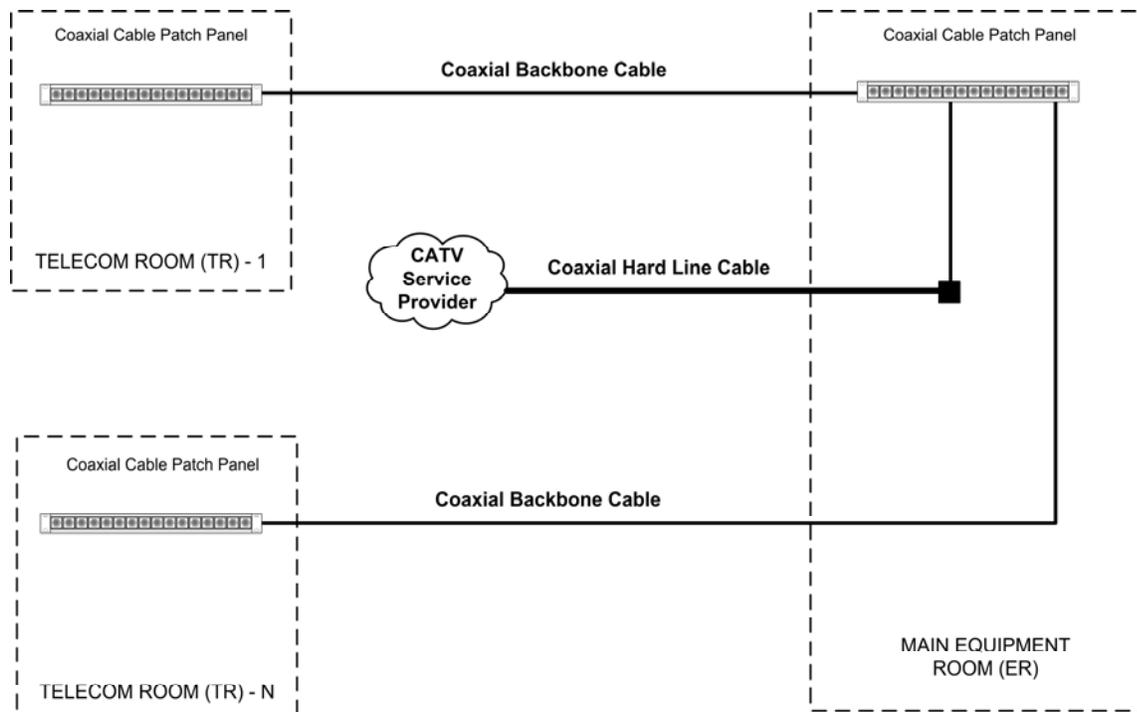


Figure 1 – Main Equipment Room (ER) to Telecommunication Rooms (TRs) Coaxial Cable Backbone Cable System

### 1.5 INTRA-BUILDING COAXIAL CABLE BACKBONE CABLE SYSTEMS

- A. MAIN EQUIPMENT ROOM (ER) TO TELECOMMUNICATION ROOMS (TR) COAXIAL BACKBONE CABLE SYSTEM
1. GENERAL
    - a. When a building is not supplied with an MPEG, CATV, Head-End System, a Coaxial Cable, CATV System is required.
    - b. Provide a Coaxial Cable Backbone System for all new and renovated Buildings.
    - c. Buildings served with a MPEG CATV Head end do not require a Coaxial Cable Backbone System.
    - d. For most buildings, a star-wired, Coaxial Cable, CATV System can be served from one closet (the Main Equipment Room – ER) – drops up to 450 feet.

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

- e. For large buildings that cannot be served only from the Main Equipment Room, a CATV Coaxial Cable Backbone is required to connect the ER to the associated TRs.
  - f. The CATV Backbone System shall have a minimum frequency bandwidth between 5MHz and 750MHz.
2. COAXIAL BACKBONE CABLE
- a. Provide a plenum-rated, quad shield RG-11 or PIII .500 Hard Line,, CATV, Coaxial Cable between the Main Equipment Room (ER) and each of the associated Telecommunications Rooms (TRs).
  - b. Extend CATV Backbone Coaxial Cables from the wall-field to the associated Coaxial Cable Patch Panel with RG-6 male-male, pig-tails.
  - c. Extend CATV Service Provider Coaxial Cables from the wall-field to the associated Coaxial Cable Patch Panel with RG-11 male-male, pig-tails.
  - d. **Extend the** CATV service from the Service Provider's DEMARC to the Main Equipment Room (ER).
  - e. The Coaxial RG-6 and RG-11 cables shall be CATVP rated.
  - f. The Coaxial backbone cables shall be sweep tested to 1000 MHz and shall meet the following minimum performance values listed in dB/100 feet:

| Mhz  | Series 6 | Series 11 | 500 Hard Line |
|------|----------|-----------|---------------|
| 55   | 1.50     | 0.95      | 0.55          |
| 450  | 4.28     | 2.69      | 1.63          |
| 750  | 5.82     | 3.58      | 2.16          |
| 1000 | 6.54     | 4.23      | 2.53          |

Figure 2 –Coaxial Backbone Cable Minimal Parameters

3. COAXIAL CABLE CONNECTORS
- a. Provide two-part, crimp-style, Coax Cable, Male F-Connectors at each end of the RG-11, Coaxial Backbone Cables.
  - b. Provide two-part, Coax Cable, Female F-Connectors at each end of the Hard-Line, Coaxial Backbone Cables.
  - c. Match the connectors to the Coaxial Cable Manufacturer.
4. COAXIAL CABLE PATCH PANELS
- a. Provide F-Connector Bulkheads in the User Coax Drop Patch Panel for the termination of the RG-11 Coaxial Backbone Cables.

**1.6 INSTALLATION**

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and BISC standards.
- B. All coaxial cabling shall be terminated on rack-mounted patch panels using F-Connectors, as noted above.

**1.7 LABELING**

- A. Patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All Coaxial Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.
- C. All Coaxial Cable Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.

**1.8 TESTING**

- A. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- B. All Cable Tester, Record designations shall match the associated cable label, and associated patch panel label designation.
- C. All Coaxial Cables shall be tested with a hand held cable tester.

END OF SECTION

## SECTION 271513

## COMMUNICATIONS COPPER HORIZONTAL CABLING

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Communications Copper Horizontal Cabling System Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. COMMUNICATIONS COPPER HORIZONTAL CABLING SYSTEM SYSTEMS
  - 1. Modular Jacks
  - 2. Modular Cover Plates
  - 3. Horizontal Cable
  - 4. Modular Patch Panels

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.
- G. As a minimum, all equipment shall meet Category 5e transmission performance standards.
- H. All connecting equipment shall be from the same manufacturer.

**1.4 SYSTEM WARRANTY**

- A. System shall carry an industry standard, performance based warranty, by the manufacturer and contractor, for a period of at least 20 years on the horizontal cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

## 1.5 MODULAR JACKS

- A. Each 4-pair 100-ohm UTP data cable shall be terminated in an eight position, modular jack at the Work Area (WA).
- B. The data cable shall be terminated directly to the modular jack with insulation displacement connectors.
- C. The modular jack shall be a minimum of Category 5e compliant.
- D. The modular jack pair/pin assignments shall be T568B.

## 1.6 COVER PLATES

- A. Plates shall be modular, front-loading and colored to match the video/data wall plates.
- B. All plate colors shall be coordinated with the architect to match furnishings and fixtures.
- C. Wall mounted phones shall utilize 630 style faceplates.

## 1.7 HORIZONTAL CABLE

- A. In accordance with ANSI/EIA/TIA 568B.2 all horizontal data cable shall be:
  - 1. UL listed, 4-pair 100 ohm, UTP, Category 5e (**350 MHz rated**) compliant
  - 2. Conductors shall be 24 AWG, solid bare annealed copper.
  - 3. Cable shall be insulated with FEP material.
  - 4. Cable shall be NEC CMP rated.
- B. Cable shall be sequentially marked at 2-foot intervals.
- C. Cable pairs shall be color coded:
  - 1. Pair 1- White/Blue and Blue.
  - 2. Pair 2- White/Orange and Orange
  - 3. Pair 3- White/Green and Green
  - 4. Pair 4- White/Brown and Brown
- D. Provide horizontal Category-5e (minimum) cable drops for:
  - 1. Administrative Computers
  - 2. Bulletin Board System
  - 3. CCTV Cameras (as required)
  - 4. Classroom and Lab Computers
  - 5. Desk top phones
  - 6. Distance Learning Systems
  - 7. Door Phones (as required)
  - 8. Electrical Closets
  - 9. Elevator Phones
  - 10. Energy Management Systems (EMS)
  - 11. Fax Machines
  - 12. Fire Alarm Systems
  - 13. HVAC Equipment

**COMMUNICATIONS****CHAPTER 9: SPECIFICATIONS**

14. LCD TVs
  15. Master Clock System (as required)
  16. Mechanical Closets
  17. Miscellaneous Network Attached Devices
  18. Pay Station Phones (as required)
  19. Point of Sale Terminals (as required)
  20. Printers
  21. Projectors
  22. Security and Access Control Systems
  23. Set Top Boxes (as required)
  24. Teacher Technology Centers
  25. Video Conference Units
  26. Wall mounted phones
  27. Wireless Access Points (APs)
- E. Telecommunication outlet/connectors that serve an individual work area may be located in multiple faceplates.

**1.8 MODULAR PATCH PANELS**

- A. All patch panels shall be in accordance with ANSI/EIA/TIA 568B.2 (or latest) and shall be equipped with eight position, modular jacks with insulation displacement connectors, rear cable-management bars/standoffs and front label designation strips.
- B. Provide 24 or 48 port, Category 5e (minimum) rated patch panels for termination of all horizontal cabling. When the Equipment Room (ER) or Telecommunications Room (TR) serves more than one floor, sequentially group the cables by floor on separate patch panels.
- C. Provide color-coded, Category 5e (minimum) rated patch cords for all connections (plus 10% spare).

**1.9 INSTALLATION**

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and BISC1 standards.
- B. All horizontal telephone cabling shall be terminated on Category 5e (minimum) patch panels and jacks as noted above.
- C. Consider providing cable slack at both ends of the horizontal cables to accommodate future cabling system changes.

**1.10 LABELING**

- A. All patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the owner/architect.
- B. All horizontal cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.

- C. All Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.
- D. All Modular Plates shall be equipped with a pre-printed, cable identification strip, installed behind a clear plastic label holder.

**1.11 TESTING**

- A. All horizontal cabling shall be tested to Category 5e (or Category 6) performance levels in accordance with ANSI TIA/EIA-568-B.2 (or latest) specifications, using a Level III compliant tester.
- B. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- C. All Cable Tester Record designations shall match the associated cable label, patch panel label and faceplate label.

END OF SECTION

## SECTION 271533

## COAXIAL COMMUNICATIONS HORIZONTAL CABLING

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Coaxial Communications Cabling System Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a Typical Coaxial Communications Cabling System – ER Serves all Locations.
  - 2. Figure 2 describes a Typical Coaxial Communications Cabling System – Multiple TRs.
  - 3. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. COAXIAL COMMUNICATIONS HORIZONTAL CABLING
  - 1. Coaxial Cable

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.
- G. As a minimum, all equipment shall meet Category 5e transmission performance standards.

**1.4 SYSTEM WARRANTY**

- A. System shall carry an industry standard, performance based warranty, by the manufacturer and contractor, for a period of at least 20 years on the fiber-optic cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

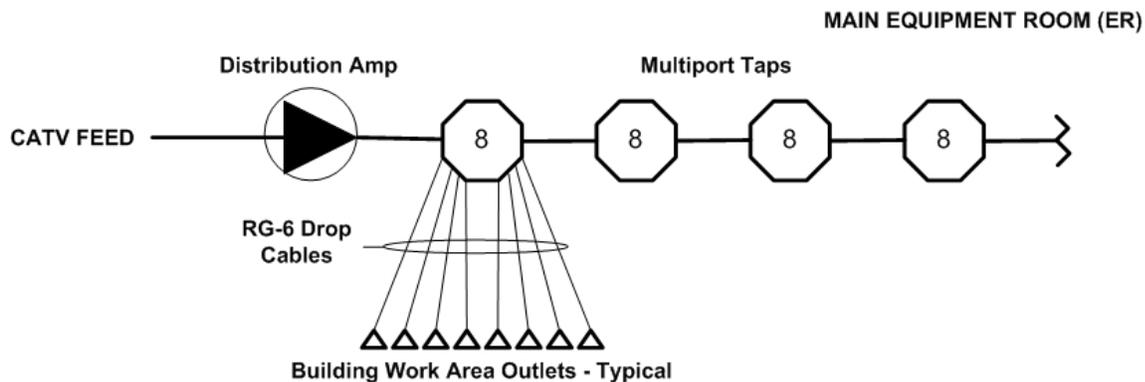


Figure 2 - Typical Coaxial Communications Cabling System – ER serves all Locations

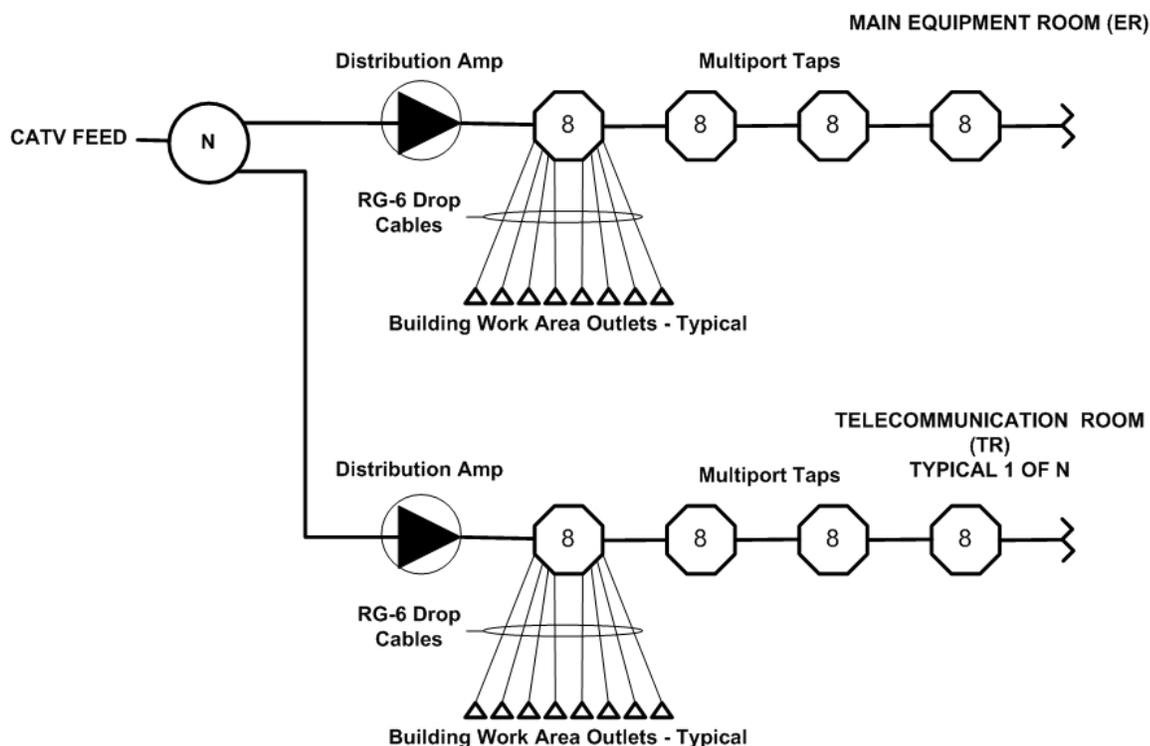


Figure 2 - Typical Coaxial Communications Cabling System – Multiple TRs

## 1.5 COAXIAL CABLE

### A. GENERAL

1. When a building is not supplied with an MPEG, CATV, Head-End System, a Coaxial Cable based CATV System is required.
2. Provide a Horizontal Coaxial Cable System for all new and renovated Buildings.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

3. Buildings served with a MPEG CATV Head end do not require a Horizontal Coaxial Cable System.
  4. For most buildings, a star-wired, Coaxial Cable, CATV System can be served from one closet (the Main Equipment Room – ER) – drops up to 450 feet.
  5. For large buildings that cannot be served only from the Main Equipment Room (ER), the horizontal coaxial cables connect to the associated TRs.
  6. The CATV Horizontal Coaxial Cable System shall have a minimum frequency bandwidth between 5MHz and 750MHz and support for HDTV.
- B. HORIZONTAL COAX CABLE
1. The Broadband Wiring System shall be a bi-directional, star-wired, home-run, coaxial distribution system using Quad Shielded RG-6/RG-11 Coax Cable.
  2. The RG-6 coaxial cables shall be CATVP rated.
  3. The coaxial cables shall be sweep tested to 1000 MHz and shall meet the following minimum performance values listed in dB/100 feet:

| Mhz  | Series 6 |
|------|----------|
| 55   | 1.50     |
| 450  | 4.28     |
| 750  | 5.82     |
| 1000 | 6.54     |

Figure 3 – RG-6 Coaxial Cable Minimal Parameters

**1.6 COAXIAL CABLE CONNECTORS**

- A. Provide two-part, crimp-style, Coax Cable, Male F-Connectors at each end of the RG-6, Horizontal Coaxial Cables.
- B. Match the connectors to the Coaxial Cable Manufacturer.

**1.7 MODULAR FACEPLATES**

- A. Terminate the Horizontal Coax Cable on a dual female F-Connector Bulkhead installed in the Work Area Outlet.

**1.8 COAXIAL CABLE PATCH PANELS**

- A. Provide 16, 24, 32 or 48 port F-Connector User Coax Drop Patch Panels for the termination of the RG-6 Horizontal Coaxial Cables.

**1.9 INSTALLATION**

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and BISC1 standards.
- B. All coaxial cabling shall be terminated on rack-mounted patch panels using F-Connectors, as noted above.

**1.10 LABELING**

- A. Patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All Coaxial Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.
- C. All Coaxial Cable Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.

**1.11 TESTING**

- A. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- B. All Cable Tester, Record designations shall match the associated cable label, and associated patch panel label designation.
- C. All Coaxial Cables shall be tested with a hand held cable tester.

END OF SECTION

## SECTION 271543

## AUDIO-VIDEO COMMUNICATIONS HORIZONTAL CABLING

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Audio-Video Horizontal Cabling System Infrastructure that shall be followed for all OSFC Technology construction projects.
- B. Figure 1 describes a Typical Classroom Audio-Video System.
- C. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. AUDIO-VIDEO COMMUNICATIONS HORIZONTAL CABLING
  - 1. Instructor HI-LO Stations
  - 2. Instructor HI-LO Cables
  - 3. Monitor/TV HI-LO Stations
  - 4. Monitor/TV HI-LO Cables
  - 5. Public Monitor/TV Stations
  - 6. Public Monitor/TV Cables
  - 7. Video Cover Plates

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.

**1.4 SYSTEM WARRANTY**

- A. System shall carry an industry standard, performance based warranty, by the contractor, for a period of at least 20 years on the cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

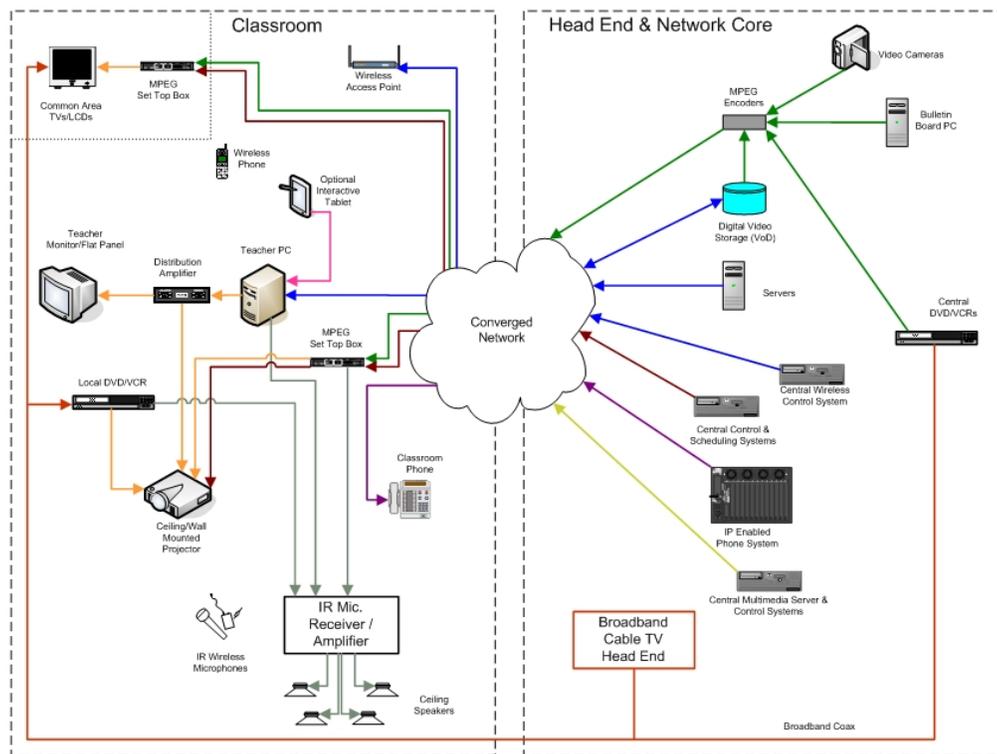


Figure 1 – Typical Classroom Audio Visual System

### 1.5 INSTRUCTOR HI-LO STATIONS

- A. The classroom and lab instructor's Technology Station shall be equipped with a Video HI/LO station.
- B. The video cabling system for the overhead mounted **or wall mounted** projector shall also include a HI-LO system for connecting the projector to local and central programming sources.
- C. The Instructor's PC shall be connected to the Video LO XGA-IN **via a local XGA Splitter**. The Instructor's Monitor shall be connected to the local XGA Splitter **output**. The PC Audio output shall be connected to the associated classroom Audio Enhancement Amplifier inputs.
- D. When an optional Interactive Tablet is supplied, it shall be connected to the Instructor's PC **via the supplied wireless interface**.
- E. The Instructor's DVD Player S-Video or Component Video Output shall be connected to the LO S-Video or LO Component-Video. The DVD Audio Outputs shall be connected to the associated classroom Audio Enhancement Amplifier inputs.
- F. The Instructor's VHS Player Composite Video Output shall be connected to the LO Composite Video. The VHS Audio Outputs shall be connected to the associated classroom Audio Enhancement Amplifier inputs.
- G. The XGA Video output from the MPEG Set-Top-Box shall be connected to the second XGA input on the Projector. The Set-Top-Box audio output shall be connected to the associated classroom Audio Enhancement Amplifier inputs.

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

- H. Provide additional XGA splitters, A/B switches, and Distribution amplifiers as required.
- I. The HI video outlets at the Projector shall have as a minimum the following:
1. **HD-15 Female Jack connected to LO Station for XGA-IN.**
  2. S-Video Female Jack connected to LO Station.
  3. RCA Female Composite-Video Jack (Yellow) connected LO Station.
  4. RJ-45 Female Jack for Connection of Projector to Central Projector Control System via the Local Area IP Network.
  5. RJ-45 Female Jack for Connection of optional MPEG Set Top Box to the Local Area IP Network.
  6. RCA L/R Audio Jacks (White/Red) for connection of MPEG Set Top Box to LO Station.
- J. The LO video outlets at the Instructor's Technology Center shall have as a minimum the following:
1. **HD-15 Female Jack connected to HI Station for XGA-Out.**
  2. S-Video Female Jack connected to HI Station for connection of the Instructor's DVD player output to the Projector.
  3. RCA Female Composite-Video Jack (Yellow) connected HI Station for connection of the Instructor's VHS player output to the Projector.
  4. RJ-45 Female Jack for Connection of Instructor's PC to the Local Area IP Network.
  5. RCA L/R Audio Jacks (White/Red) for connection of MPEG Set Top Box to the associated classroom Audio Enhancement Amplifier inputs.
  6. Optional Female "F" Connector for connection of Instructor's DVD/VHS Player to Broadband Network, as required when no MPEG CATV Head End is provided.

### 1.6 INSTRUCTOR HI-LO CABLES

- A. XGA CABLES
1. **Provide five-conductor mini-coaxes connected to HD-15 female connectors.**
- B. S-VIDEO CABLE
1. Provide **coaxial** cable connected to S-Video female connectors.
- C. COMPOSITE-VIDEO CABLE
1. Provide **coaxial** cable connected to Female RCA connector (Yellow).
- D. AUDIO CABLE
1. Provide **shielded twisted pair** cable connected to Female RCA connectors (White/Red).
- E. PROJECTOR NETWORK CABLE
1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.

- F. SET-TOP-BOX NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- G. INSTRUCTOR TECHNOLOGY CENTER NETWORK CABLE
  1. Provide two (2) Category-5e UTP cables connected to the Category-5e patch panel in associated Telecommunications room.
- H. VHS CATV CABLE
  1. Provide one (1) optional RG-6 Broadband CATV cable connected to User CATV Patch Panel in associated Telecommunications room.

### 1.7 MONITOR/TV HI-LO STATIONS

- A. The Monitor/TV Station, typically located in Conference Rooms and Small Self-Contained Classrooms, shall be equipped with a Video HI/LO station.
- B. The Monitor/TV Station, typically located in Reading Rooms, is in addition to the Instructor's Technology Station and shall be equipped with a Video HI/LO station. This unit is optional depending on the size of the room.
- C. The video cabling system for the wall-mounted, monitor/TV unit shall also include a HI-LO system for connecting the monitor/TV unit to local and central programming sources.
- D. The local XGA programming source shall be connected to the Video LO XGA-IN and the associated L/R audio outputs shall be connected to the monitor/TV inputs.
- E. Local DVD programming source S-Video Output shall be connected to the LO S-Video. The DVD Audio Outputs shall be connected to the monitor/TV audio inputs.
- F. Local VHS programming source Composite Video Output shall be connected to the LO Composite Video. The VHS Audio Outputs shall be connected to the monitor/TV audio inputs.
- G. The XGA Video output from the associated MPEG Set-Top-Box shall be directly connected to a XGA input on the Monitor/TV. The Set-Top-Box audio output shall be directly connected to the monitor/TV audio inputs.
- H. The HI video outlets at the Monitor/TV shall have as a minimum the following:
  1. HD-15 Female Jacks connected to LO Station for XGA-IN.
  2. S-Video Female Jack connected to LO Station.
  3. RCA Female Composite-Video Jack (Yellow) connected LO Station.
  4. RCA L/R Audio Jacks (White/Red) connected to LO station.
  5. RJ-45 Female Jack for Connection of Monitor/TV to Central Control System via the Local Area IP Network.
  6. RJ-45 Female Jack for Connection of optional MPEG Set Top Box to the Local Area IP Network.
  7. Optional Female "F" Connector for connection of Monitor/TV to Broadband Network, as required when no MPEG CATV Head End is provided.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- I. The LO video outlets shall have as a minimum the following:
  1. HD-15 Female Jacks connected to HI Station for XGA-IN.
  2. S-Video Female Jack connected to HI Station for connection of the local DVD player output to the Monitor/TV.
  3. RCA Female Composite-Video Jack (Yellow) connected HI Station for connection of the local VHS player output to the Monitor/TV.
  4. RJ-45 Female Jack for Work Area Connection to the Local Area IP Network.
  5. RCA L/R Audio Jacks (White/Red) for connection of local DVD and VHS units to the Monitor/TV audio inputs.

## 1.8 MONITOR/TV HI-LO CABLES

- A. XGA CABLES
  1. Provide one (1) five-conductor mini-coax connected to HD-15 female connectors.
- B. S-VIDEO CABLE
  1. Provide **coaxial** cable connected to S-Video female connectors.
- C. COMPOSITE-VIDEO CABLE
  1. Provide **coaxial** cable connected to Female RCA connector (Yellow).
- D. AUDIO CABLE
  1. Provide **shielded twisted pair** cable connected to Female RCA connectors (White/Red).
- E. MONITOR/TV NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- F. SET-TOP-BOX NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- G. WORK AREA NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- H. MONITOR/TV CATV CABLE
  1. Provide one (1) optional RG-6 Broadband CATV cable connected to User CATV Patch Panel in associated Telecommunications room.

## 1.9 PUBLIC MONITOR/TV HI-LO STATIONS

- A. The Public Monitor/TV Station, typically located in Entrances, Corridors and/or Reception areas, and Small Self-Contained Classrooms, shall be equipped with a Video HI station.
- B. The video cabling system for the wall-mounted, monitor/TV unit shall also include a HI system for connecting the monitor/TV unit to local and central programming sources.

- C. The XGA Video output from the associated MPEG Set-Top-Box shall be directly connected to a XGA input on the Monitor/TV. The Set-Top-Box audio output shall be directly connected to the monitor/TV audio inputs.
- D. The HI video outlets at the Monitor/TV shall have as a minimum the following:
  1. RJ-45 Female Jack for Connection of Monitor/TV to Central Control System via the Local Area IP Network.
  2. RJ-45 Female Jack for Connection of optional MPEG Set Top Box to the Local Area IP Network.
  3. Optional Female "F" Connector for connection of Monitor/TV to Broadband CATV Network, as required when no MPEG CATV Head End is provided.

**1.10 PUBLIC MONITOR/TV HI-LO CABLES**

- A. MONITOR/TV NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- B. SET-TOP-BOX NETWORK CABLE
  1. Provide one (1) Category-5e UTP cable connected to Category-5e patch panel in associated Telecommunications room.
- C. MONITOR/TV CATV CABLE
  1. Provide one (1) RG-6 Broadband CATV cable connected to User CATV Patch Panel in associated Telecommunications room.

**1.11 VIDEO COVER PLATES**

- A. Plates shall be modular to fit all video jack components and shall match the associated voice/data plates.

**1.12 INSTALLATION**

- A. Contractor shall provide and install Video HI-LO Wiring System.
- B. Cables and associated connectors shall be terminated in accordance with industry standards.
- C. Route the classroom Audio Enhancement Amplifier IR sensor coax and associated speaker cables through the LO faceplate to the Amplifier.

**1.13 LABELING**

- A. Cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All Audio-Video Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.

**1.14 TESTING**

- A. Video Wiring system and associated systems shall be tested end-to-end complete.

END OF SECTION

**SECTION 272100****DATA COMMUNICATIONS NETWORK EQUIPMENT****GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Data Communications Network Infrastructure that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a Typical Data Communications Network System – Single Building.
  - 2. Figure 2 describes a Typical Data Communications Network System – Multiple Buildings on Same Campus.
  - 3. Figure 3 describes a Typical Data Communications Network System – District Wide.
  - 4. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. DATA COMMUNICATIONS NETWORK EQUIPMENT
  - 1. File/Building Server.
  - 2. Network Switches.
  - 3. Network Core Switch.
  - 4. Network Security Equipment.
  - 5. Uninterruptible Power Supplies (UPSs).

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.

**1.4 SYSTEM WARRANTY**

- A. The Local Area Network Electronics and software shall be warranted by the contractor for a period of one (1) year from date of substantial completion. Provide advanced replacement for all Network Electronics for the one (1) year-period.

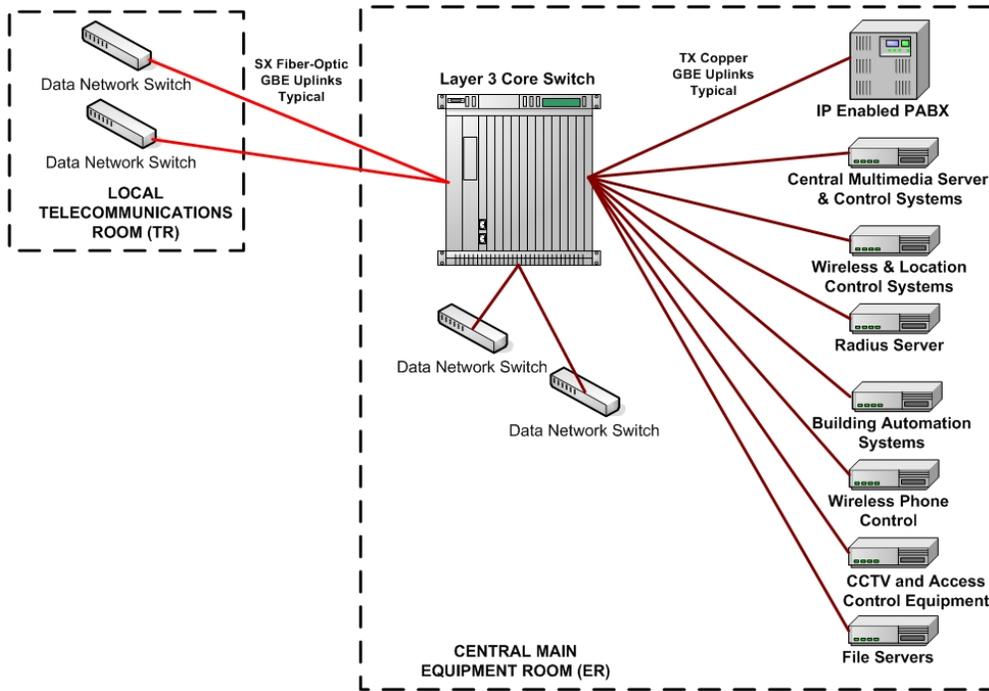


Figure 1 - Typical Data Communications Network System – Single Building

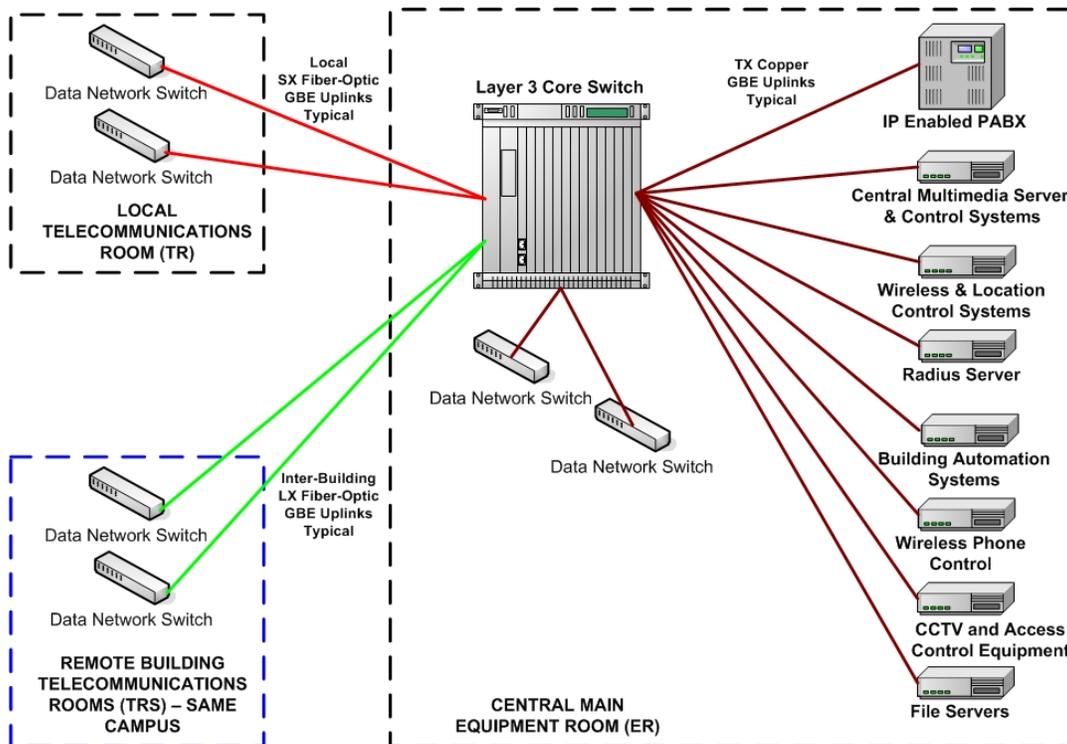


Figure 2 - Typical Data Communications Network System – Multiple Buildings on Same Campus

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

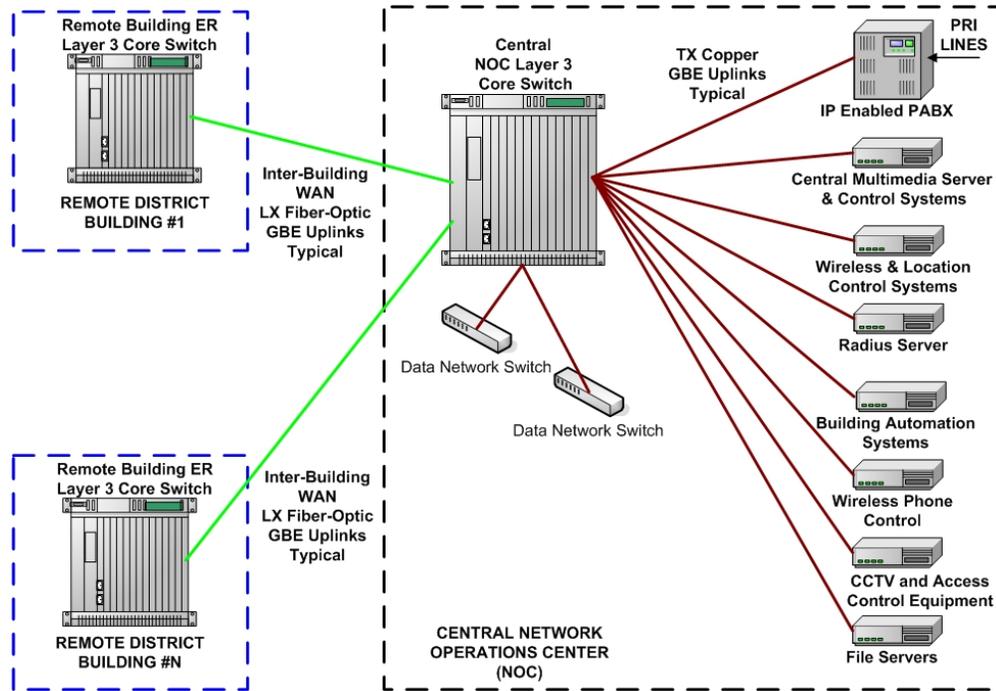


Figure 3 - Typical Data Communications Network System – District Wide

### 1.5 GENERAL

- A. Each Building shall be provided with a Local Area Network (LAN) System.
- B. Existing Facilities that are being remodeled shall be upgraded to the current requirements stated herein.
- C. Single Building projects shall be compatible with the existing District Network infrastructure.
- D. Wide Area Network (WAN) Interfaces shall be provided to interface the District's WAN provider. Coordinate WAN requirement with the District's fiber provider or DA-Site as applicable.
- E. Buildings shall be designed as to minimize the quantity of Telecommunications Rooms and to centralize as much of the Data Network Equipment as possible.
- F. Multiple buildings on the same campus should be designed to share common Data Network Electronics and equipment wherever possible.
- G. Districts should design their Data Networks to take advantage of Centralization of Common Network Equipment at a Network Operations Center(s).

- H. Items that should be centralized include:
  1. File/Building Servers.
  2. L-3 Routing Devices.
  3. Network Management Equipment.
  4. Security Devices, Radius Servers, etc.
  5. WAN access equipment.
  6. Wireless Management Equipment.
  
- I. As a minimum, the Network may be used to support the following applications on a Local and Wide Area basis:
  1. Automation Systems.
  2. Clock Systems.
  3. Control Systems.
  4. Data Networking
  5. Security Systems.
  6. Video Conferencing.
  7. Video Streaming/Media Retrieval.
  8. VoIP Telecommunications.
  9. Wireless Access Points.

#### 1.6 FILE/BUILDING SERVER

- A. Provide Network File/Building Server for the central administration and storage of computer files and information. The Networked Server shall be of a current design criteria, utilizing dual Processor Architecture, 100/1000 Ethernet NIC, Minimum 3.0 GHz, 4GB RAM, 15 inch color monitor, rack-mounted and RAID level hard drive storage (minimum 160 GB).
  
- B. ***Provide Operating System based on District requirements.***

#### 1.7 NETWORK SWITCHES

- A. Provide 10/100BaseT Layer 2 Manageable Ethernet Switches for all Horizontal connections with a minimum of one (1) full duplex Gigabit uplink for every 24 10/100 Ethernet Ports.
  
- B. Optional 10/100/1000 switches can be utilized.
  
- C. The 10/100 switches shall support a minimum forwarding bandwidth of 30 Mbps.
  
- D. Chassis mounted units are acceptable for 10/100 Edge Switches, provided that dual power supplies are provided and one Gigabit Uplink, per each group of 24 10/100 ports, is furnished for connection to the Central Layer-3 Core Switch.
  
- E. The Network switches shall support advanced services such as:
  1. IP Telephony.
  2. Wireless Access Points.
  3. Building Management Systems.
  4. Video Streaming.
  
- F. Power Over Ethernet (POE) Switches shall be IEEE 802.3.af compliant.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

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- G. Limit POE port loading to 50% of the active ports for 48 port switches to minimize heat rise.
  
  - H. The 10/100 switches shall support the following features and specifications:
    - 1. 1000BASE-LX/LH.
    - 2. 1000BASE-SX.
    - 3. 1000BASE-X (SFP).
    - 4. 1000BASE-ZX.
    - 5. Access Control Lists (ACL).
    - 6. Advanced QoS.
    - 7. IEEE 802.1s.
    - 8. IEEE 802.1D Spanning Tree Protocol.
    - 9. IEEE 802.1p CoS Prioritization.
    - 10. IEEE 802.1Q VLAN.
    - 11. IEEE 802.1s.
    - 12. IEEE 802.1w.
    - 13. IEEE 802.1x.
    - 14. IEEE 802.3 10BASE-T specification.
    - 15. IEEE 802.3ab 1000BASE-T specification.
    - 16. IEEE 802.3ad.
    - 17. IEEE 802.3af POE.
    - 18. IEEE 802.3u 100BASE-TX specification.
    - 19. IEEE 802.3x full duplex on 10BASE-T, 100BASE-TX, and 1000BASE-T ports.
    - 20. IEEE 802.3z 1000BASE-X specification.
    - 21. IPv6.
    - 22. Rapid Spanning Tree.
    - 23. Rate Limiting.
    - 24. RMON I and II standards.
    - 25. SNMPv1, SNMPv2c, and SNMPv3.
  
  - I. Provide sufficient 10/100 ports to accommodate, as a minimum, the following devices as required (note some devices may require a GBE connection):
    - 1. Access Control System.
    - 2. Admin PCs.
    - 3. Classroom PC Devices.
    - 4. Clock Systems.
    - 5. Distant Learning Systems.
    - 6. Instructor PCs.
    - 7. IP Phones, as required.
    - 8. IP Cameras, as required.
    - 9. Monitor/TVs, as required.
    - 10. MPEG Encoders.
    - 11. PABX System.
    - 12. Printers.
    - 13. Projectors.
    - 14. Set Top Boxes, as required.
    - 15. UPS Units.
    - 16. Wireless Access Points.

**1.8 NETWORK CORE SWITCH**

- A. Provide a Central Layer-3, Ethernet Routing Switch with advanced QoS and a minimum 256 Gigabit backbone capacity to service the entire building or campus.
- B. Equip the Central Layer-3 switch with a minimum of two (2) Power Supplies and two (2) Redundant Central Control/Supervisor Units.
- C. All Core switch Gigabit Port Blades must support full line speed and shall not be over-subscribed.
- D. Provide sufficient Gigabit (SX, LX and TX) Ports and 10/100/1000 Ports on the Layer-3 Core Switch, as a minimum, for the following devices:
  - 1. 10/100 Network Switch Up-Links – one link per 24 10/100 ports -- typically SX or LX based on distance). Distribute pairs of uplinks across multiple blades.
  - 2. Building Automation Systems, as required (typically TX).
  - 3. CCTV DVR System (typically TX).
  - 4. File Servers (typically TX).
  - 5. Firewall, as required (typically TX).
  - 6. Media Distribution Servers & Controllers (typically TX).
  - 7. Radius Authentication Server, as required, (typically TX).
  - 8. WAN Connectivity (typically LX or CWDM).
  - 9. Wireless Controllers (typically TX).
  - 10. Wireless Phone Controller (typically TX).
  - 11. Wireless Control Console (typically TX).
- E. In addition to the above listed features and specifications for the Network Switches, the Network Core Switch shall support the following Features and Specifications:
  - 1. 10 Gbps Support capabilities.
  - 2. BGP4 and Multicast Border Gateway Protocol (MBGP).
  - 3. Full Internet Control Message Protocol (ICMP) support.
  - 4. Hot Standby Router Protocol (HSRP).
  - 5. ICMP Router Discovery Protocol.
  - 6. IGMP filtering.
  - 7. IGMP v1, v2, and v3.
  - 8. IP Multicast routing protocols.
  - 9. IP routing protocols: EIGRP, OSPF, Routing Information Protocol (RIP), and RIP2.
  - 10. Non-Blocking GBE Ports.
  - 11. NSF awareness.
  - 12. Policy-based routing (PBR).
  - 13. Virtual Router Redundancy Protocol (VRRP).
- F. Attach Data Network 10/100 or 10/100/1000 switches to the Network Core Switch with one GBE Uplink per 24 Data Network Switch Ports.

**1.9 NETWORK SECURITY EQUIPMENT**

- A. **RADIUS SERVER**
  - 1. If the District does not have a Central Radius Server, provide a Radius Server for Network Authentication, VLAN Assignment and Policy Assignment for IP Network Attached Devices.

**COMMUNICATIONS****CHAPTER 9: SPECIFICATIONS**

- B. FIRE WALL
  1. If the District does not have a Central Firewall and Intrusion Detection Device for connection to the Wide Area Network and Internet, provide a Firewall and Intrusion Detection Device for Protection and Security. Establish all Internet Connections via a Firewall.
  2. Size the Firewall based on planned Network throughput, available WAN bandwidth and attached IP Devices.
  3. Provide VPN services in the Firewall for remote access and network maintenance services.
  4. Coordinate requirements with District Technology Department.

**1.10 UNINTERRUPTIBLE POWER SUPPLIES (UPSs)**

- A. Provide Dual Conversion UPS units for ER and TR Local area Network Electronics and File Server, providing sufficient protection from power anomalies.
- B. Provide Power strips, connected to the UPS Unit via twist-lock plugs. Locate the power strips in the equipment racks and on the equipment backboards for powering all electronics systems in the ER and TRs.
- C. Provide multiple UPS Units based on expected power load or a single large UPS Unit. Locate the multiple UPS units in the associated equipment racks or locate a larger central UPS unit in the Room.
- D. Connect the UPS Units to Building Emergency Generator when available.
- E. For buildings without a Generator, supply a two-hour (2) standby.
- A. Provide shutdown connections from the UPS to servers for graceful power down in the event of a power failure.
- G. Equip the UPS Units with a twist-Lock Power cable and SNMP Management Card.
- H. Connect the UPS SNMP Management to the Management VLAN.
- I. Coordinate UPS voltage, circuit size, and connection requirements with the Electrical Design Professional.

**1.11 INSTALLATION**

- A. Install File Server and setup basic user accounts and network configuration.
- B. Install Data Network Ethernet Switches and validate connectivity throughout. Establish all VLANs, QoS, IP Routing and IP Subnets.
- C. Consult with the District and consider providing the following VLANs as a minimum:
  1. Administration.
  2. HVAC.
  3. Management.
  4. Point of Sale.
  5. Student.

- 6. Video.
  - 7. Voice.
  - 8. Wireless.
- D. Coordinate network installation and integration with other systems connected to the network with District's and applicable DA-Site's technical and operational requirements.
  - E. Install and setup UPS units and establish power down procedures.
  - F. Connect System to DA-Site WAN Links and configure as per DA-Site requirements, when applicable.
  - G. Program and configure any State of Ohio Educational Network ATM switches required to access the DA-Site or the State of Ohio IVDL Network.
- 1.12 LABELING AND MARKING
- A. Provide a typed schedule of all data ports according to each related room jack designation for all TRs, and ER, in accordance with District's requirements.
- 1.13 TESTING
- A. Test the system "end-to-end" (from TR to ER, and from TR to station jack) at the direction of the Design Professional and verify, in writing, that the data network system is in proper working condition.
  - B. Verify and demonstrate proper operation of all switches, Access Points, VLANs, Routing, WAN Connectivity and possible ATM Connectivity with District and DA-Site representative, if applicable.
- 1.14 TRAINING
- A. Provide a minimum of twenty-four (24) hours of training to the District's personnel **and/or designated representative. Plan for multiple training trips to the site. Training session(s) shall cover the following topics at a minimum:**
    - 1. **System Equipment Connectivity**
    - 2. **Device Configurations**
    - 3. **Operation, maintenance, and upgrade procedures.**
  - B. **Trainer must be certified by the manufacturer.**
  - C. **Provide a copy of a sign off sheet (signed by District staff) for the completed training with the close-out documents.**
  - D. Provide two (2) video copies of the training **sessions.**

END OF SECTION

## SECTION 272133

## DATA COMMUNICATIONS WIRELESS ACCESS POINTS

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Data Communications Network Infrastructure that shall be followed for all OSFC Technology construction projects.
- B. Figure 1 describes Typical AP placement to insure proper coverage.
- C. Figure 2 describes Improper AP placement in narrow areas.
- D. Figure 3 describes Proper AP placement in narrow areas.
- E. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. DATA COMMUNICATIONS WIRELESS ACCESS POINTS
  - 1. Wireless Controllers and Network Tracking
  - 2. Wireless Access Points

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.
- G. All equipment shall provide protection and containment of unwanted wireless signals and prevent student access to unwanted networks and content, in accordance with CIPA requirements.

## 1.4 SYSTEM WARRANTY

- A. The Wireless Network Electronics and software shall be warranted by the contractor for a period of one (1) year from date of substantial completion. Provide advanced replacement for all Network Electronics for the one (1) year-period.

## 1.5 WIRELESS NETWORKING

## A. GENERAL

1. Provide Centrally Powered, **802.11n (current draft of standard)** Wireless Access Points and associated Wireless Network Controller(s), to support wireless Network Devices and Phones throughout the building and the associated campus.
2. Provide a Category-5e (minimum) cable drop for each AP. Terminate the AP Cable drop on a Category-5e Patch Panel at the associated Telecommunication Room (TR).
3. Connect the AP to the IP Network via an IEEE 802.3af Power Over Ethernet (POE) Switch Port or via a Mid-Span IEEE 802.3af POE Injector connected to the IP Network.
4. Coordinate 802.31x, VLAN and Security Settings/Requirements with the District.
5. Provide Wireless coverage for the entire building and associated perimeter area.
6. Provide minimum of -75 dB signal level at all locations in building for **802.11n (current draft of standard)** coverage.
7. Supply sufficient Access Points to provide for expected throughput and load sharing.
8. For labs and other high-density areas, make sure that the users can “see” at least 3 Access points to provide for load sharing and balancing.
9. Perform an RF Survey to verify coverage.
10. Coordinate with local Law Enforcement and Safety Forces regarding their requirements for remote and wireless access into building Security and Energy Management Systems.
11. Law Enforcement and Safety Forces shall be responsible for providing their own remote access equipment.

## B. WIRELESS CONTROLLERS AND LOCATION TRACKING

1. Equip each Building with a Wireless Controller(s). **Provide Location Tracking as an option. This may be a separate appliance or software upgrade to wireless controller(s).**
2. These devices shall be directly attached to the associated L-3 Network Core Switch via Gigabit interfaces as required.
3. These devices shall provide shall provide dynamic channel assignment, interference detection and avoidance, load balancing across multiple access points, guest networking, Voice over WLAN (VoWLAN) Support, layer-2 and layer-3 roaming support, coverage hole detection and avoidance, dynamic power control, user location and tracking services, and real-time rogue access point detection and containment.
4. The Wireless Network Controllers and Associated Location Tracking devices shall be controlled via a centrally located Wireless Control System Console. Typically, only one Wireless Control Console is required per District.

- C. WIRELESS ACCESS POINTS
1. Provide centrally powered IEEE **802.11n (current draft of standard)** Wireless Access Points (APs) for each new and remodeled building.
  2. The APs shall provide for rapid traffic forwarding capabilities that will enable the Access Points to support real-time voice, video and data services.
  3. Each AP shall be aware of neighboring access points, enabling effective real-time, and air traffic-management through load balancing.
  4. This feature shall be used to ensure maximum network uptime – clients shall be routed around a failed access point to the closest available alternative on a real-time basis without manual intervention.
  5. Each Access Point shall support a minimum of 14 VoWLAN Phones and dynamically throttle back non-VoIP traffic.
  6. Place and dimension the number of Access Points based on required throughput, load balancing and location tracking.
  7. ***The specifications for the AP's shall conform to the IEEE 802.11n standard or current draft standard at time of design (manufacturer of the AP's must guarantee that units are upgradeable to meet final ratified standard).***

#### 1.6 INSTALLATION

- A. Contractor shall provide and install Wireless System and associated cabling, POE devices, Central Controllers and Console.
- B. The Building Floor Plans and Site Plans shall be entered into the Central Wireless Control Console.
- C. The Central Wireless Control Console floor and site plans shall be calibrated after the installation has been performed.
- D. Access Point cables and associated connectors shall be terminated in accordance with industry standards.
- E. Balance Wireless Access Points to insure complete coverage with minimal service degradation.
- F. Setup Wireless Access Security and provide for CIPA Compliance.
- G. Determine the optimum location of all devices in the wireless LAN coverage areas and consider the access point density and location.
- H. Locate all internal Access Points above the ceiling tile grid wherever possible.
- I. Ensure that no fewer than 3 access points, and preferably 4 or 5, provide coverage to every area where device location is required. The more access points that detect a device, the better. This high level guideline translates into the following best practices, ordered by priority:
  1. Most importantly, access points should surround the desired location.
  2. Roughly, one access point should be placed every 43-53 linear feet (~13-16 meters). This translates into one access point every 1,800 to 2,800 square feet (~170-260 square meters).

3. Place access points along the periphery of coverage areas to help locate devices close to the exterior of rooms and buildings and to provide the best possible coverage (see figure 1)

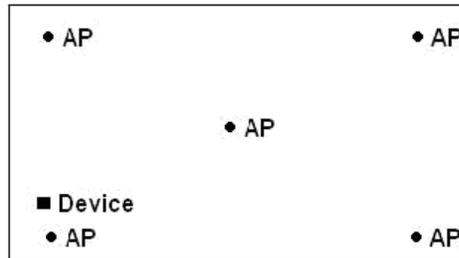


Figure 1 – Typical AP placement to insure proper coverage

4. In long and narrow coverage areas, refrain from placing access points in a straight line. Instead, attempt to stagger them (see figures 2 and 3).

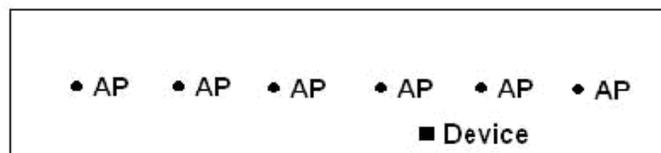


Figure 2 – Improper AP placement in narrow areas

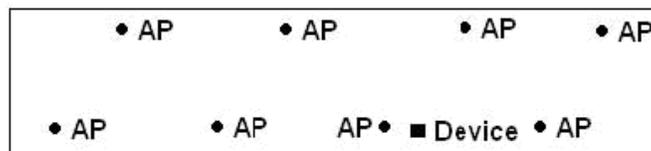


Figure 3 – Proper AP placement in narrow areas

5. Provide Antennas mounted external to the building for coverage of areas surrounding the building such as: playgrounds, parking lots, athletic fields, etc.
6. Connect the external antennas to APs mounted inside of the building.

## 1.7 LABELING

- A. Cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All AP Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.

## 1.8 TESTING

- A. Perform complete site survey after system placement and verify coverage and throughput.

**1.9 TRAINING**

- A. Provide a minimum of eight (8) hours of training to the District's personnel and/or designated representative. Plan for multiple training trips to the site. Training session(s) shall cover the following topics at a minimum:**
- 1. System Equipment Connectivity**
  - 2. Device Configurations**
  - 3. Operation, maintenance, and upgrade procedures.**
- B. Trainer must be certified by the manufacturer.**
- C. Provide a copy of a sign off sheet (signed by District staff) for the completed training with the close-out documents.**
- D. Provide two (2) video copies of the training sessions.**

END OF SECTION

## SECTION 273113

## IP-ENABLED PABX SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform IP-Enabled PABX System that shall be followed for all OSFC Technology construction projects.
- B. Refer to Section 8500, Technology Systems for additional information.

## 1.2 SECTION INCLUDES

- A. Central IP-Enabled PABX.
- B. Attendant Console Terminal.
- C. Executive Display Digital Voice Terminal.
- D. Standard Display Digital Voice Terminal.
- E. Single Line Voice Terminal.
- F. Voice Mail with Automated Attendant.
- G. E-911 Console.
- H. Uninterruptible Power Supply (UPS)

## 1.3 QUALITY ASSURANCE

- C. All equipment shall be UL listed.
- D. Compliance with the National Electric Code.
- E. Compliance with FCC rules.
- F. Comply with latest NENA E-911 requirements.

## 1.4 SYSTEM WARRANTY

- A. The telephone components, software, parts etc. shall carry a ONE (1) year full warranty, including labor and material.

1.5 **GENERAL REQUIREMENTS**

- A. Each Building's telephone system **must provide the following minimum requirements:**
  - 1) **Support for E-911.**
  - 2) **Support for the following carrier and Inter-switch interfaces:**
    - a) **Digital (T-1, PRI).**

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

- b) **Session Initiation Protocol (SIP).**
  - c) **Analog (POTS) lines.**
  - d) **Provide carrier circuit interfaces adequate to handle ALL incoming and outgoing calls.**
  - 3) **Support for Direct Inward Dialing (DID).**
  - 4) **Support for the following endpoints (phones/devices):**
    - a) **Digital (TDM)**
    - b) **IP (must support non proprietary H.323 and SIP compliant devices).**
    - c) **Analog (phones/faxes etc.)**
    - d) **Endpoints that provide "full duplex speakerphone" capability must be provided in specific rooms.**
    - e) **Provide system with capacity for all endpoints required plus 10% spare.**
  - 5) **Provide support for a minimum of two (2) fax stations per building.**
  - 6) **Provide UPS.**
- B.** System to have maintenance and administration terminal and remote access capabilities.
- C.** A common Telephone Switching Platform shall be used across the District to insure inter-operability. In the event that the District already has an established Telephone System that meets OSFC requirements, additional buildings may be added to the District, specifying existing Vendor's system.
- D.** In the event that no standard system exists for the District, then the OSFC PA shall decide if the first systems bid establish a critical mass and if the multiple vendor requirement can be waived.

### 1.6 WORK BY LOCAL UTILITIES

- A. Coordinate all work with the local and long-distance Service Providers (SPs).

### 1.7 IP-ENABLED PABX

- A. The Central Switching Exchange shall be a fully-digital, IP-Enabled (minimum) PBX Telephone Switch. **Key Systems and** hybrid intercom/telephone systems will NOT be acceptable.
- B. The IP-ENABLED PABX shall be Digital Signal Processing based to provide the flexibility to adapt to the changes in communications.
- C. The IP-ENABLED PABX must be modular in design.
- D. The IP-ENABLED PABX shall be sized according to student population and traffic requirements and shall be equipped with **carrier circuit interfaces** for incoming/outgoing call lines. The minimum circuits shall be as follows:
  - 1) One PRI **or equivalent SIP trunk** for up to 100 stations.
  - 2) Two PRIs **or equivalent SIP trunks** for greater than 100 stations.
  - 3) **Additional PRIs or equivalent SIP trunks** based on traffic requirements.

- 
- 4) *The use of analog central office (CO) line interface is acceptable if system is supporting existing analog phone service and as long as adequate line capacity is provided to support call traffic. System must still include digital carrier interface for future growth.***
- E.** The IP-ENABLED PABX shall be equipped with full Name and Number Caller ID functions for incoming and outgoing calls.
- F.** The IP-ENABLED PABX must be equipped with a minimum of three (3) analog lines to the local Service Provider for E-911 services and PRI backup.
- G.** Connect the Analog Lines to a Power Failure Transfer (PFT) Unit and supply a minimum of three (3) analog phones, located in the Central Office Area for emergency operation.
- H.** The telephone system must have the following minimum features:
- 1) Access Codes.
  - 2) Attendant's Console.
  - 3) Automatic Location Identifier (ALI).
  - 4) Automatic Number Identification Support (ANI).
  - 5) Call Accounting Software and Hardware.
  - 6) Call Conferencing.
  - 7) Call Forwarding on Busy.
  - 8) Call Forwarding External Calls
  - 9) Call Forwarding Internal Calls.
  - 10) Call Hold.
  - 11) Call Pickup.
  - 12) Call Screening.
  - 13) Dialed Number Identification Service (DNIS).
  - 14) Direct Inward Dialing (DID).
  - 15) Distinctive ring tones.
  - 16) Do Not Disturb
  - 17) E-911 and latest NENA support.
  - 18) E-911 Call Recording and Bridging to E-911 Central Console.
  - 19) FCC Registration.
  - 20) Full Caller ID – Incoming/Outgoing.
  - 21) Full duplex, Digital Display, Speaker Phones.
  - 22) Hands Free Intercom – Phone-to-Phone.
  - 23) IEEE 802.3af compliant VoIP Power
  - 24) Least Cost Routing.
  - 25) Maintenance and Administration Terminal.
  - 26) Malicious Call Trace/Hold.
  - 27) Message Waiting Lamp.
  - 28) Paging Interface (minimum 6 zones).
  - 29) Minimum of eight (8) Pre-program buttons.
  - 30) PRI/T-1 Trunking.
  - 31) Remote diagnostics.
  - 32) SIP Signaling Protocol
  - 33) Standards Based, VoIP Phone Support.
  - 34) Support wireless 802.11 VoWLAN phones
  - 35) System Speed Dial.
  - 36) Unified Messaging.
  - 37) VoIP Trunking – H.323 and SIP.
-

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- I.** Inter-Building Trunks (Links) between Systems shall be designed using T-1 Lines, PRI Lines or VoIP Trunking. A minimum capacity of 23 inter-building links shall be provided. Dimension all Trunks based on a minimum of P=0.01 Grade of Service.
- J.** When a high-speed WAN connection exists, use a VoIP connection between buildings.
- K.** Design the District-Wide system to provide for Least-Cost Routing and Toll-Bypass when applicable. Supply additional PRI circuits as required.
- L.** Provide IEEE 802.3af compliant Power Injectors/switches for all VoIP Phone instruments.
- M.** Each District Building's IP-ENABLED PABX shall be capable of complete stand-alone operation (with the exception of centralized voicemail) in the event that the Inter-Building Trunks (Links) are not operational.
- N.** District-Wide Systems shall function as a single system with Common Features, Centralized Voice Mail, and Centralized Call Detail Recording with a single record per call and the ability for Centralized Attendant Service for the entire District.
- O.** When more than one building per District is involved, all incoming and outgoing calls **may** be routed over **carrier circuits** connected to a Central IP-Enabled PABX. The Central IP-ENABLED PABX capacity shall be dimensioned to handle all current and planned District buildings.
- P.** IP-ENABLED PABX units shall employ a hardened Operating System that is not susceptible to Internet Computer Viruses.
- Q.** IP-ENABLED PABX units shall be provided with a minimum of 10% spare line/station capacity at initial installation.
- R.** The PABX shall be an IP-Enabled PABX or an IP Based PABX. The all IP Based system shall maintain the same high level of functionality, redundancy and programmable features as originally specified. Any all-IP system shall employ standards based signaling, instrument powering and redundant call servers in each District Building served by the system. See Section 273123 for additional details.
- S.** Provide centralized PABX and phone instrument power with a minimum of two (2) Busy-Hour standby capabilities for all PABX equipment. IP Based systems shall also be provided with two (2) Busy-Hour standby capabilities for all powered Switches or Patch Panels located in each Telecommunications Room (TR). Connect the Central Power Supplies to Building Emergency Power when available.
- T.** All IP Instruments and power sources shall be IEEE 802.3af compliant.
- U.** All PABX systems shall support IP Inter-building trunking (H.323 or SIP) and the attachment of IP Instruments such as IP Phones, PDAs, Soft Phones and 802.11 Phones.
- V.** As a minimum, the Call Accounting shall include date, time, duration of call, extension number, account code (if applicable) and number dialed along with software export features to standard spread sheets.

## 1.8 ATTENDANT CONSOLE TERMINAL

- A. Minimum of 32 Character LCD Display.
- B. Display day, date and time.
- C. Display call durations.
- D. Display caller name and extension/telephone number and incoming caller-ID information.
- E. Hands free, Full-Duplex, Speakerphone.
- F. Shall have a system display panel capable of showing all system extension numbers and their status and capable of extending calls via single touch operation.
- G. Provide a minimum of two (2) consoles per building for load sharing and redundancy.

## 1.9 ADMINISTRATIVE DISPLAY DIGITAL VOICE TERMINAL

- A. Provide one administrative phone for all administrative areas, conference rooms, small group rooms, **nurse/health office, and special needs rooms.**
- B. At least sixteen characters display window.
- C. At least sixteen programmable keys.
- D. Hands free, **Full-Duplex** Speakerphone.
- E. Display caller name and extension/telephone number.
- F. Message Waiting Lamp.
- G. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the central console, as well as the local 911 center.

1.10 **STANDARD DISPLAY** DIGITAL VOICE TERMINAL

- A. Provide one standard 8 button phone for all classrooms, labs, **general offices**, and other areas not covered above in section **1.9**.
- B. At least sixteen characters display window.
- C. At least eight (8) programmable keys.
- D. Hands free, Speakerphone. **Full Duplex required if One Way Paging Variance is utilized.**

**COMMUNICATIONS**

- E. Display caller name and extension/telephone number.
- F. Message Waiting Lamp.
- G. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the central console, as well as the local 911 center.

**1.11 CONFERENCE PHONE**

- A. *As a minimum, provide Multi-User, Full-Duplex conference Speakerphone for Conference Rooms and/or Principal's Office.***

**1.12 VoWLAN PHONES**

- A. Provide a minimum of **two** Wireless VoIP (VoWLAN) Phone instruments, with carrying case and charger units.
- B. Provide integral VoWLAN 802.11e QoS capability or SVP server for VoWLAN QoS.

**1.13 VOICE MAIL SYSTEM**

- A. System shall have the following number of voice ports:
  - 1)** Minimum of 4 ports (450 students).
  - 2)** Minimum of 8 ports (650 students).
  - 3)** Minimum of 12 ports (850 students).
- B. System shall have the following capacity:
  - 1)** One voice mail box per station plus 20% minimum spares.
- C. System shall have an automated attendant.
- D. System shall be fully integrated with IP-Enabled PABX.
- E. System shall activate telephone station "message waiting" light.
- F. System shall have Integrated Messaging capability. Supply based on District's requirements. Verify E-Mail Server compatibility (Exchange, Notes, Groupwise, etc.)

**1.14 E-911 CONSOLE**

- A. System shall support Call Bridging at Console for all E-911 calls.
- B. System shall provide Call Recording for E-911 Calls.
- C. System shall support full NENA Compliant ANI and ALI data transmission from local Data Base to PSAP.

**1.15 UNINTERRUPTIBLE POWER SUPPLIES (UPS)**

- A. Provide Dual Conversion UPS units for Main Telephone Switch, providing sufficient protection from power anomalies for two (2) busy hours.
- B. Provide multiple UPS Units based on expected power load or a single large UPS Unit. Locate the multiple UPS units in the associated equipment racks or locate a larger central UPS unit in the Room.

- C. Connect the UPS Units to Building Emergency Generator.
- D. For buildings without a Generator, supply a four-hour (4) standby.
- E. Provide shutdown connections from the UPS for graceful power down in the event of a power failure.
- F. Equip the UPS Units with a twist-Lock Power cable and SNMP Management Card.
- G. Connect the UPS SNMP Management to the Management VLAN.
- H. Coordinate UPS voltage, circuit size, and connection requirements with the Electrical Design Professional.

**1.16 INSTALLATION**

- A. Coordinate complete system installation, and Technology Head End Integration with District and other Technology Trades.
- B. Coordinate installation and interconnect with local and long-distance Service Provider (SP). Contractor shall be responsible for all final cross connects and system Data Base loading and verification.
- C. Contractor shall connect to, and interface with the in-house paging system and provide paging from any telephone handset.
- D. Connect system to IP Data Network and program required VLANs and 803.11e support.
- E. Interconnect with existing systems via VoIP trunking.
- F. Integrate system with District's Numbering Plan.

**1.17 SYSTEM PROGRAMMING**

- A. Contractor shall provide the District/architect with a complete set of forms for the entire system and extension features for final programming.
- B. Final programming of the system shall be co-developed between the District/architect and the contractor and must be approved prior to being implemented for system start-up.
- C. Contractor shall supply the "latest" software updates as part of the system configuration or two (2) years after system acceptance.

**1.18 TRAINING**

- A. Contractor shall provide a minimum of four (4) 2-hour, user system training classes, sixteen hours (16) of attendant Console Training and forty hours (40) of system programming and administration training to the District. Training shall be provided to all staff and shall be scheduled in advance with the District.
  - 1) Contractor shall provide two (2) video copies of all training.

END OF SECTION

## SECTION 273123

## IP ONLY PABX SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform IP ONLY PABX System that shall be followed for all OSFC Technology construction projects.
- B. Refer to Section 8500, Technology Systems, 27 13 13, Copper Back Bone Systems and 27 31 13, IP-Enabled PABX System for additional information.

## 1.2 SECTION INCLUDES

- A. Central IP PABX.
- B. Attendant Console Terminal.
- C. Executive Display Voice Terminal.
- D. Standard Display Voice Terminal.
- E. Single Line Voice Terminal.
- F. Voice Mail with Automated Attendant.
- G. E-911 Console.
- H. Uninterruptible Power Supply (UPSs).

## 1.3 QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. Compliance with the National Electric Code.
- C. Compliance with FCC rules.
- D. Comply with latest NENA E-911 requirements.

## 1.4 SYSTEM WARRANTY

- A. The telephone components, software, parts etc. shall carry a ONE (1) year full warranty, including labor, software and material.

1.5 **GENERAL REQUIREMENTS**

- A. ***Each Building's telephone system must provide the following minimum requirements:***
  - 1) ***Support for E-911.***

- 2) **Support for the following carrier and Inter-switch interfaces:**
    - a) **Digital (T-1, PRI)**
    - b) **Session Initiation Protocol (SIP)**
    - c) **Analog (POTS) lines**
    - d) **Provide carrier circuit interfaces adequate to handle ALL incoming and outgoing calls.**
  - 3) **Support for Direct inward Dialing (DID).**
  - 4) **Support for the following endpoints (phones/devices):**
    - a) **Digital (TDM)**
    - b) **IP (must support non-proprietary H.323 and SIP-compliant devices)**
    - c) **Analog (phones/faxes etc.)**
    - d) **Endpoints that provide "full duplex speakerphone" capability must be provided in specific rooms.**
    - e) **Provide system with capacity for all endpoints required plus 10% spare.**
  - 5) **Provide support for a minimum of two (2) fax stations per building.**
  - 6) **Provide UPS.**
- B. System to have maintenance and administration terminal and remote access capabilities.
- C. A common Telephone Switching Platform shall be used across the District to insure inter-operability. In the event that the District already has an established Telephone System that meets OSFC requirements, additional buildings may be added to the District, specifying existing Vendor's system.
- D. In the event that no standard system exists for the District, then the OSFC PA shall decide if the first systems bid establish a critical mass and if the multiple vendor requirement can be waived.

#### 1.6 WORK BY LOCAL UTILITIES

- A. Coordinate all work with the local and long-distance Service Providers (SPs).

#### 1.7 IP PABX

- A. The Central Switching Exchange shall be a fully-digital, IP Based PBX Telephone Switch.
- B. The IP PABX must be modular in design.
- C. The IP PABX shall be sized according to student population and traffic requirements and shall be equipped with **carrier circuit interfaces** for incoming/outgoing call lines. The minimum circuits shall be as follows:
  - 1) One PRI **or equivalent SIP trunk** for up to 100 stations.
  - 2) Two PRIs **or equivalent SIP trunks** for greater than 100 stations.
  - 3) Additional PRIs **or equivalent SIP trunks** based on traffic requirements.
  - 4) **The use of an analog central office (CO) line interface is acceptable if system is supporting existing analog phone service and as long as adequate line capacity is provided to support call traffic. System must still include digital carrier interface for future growth.**

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- D.** The IP PABX shall be equipped with full Name and Number Caller ID functions for incoming and outgoing calls.
- E.** With few exceptions, the IP Only PABX system shall provide the same basic features and functionality as an IP-Enabled PABX.
- F.** The IP PABX must be equipped with a minimum of three (3) analog lines to the local Service Provider for E-911 services and PRI backup.
- G.** Connect the Analog Lines to a Power Failure Transfer (PFT) Unit and supply a minimum of three (3) analog phones, located in the Central Office Area for emergency operation.
- H.** The common control units for the IP PABX shall be fully duplicated.
- I.** The media gateways and other ancillary devices shall be distributed across a minimum of at least two (2) units for redundancy. For example, analog interfaces, PRI interfaces, etc. shall be duplicated.
- J.** For single building configurations, the duplicate Common Control Units, media gateways and other common devices shall all be located in the Main Equipment Room.
- K.** For multiple building configurations, consideration shall be given to distributing the common control units and media gateways between two buildings.
- L.** When an IP PABX system is deployed across the District, all **carrier circuits** and Voice mail and other common Services shall be centralized – a minimum of two central locations is required.
- M.** Design the District-Wide system to provide for Least-Cost Routing and Toll-Bypass when applicable. Supply additional PRI circuits as required.
- N.** All buildings shall be equipped with a survivable remote unit that shall continue to provide basic call processing for users via the back-up analog lines. Voice mail will not be required during a WAN Link cut between a remote building and a Core Building.
- O.** When the Wide Area Network permits, remote buildings shall be configured in such a fashions as to “dual-home” on the two, distributed Central Processing units.
- P.** With few exceptions, all IP station devices shall be served by a dedicated Work Area Cable and Voice traffic shall be segregated from standard data traffic by providing dedicated 802.3af Power Over Ethernet (POE) Switches for the Voice Network.
- Q.** The POE switches shall follow the same design rules as the Data Network Switches, namely, one (1) dedicated GBE link to the Data Network Layer-3 Core switch per 24 10/100 ports.
- R.** The designer shall adjust the quantity of L-3 Core switch ports and associated fiber and UPS units to accommodate the additional POE switches.

- S.** All IP Phone instruments shall be 802.3af powered from POE Ethernet switches.
- T.** Due to the advanced features available on some IP Phones, consideration shall be given to locating selected IP instruments on desktops rather than wall mounting the units.
- U.** Consideration shall be given to supplying additional call processing software to enable user desk-top PCs to interoperate with the IP PABX advanced SIP based presence features (audio and video conferencing, integrated messaging, etc.).
- V.** Connections between the Data Network and the voice network shall be made via a vendor supplied firewall device.
- W.** As a minimum, the Call Accounting shall include date, time, duration of call, extension number, account code (if applicable) and number dialed along with software export features to standard spread sheets.
- X.** The IP PABX telephone system must have the following minimum features:
- 1) Access Codes.
  - 2) Attendant's Console.
  - 3) Automatic Location Identifier (ALI).
  - 4) Automatic Number Identification Support (ANI).
  - 5) Call Accounting Software and Hardware.
  - 6) Call Conferencing.
  - 7) Call Forwarding on Busy.
  - 8) Call Forwarding External Calls
  - 9) Call Forwarding Internal Calls.
  - 10) Call Hold.
  - 11) Call Pickup.
  - 12) Call Screening.
  - 13) Dialed Number Identification Service (DNIS).
  - 14) Direct Inward Dialing (DID).
  - 15) Distinctive ring tones.
  - 16) Do Not Disturb
  - 17) E-911 and latest NENA support.
  - 18) E-911 Call Recording and Bridging to E-911 Central Console.
  - 19) FCC Registration.
  - 20) Full Caller ID – Incoming/Outgoing.
  - 21) Full duplex, Digital Display, Speaker Phones.
  - 22) Hands Free Intercom – Phone-to-Phone.
  - 23) IEEE 802.3af compliant VoIP Power
  - 24) Least Cost Routing.
  - 25) Maintenance and Administration Terminal.
  - 26) Malicious Call Trace/Hold.
  - 27) Message Waiting Lamp.
  - 28) Paging Interface (minimum 6 zones).
  - 29) Minimum of eight (8) Pre-program buttons.
  - 30) PRI/T-1 Trunking.
  - 31) Remote diagnostics.
  - 32) SIP Signaling Protocol
  - 33) Standards Based, VoIP Phone Support.
  - 34) Support wireless 802.11 VoWLAN phones

**COMMUNICATIONS****CHAPTER 9: SPECIFICATIONS**

- 35)** System Speed Dial.
- 36)** Unified Messaging.
- 37)** VoIP Trunking – H.323 and SIP.
- Y.** The IP PABX shall be dimensioned to support a minimum ABH traffic capacity of 7.0 ccs per line.
- Z.** Inter-Building Trunks (Links) between Systems shall be designed using T-1 Lines, PRI Lines or VoIP Trunking. A minimum capacity of 23 inter-building links shall be provided. Dimension all Trunks based on a minimum of P=0.01 Grade of Service.
- AA.** When a high-speed WAN connection exists, use a VoIP connection between buildings.
- BB.** Provide IEEE 802.3af compliant Power Injectors/switches for all VoIP Phone instruments.
- CC.** Each District Building's IP PABX shall be capable of complete stand-alone operation (with the exception of centralized voicemail) in the event that the Inter-Building Trunks (Links) are not operational. Calling operation shall be limited only by the external links (trunks) available,
- DD.** District-Wide Systems shall function as a single system with Common Features, Centralized Voice Mail, and Centralized Call Detail Recording with a single record per call and the ability for Centralized Attendant Service for the entire District.
- EE.** When more than one building per District is involved, all incoming and outgoing calls shall be routed over PRI Line(s) connected to a Central IP-Enabled PABX. The Central IP-ENABLED PABX capacity shall be dimensioned to handle all current and planned District buildings.
- FF.** IP PABX units shall employ a hardened Operating System that is not susceptible to Internet Computer Viruses.
- GG.** IP PABX units shall be provided with a minimum of 10% spare line/station capacity at initial installation.
- HH.** The all IP Based system shall maintain the same high level of functionality, redundancy and programmable features as originally specified. Any all-IP system shall employ standards based signaling, instrument powering and redundant call servers in each District Building served by the system.
- II.** Provide centralized PABX and phone instrument power with a minimum of two (2) Busy-Hour standby capabilities for all PABX equipment. IP Based systems shall also be provided with two (2) Busy-Hour standby capabilities for all powered Switches or Patch Panels located in each Telecommunications Room (TR). Connect the Central Power Supplies to Building Emergency Power when available.
- JJ.** All IP Instruments and power sources shall be IEEE 802.3af compliant.
- KK.** All PABX systems shall support IP Inter-building trunking (H.323 or SIP) and the attachment of IP Instruments such as IP Phones, PDAs, Soft Phones and 802.11 Phones.

**1.8 ATTENDANT CONSOLE TERMINAL**

- A. Minimum of 32 Character LCD Display.
- B. Display day, date and time.
- C. Display call durations.
- D. Display caller name and extension/telephone number and incoming caller-ID information
- E. Hands free, Full-Duplex, Speakerphone.
- F. Shall have a system display panel capable of showing all system extension numbers and their status and capable of extending calls via single touch operation.
- G. Provide a minimum of two (2) consoles per building for load sharing and redundancy.
- H. Optional soft consoles should be considered by the designer for the attendant.

**1.9 ADMINISTRATIVE DISPLAY IP VOICE TERMINAL**

- A. Provide one administrative phone for all administrative areas, conference rooms, small group rooms, **nurse/health office, and special needs rooms.**
- B. At least sixteen characters display window.
- C. At least sixteen programmable keys.
- D. Hands free, **Full-Duplex** Speakerphone.
- E. Display caller name and extension/telephone number.
- F. Message Waiting Lamp.
- G. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the central console, as well as the local 911 center.
- H. IEEE 802.3af powered.

**1.10 STANDARD DISPLAY DIGITAL VOICE TERMINAL**

- A. Provide one standard 8-button phone for all classrooms, labs, **general offices**, and other areas not covered in section **1.9** above.
- B. At least sixteen characters display window.
- C. At least eight (8) programmable keys.
- D. Hands free, Speakerphone. **Full Duplex required if One Way Paging Variance is utilized.**

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- E. Display caller name and extension/telephone number.
- F. Message Waiting Lamp.
- G. Pre-programmed E-911 button that automatically puts the phone into a hands-free mode, and initiates a 3-way conference call with the central console, as well as the local 911 center.
- H. IEEE 802.3af powered.

**1.11 CONFERENCE PHONE**

- A. ***At a minimum, provide Multi-User, Full-Duplex conference Speakerphone for Conference Rooms and/or Principal's Office.***

**1.12 VoWLAN PHONES**

- A. Provide a minimum of **two** Wireless VoIP (VoWLAN) Phone instruments, with carrying case and charger units.
- B. Provide integral VoWLAN 802.11e QoS capability or SVP server for VoWLAN QoS.

**1.13 VOICE MAIL SYSTEM**

- A. System shall have the following number of voice ports:
  - 1) Minimum of 4 ports (450 students).
  - 2) Minimum of 8 ports (650 students).
  - 3) Minimum of 12 ports (850 students).
- B. System shall have the following capacity:
  - 1) One voice mailbox per station plus 20% minimum spares.
- C. System shall have an automated attendant.
- D. System shall be fully integrated with the IP PABX.
- E. System shall activate telephone station "message waiting" light.
- F. System shall have Integrated Messaging capability. Supply based on District's requirements. Verify E-Mail Server compatibility (Exchange, Notes, Groupwise, etc.)

**1.14 E-911 CONSOLE**

- A. System shall support Call Bridging at Console for all E-911 calls.
- B. System shall provide Call Recording for E-911 Calls
- C. System shall support full NENA Compliant ANI and ALI data transmission from local Data Base to PSAP.

**1.15 UNINTERRUPTIBLE POWER SUPPLIES (UPS)**

- A. Provide Dual Conversion UPS units for call processing equipment, providing sufficient protection from power anomalies for two (2) busy hours.
- B. Provide multiple UPS Units based on expected power load or a single large UPS Unit. Locate the multiple UPS units in the associated equipment racks or locate a larger central UPS unit in the Room.

- C. Connect the UPS Units to Building Emergency Generator when available.
- D. For buildings without a Generator, supply a four-hour (4) standby.
- E. Provide shutdown connections from the UPS for graceful power down in the event of a power failure.
- F. Equip the UPS Units with a twist-Lock Power cable and SNMP Management Card.
- G. Connect the UPS SNMP Management to the Management VLAN.
- H. Coordinate UPS voltage, circuit size, and connection requirements with the Electrical Design Professional.

**1.16 INSTALLATION**

- A. Coordinate complete system installation, and Technology Headend Integration with District and other Technology Trades.
- B. Coordinate installation and interconnect with local and long-distance Service Provider (SP). Contractor shall be responsible for all final cross connects and system Data Base loading and verification.
- C. Contractor shall connect to, and interface with the in-house paging system and provide paging from any telephone handset.
- D. Connect system to IP Data Network and program required VLANs, Firewall and 803.11e support.
- E. Interconnect with existing systems via VoIP trunking.
- F. Integrate system with District's Numbering Plan.

**1.17 SYSTEM PROGRAMMING**

- A. Contractor shall provide the District/architect with a complete set of forms for the entire system and extension features for final programming.
- B. Final programming of the system shall be co-developed between the District/architect and the contractor and must be approved prior to being implemented for system start-up.
- C. Contractor shall supply the "latest" software updates as part of the system configuration for two (2) years after system acceptance.

**1.18 TRAINING**

- A. Contractor shall provide a minimum of four (4) 2-hour, user system training classes, sixteen hours (16) of attendant Console Training and forty hours (40) of system programming and administration training to the District. Training shall be provided to all staff and shall be scheduled in advance with the District.
  - 1) Contractor shall provide two (2) video copies of all training.

END OF SECTION

## SECTION 274117

## BROADBAND VIDEO RF DISTRIBUTION SYSTEM

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Coaxial Broadband RF Distribution System that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a Typical Coaxial Communications Cabling System – ER Serves all Locations.
  - 2. Figure 2 describes a Typical Coaxial Communications Cabling System – Multiple TRs.
  - 3. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. BROADBAND VIDEO RF DISTRIBUTION SYSTEM
  - 1. RF Head End.

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.
- G. As a minimum, all equipment shall meet Category 5e transmission performance standards.

**1.4 SYSTEM WARRANTY**

- A. System shall carry an industry standard, performance based warranty, by the manufacturer and contractor, for a period of at least 20 years on the coax cabling; including patch panels, patch cables, terminations and labor. The remaining portions of the system shall be warranted for a period of one (1) year from date of substantial completion.

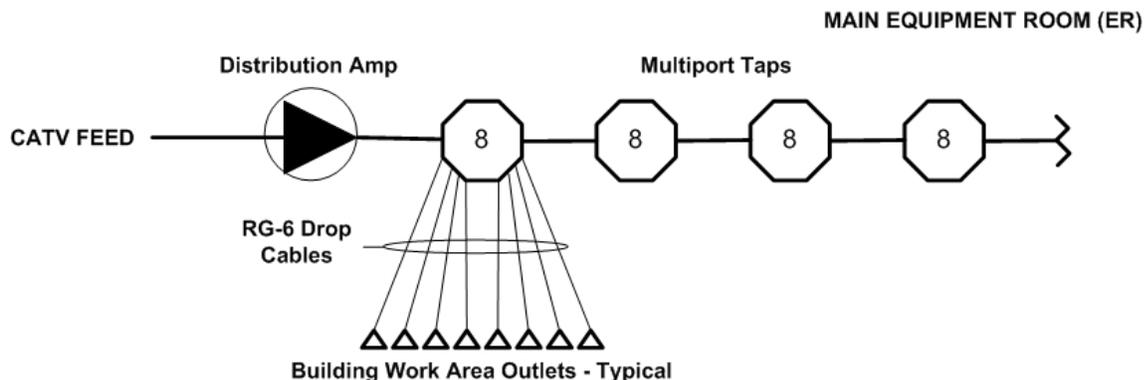


Figure 2 - Typical Coaxial Communications Cabling System – ER serves all Locations

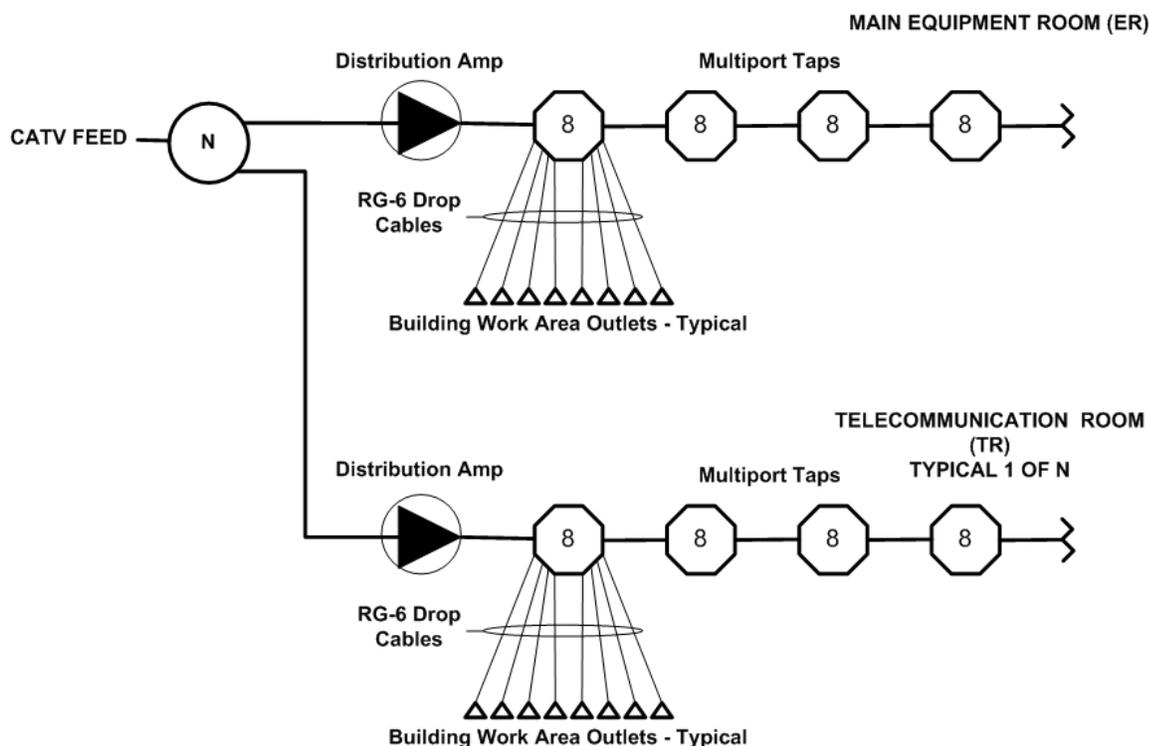


Figure 2 - Typical Coaxial Communications Cabling System – Multiple TRs

## 1.5

### RF HEAD END

#### A. GENERAL

1. When a building is not supplied with an MPEG, CATV, Head-End System, a Coaxial Cable based CATV RF Broadband System is required.
2. Provide a Horizontal Coaxial Cable RF Broadband System for all new and renovated Buildings.
3. Buildings served with a MPEG CATV Head end do not require a Horizontal Coaxial Cable System.

**COMMUNICATIONS****CHAPTER 9: SPECIFICATIONS**

4. For most buildings, a star-wired, Coaxial Cable, CATV System can be served from one closet (the Main Equipment Room – ER) – drops up to 450 feet.
  5. For large buildings that cannot be served only from the Main Equipment Room (ER), the horizontal coaxial cables connect to the associated TRs.
  6. The CATV Horizontal Coaxial Cable RF Broadband System shall have a minimum frequency bandwidth between 5MHz and 1000MHz and full support for HDTV.
  7. All RF devices shall be two-way for return video capability.
  8. Provide all combining and splitting devices, as required.
  9. Provide terminating devices and directional couplers, as required.
  10. Provide all video distribution amps, as required.
  11. Provide channel elimination filters, as required.
  12. Provide Agile Channel Modulators, as required.
  13. Provide Cable Equalizers, as required.
- B. HORIZONTAL COAX CABLE**
1. The RF Broadband Wiring System shall be a bi-directional, star-wired, home-run, coaxial distribution system using Quad Shielded RG-6 Coax Cable.
  2. The RG-6 coaxial cables shall be CATVP rated.
  3. The coaxial cables shall be sweep tested to 1000 MHz and shall meet the following minimum performance values listed in dB/100 feet:

| Mhz  | Series 6 |
|------|----------|
| 55   | 1.50     |
| 450  | 4.28     |
| 750  | 5.82     |
| 1000 | 6.54     |

Figure 3 – RG-6 Coaxial Cable Minimal Parameters

**1.6 COAXIAL CABLE CONNECTORS**

- A. Provide two-part, crimp-style, Coax Cable, Male F-Connectors at each end of the RG-6, Horizontal Coaxial Cables.
- B. Match the connectors to the Coaxial Cable Manufacturer.

**1.7 RF DISTRIBUTION AMPLIFIER SYSTEM**

- A. Provide a rack-mounted RF Broadband amplifier 49-750 MHz and minimum of 32 dB Gain for the head end.
- B. Connect the RF Amplifier input to the CATV Feed and connect the output to a bank of centrally mounted 8 port taps.
- C. Connect the Work Area Coaxes to the taps as required to provide the required Work Area Outlet signal strength.
- D. Provide multiple tap values based on the coax cable lengths served. Terminate all unused outputs.

- E. Supply equalizers on the amplifier input, as required, to insure a +/- 2 dB flat signal input to the Distribution Amplifier.
- F. The amplifier input should be set 3-6 dB over the amplifier noise factor (sweet spot) – which is usually around 8 dB – yielding a typical input value between +11 -- +14 dBmv.
- G. If the CATV feed is not strong enough install a pre-amplifier on the CATV feed or arrange for the CATV service provider to adjust the incoming signal upwards. The optimum CATV input signal for the case where the ER serves all locations is +11 to +14 dBmv, flat across all input channels.
- H. Adjust the amplifier gain and slope to provide a minimum of a +3 dBmv signal across all channels at each Work Area outlet.
- I. The maximum signal across all channels shall be limited to +10 dBmv.
- J. When the building size requires more than one serving area, split the incoming CATV signal as required based on the number of serving areas and connect the splitter outputs to RG-11 feeder cables for each serving area.
  1. Adjust the CATV feeder signal upwards accordingly to compensate for the additional loss of the head end splitter.
  2. Provide a pre-amplifier on the CATV input signal feed if unable to obtain the required signal levels.
  3. Provide equalizers at the end of long RG-11 feeders to insure a flat input signal level to the far end Distribution amplifiers.
  4. Install attenuators on amplifier inputs as required to keep the input signal within the +11 to +14 dBmv (typical) sweet-spot range.

## 1.8 INSTALLATION

- A. All cabling shall be installed according to ANSI/EIA/TIA specifications and **BICSI** standards.
- B. All coaxial cabling shall be terminated on rack-mounted patch panels using F-Connectors, as noted above.
- C. Broadband Wiring System shall be designed for signal balance of +3 to +10dBmv signal level at every video outlet location over the entire channel range.
- D. Adjust amplifier tilt and gain as required. Connect User Coax to appropriate multi-port tap based on loss required to balance system. Supply Cable Equalizers as required.

## 1.9 LABELING

- A. Patch panels, cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All Coaxial Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.

**COMMUNICATIONS**CHAPTER 9: SPECIFICATIONS

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- C. All Coaxial Cable Patch Panels shall be equipped with pre-printed, cable identification designation strips installed behind clear plastic label holders on the front of the patch panel.

## 1.10 TESTING

- A. All Cable test results shall be stored and presented to the Architect in both hard copy and electronic format for approval.
- B. All Cable Tester, Record designations shall match the associated cable label, and associated patch panel label designation.
- C. All Coaxial Cables shall be tested with a hand held cable tester.

END OF SECTION

## SECTION 274119

## VIDEO DISPLAY EQUIPMENT

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for uniform Interactive Video Display Equipment that shall be followed for all OSFC Technology construction projects.
- B. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. VIDEO DISPLAY EQUIPMENT
  - 1. LCD TV AND PROJECTOR MOUNTS
  - 2. LCD TV/Monitor Units
  - 3. Projectors

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- E. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards as applicable.

**1.4 SYSTEM WARRANTY**

- A. The Video Display Equipment Systems and associated software shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

**1.5 GENERAL**

- A. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.6 LCD TV AND PROJECTOR MOUNTS**

- A. Provide wall type LCD mounts with appropriate forward tilt, as required.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- B. Provide Ceiling Mounts for projectors with appropriate knockouts for electrical outlet and A/V cables.
- C. Utilize security/theft-deterrent mounting hardware on all projectors and displays and mounts as required.

## 1.7 PROJECTORS

- A. Provide High-Resolution Projectors for each classroom and large venue viewing spaces.
- B. Projectors are the required classroom display device. Provide Projectors for small viewing rooms or conference room, as required.
- C. ***Projector shall produce light output that results in a minimum of 10:1 contrast ratio. The projector's lumen output shall be at least 60 foot-candles of full white light on the projection screen when the projected image fills the screen. Example given: Typical 900 to 1000 SF classroom utilizing a screen 60"H x 80"W (3:4 aspect ratio) screen would require a projected output of => 2500 lumen. Projector shall be network attached, projector with native XGA resolution or better for classrooms. Projectors shall have support for 16:9.***
- D. The primary classroom display device shall be an overhead-mounted ***or wall mounted (integrated with interactive whiteboard)***, XGA projector with associated permanent mounting and security hardware and associated screen or reflective marker surface (Use an associated ***device*** as the TV Tuner when District has a Broadband Head-end).
- E. Provide Projectors with Ethernet connection and central management software.

## 1.8 TV/MONITOR

- A. The LCD Monitors/TVs shall be equipped with a combination analog and digital 181-channel tuner and shall have minimum native resolution of 1024 x 768 (XGA) and support 1080p without the use of scan-converters or line-doublers.
- B. The minimum LCD TV/Monitor shall be 32 inches.
- C. Provide LCD Monitor/TV for Public viewing in Entrances, Corridors and/or Reception areas, meeting rooms, and Small Self-Contained Classrooms.
- D. Provide LCD Monitor/TV Units with Ethernet connection and central management software.
- E. Large XGA monitors may ONLY be supplied to match existing installations or based on specific District requirements and OSFC approval. Connect to associated DVD/VHS Player, Instructor PC and optional Set-Top-Box to Classroom Sound System.

**1.9 LARGE VENUE VIDEO PROJECTOR**

- A. Provide a large screen format, 5000 Lumen minimum, projector for the student dining area, auditorium and other large venue areas. Provide Keystone correction as required.
- B. Provide a lift system allowing multiple heights for storage, normal use, and service, as required.
- C. Provide front or rear screen projection based on District's and Architect's requirements.

**1.10 OPTIONAL A/V CONTROL SYSTEM**

- A. Full user control of VCR/DVD and projector through either web-based application or user wall panel.
- B. System diagnostics and scheduled operation of media devices via web-based application.

**1.11 INSTALLATION**

- A. Mount Projectors and LCD TV/Monitors using manufacturer's recommended hardware.
- B. Connect Devices to IP Network for Central Control.
- C. Adjust all Projectors for proper focus, keystone correction and display size.
- D. Install all associated software monitoring and control programs.

**1.12 TESTING**

- A. Verify picture quality on all A/V inputs.
- B. Test all associated software control programs.

END OF SECTION

## SECTION 274120

## INTERACTIVE AUDIO-VIDEO EQUIPMENT

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for uniform Interactive Audio-Video Equipment that shall be followed for all OSFC Technology construction projects.
- B. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.
- C. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Interactive Audio-Video Equipment
  - 1. Interactive White Boards.
  - 2. Interactive Writing Tablets.
  - 3. **Student Response System.**
  - 4. **Document Camera.**

## 1.3 QUALITY ASSURANCE

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- E. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards as applicable.

## 1.4 SYSTEM WARRANTY

- A. The Interactive Audio-Video Equipment Systems and software shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 INTERACTIVE AUDIO-VIDEO EQUIPMENT

- A. Interactive White Boards
  - 1. Provide Interactive White Boards and Software, **refer to Section 8500 for suggested quantities.**
  - 2. Consider wireless controls for units based on cabling requirements.
  - 3. Provide stands for portable units and wall-mounts for permanently installed units.

- B. **Interactive Tablet**
1. Provide Interactive Tablets and Software, *refer to Section 8500 for suggested quantities.*
- C. **Student Response System**
1. **Wireless response system with:**
    - a. **Student Response Pads**
    - b. **Receiver that connects to PC**
    - c. **Associated Software**
  2. **Each system will include a minimum of 30 pads and one receiver.**
  3. **Refer to Section 8500 for suggested quantities.**
- D. **Document Camera**
1. **Includes:**
    - a. **Camera with minimum resolution of 1042 (h) x 768 (v) pixels and minimum total zoom of 40x (optical and digital).**
    - b. **20 fps motion.**
    - c. **Multiple inputs and outputs.**
    - d. **Integrated light.**
    - e. **Capture Software.**
  2. **Refer to Section 8500 for suggested quantities.**

#### 1.6 INSTALLATION

- A. Install the Interactive White Boards at the front of the classroom and focus the associated classroom projector so that the image covers the Interactive White Board.
- B. Connect the Interactive White Board to the Instructor's PC and install the associated Software on the Instructor's PC.
- C. Install the **Interactive Tablet** at the Instructor's Technology Center. Connect the unit in series with XGA output from the Instructor's PC to the associated classroom/lab projector.
- D. Connect the **Interactive Tablet** to the Instructor's PC and install the associated Software on the Instructor's PC.
- E. **Connect the Student Response System and Document Camera to the Instructor's PC and install the associated Software on the Instructor's PC as coordinated with the District.**

#### 1.7 TESTING

- A. The devices and associated software systems shall be tested end-to-end complete.

#### 1.8 TRAINING

- A. Provide minimum of eight (8) hours training for District personnel on the operation and maintenance of each of the systems.
- B. Provide two (2) video copies of all training.

END OF SECTION

## SECTION 274125

## DIGITAL ON-DEMAND INSTRUCTIONAL DELIVERY SYSTEM

**GENERAL GUIDELINES****1.1 GENERAL**

- A. This Section defines the general design requirements for a uniform Digital-On-Demand Instructional Delivery System that shall be followed for all OSFC Technology construction projects.
- B. Figure 1 describes Typical Digital-On-Demand Instructional Delivery System.
- C. Refer to Section 8500, Technology Systems, and Section 8600, Electrical Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. DIGITAL-ON-DEMAND INSTRUCTIONAL DELIVERY SYSTEM
  1. Digital Video On-Demand System.
  2. Digital Video Control and Scheduling System.
  3. Video Bulletin Board System.
  4. Video Camera System.
  5. Video DVD/VCR System.

**1.3 QUALITY ASSURANCE**

- A. All equipment shall be UL listed.
- B. All equipment and Installation Practices shall comply with the latest ANSI/NFPA-70 National Electric Code.
- C. All equipment Installation Practices shall comply with the Local Electric Code.
- D. All equipment shall comply with the latest ANSI-J-STD-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications Standard.
- E. All equipment and Installation Practices shall comply with the latest BICSI<sup>®</sup> Telecommunications Distribution Methods Manual (TDMM).
- F. All equipment shall comply with the latest ANSI TIA/EIA-568, 569, 606, 607, 862, standards.

**1.4 SYSTEM WARRANTY**

- A. The Digital-On-Demand Instructional Delivery System and software shall be warranted by the contractor for a period of one (1) year from date of substantial completion. Provide advanced replacement for all Network Electronics for the one (1) year-period.

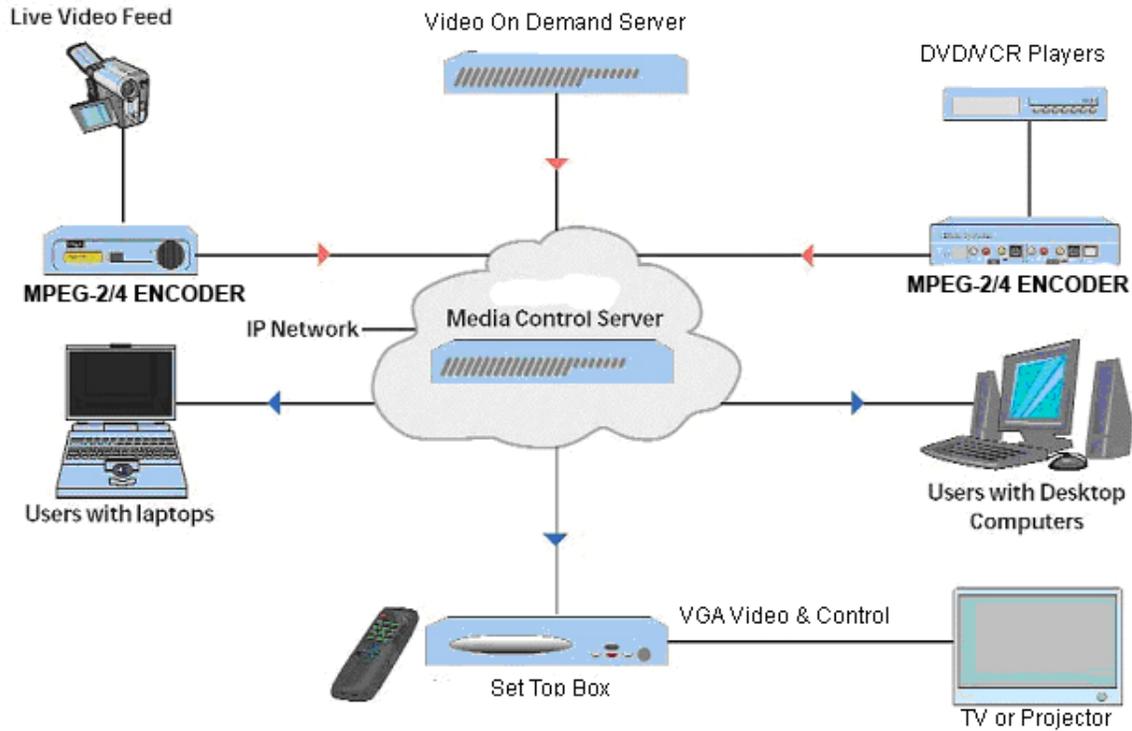


Figure 1 – Typical Digital-On-Demand Instructional Delivery System

## 1.5 DIGITAL VIDEO ON DEMAND MPEG SERVER

### A. GENERAL

1. The system shall include a centrally based media retrieval system consisting of a video server-based, on-demand, MPEG-2, MPEG-1 and MPEG-4 streaming video delivery system.
2. System shall include a video billboard message and information system delivered over the broadband system or via MPEG Decoders.
3. Control of the Central Media System components shall be via a WEB Browser interface from a PC or from a MPEG Set-Top-Box.
4. The Digital On-Demand Instructional Delivery System shall provide remote access to centrally stored digital video sources. The system shall transmit the video as a streaming data file format (MPEG-1, MPEG-2 or MPEG-4) over the Ethernet IP Network.
5. The system shall also be capable of direct access to the Internet (MPEG-4). Program the required VLANs and provide sufficient 10/100 Ethernet Ports for connection of all associated devices.
6. Classrooms shall be equipped with Set-Top-Box (STB) for receiving streamed and pre-recorded MPEG Video Signals. The STB shall be connected to the associated Classroom Projector and Audio System.
7. Provide Central Control System for Projectors for turning units on/off, selecting inputs and streaming scheduled program sources. Unit should turn all Projectors off at end of day
8. Playback of the Videos at classroom and Lab PCs shall be through a standard WEB Browser interface using a standard Media Player such as Windows Media Player, Real Player or Apple Quick-Time.

- B. DIGITAL VIDEO SERVER - VOD
1. Supply a centrally located MPEG-1, 2 and 4 Video Server Unit consisting of a PC based, Digital Video on Demand Server connected to the Network Electronics on a separate Video VLAN.
  2. Consider supplying one large VOD Server per District when WAN bandwidth permits.
  3. The Digital Video Server shall support True Video-on-Demand (VOD), Near-Video-on-Demand (NVOD), and Subscription-Video-on-Demand (SVOD).
  4. The Digital Video Server shall have a scalable output from a minimum of 25 to 200 – 3 Mbps video MPEG streams.
  5. The Digital Video Server shall have fault-tolerant, RAID storage with minimum capacity of 200 hours with hot-swappable drives.
  6. The Digital Video Server shall be connected to the local area network through a minimum of one (1) Gigabit Ethernet connection.
  7. Size the VOD Server based on District Video Storage requirements.

#### 1.6 DIGITAL VIDEO CONTROL AND SCHEDULING SYSTEM

- A. The Video Control and Scheduling System shall provide a simple interface to easily locate available Live and On Demand media assets on Windows PCs, Macs, and Set Top Boxes.
- B. Users shall be able to navigate and search for specific videos, select the video, and it immediately begins playing. For On Demand videos, users shall have full Fast Forward and Rewind capabilities.
- C. The Video Control and Scheduling System shall provide a calendar-based scheduling system that shall allow users to quickly and easily schedule Live Broadcasts from MPEG encoders, Stored Broadcasts from Video on Demand servers, Recordings, and Conferences. Scripting functionality shall also allow users to set up custom schedules.

#### 1.7 VIDEO BULLETIN BOARD SYSTEM

- A. Provide a PC based Bulletin Board system consisting of a Pentium-4 PC, minimum 2.0 GHz, equipped with minimum of 1 Gb of RAM, minimum of a 80 Gb, 7200 RPM Hard Drive, 15 inch Color Monitor/Panel, Multi-output Video Card (VGA and S-video or Composite), Microsoft Windows XP-Pro or later, and Microsoft Office 2003 or later (BBS Software will consist of Power Point Presentations), and PC Anywhere Remote Control Software.
- B. Connect Composite or S-Video and Audio output of Bulletin Board PC to A/V MPEG-2 Encoder input for streaming of Bulletin Board Broadcasts to PCs and Set Top Boxes.
- C. Connect the Bulletin Board PC to Network Electronics via a 100 Mb Ethernet Connection.

**1.8 VIDEO CAMERA SYSTEM**

- A. Provide 2 digital Video Cameras with a wheeled tripod for remote origination of video broadcasts, and announcements. Equip each camera with a dual MPEG-2/4 Encoder Unit for broadcasting low and high bit rate MPEG streams.
- B. It shall be possible to broadcast the portable camera signal across the IP Network to Monitors, Projectors and/or PCs in the school or any of the other schools within the District, and simultaneously record the signal if desired. The Camera(s) can be used for Video Announcements, recording of lessons and/or events or as a point-to-point link between any two (2) schools.

**1.9 VIDEO DVD/VCR SYSTEM**

- A. Provide 2 DVD/VCR Combo units located in the Media Center for live streaming and recording. Equip each DVD/VCR combo unit with a dual MPEG-2/4 Encoder Unit for broadcasting low and high bit rate MPEG streams.

**1.10 INSTALLATION**

- A. Contractor shall install and program all Digital Video Distribution Equipment and establish all necessary VLANs as required.

**1.11 LABELING**

- A. Cables, jacks, system components, etc. shall be labeled according to ANSI/EIA/TIA-606 specifications and in coordination with the District/architect.
- B. All Video Cables shall be equipped with a self-laminating, wrap-around, machine printed label at both ends of the cable.

**1.12 TESTING**

- A. Video Wiring system and associated systems shall be tested end-to-end complete.

**1.13 TRAINING**

- A. Provide minimum of sixteen (16) hours training for District personnel on the operation and maintenance of each of the AV Media systems.
- B. Provide two (2) video copies of all training.
- C. MPEG-2 encode and place a copy of training video on VOD server.

END OF SECTION

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**SECTION 275121****STUDENT DINING / AUDITERIA SOUND REINFORCEMENT SYSTEM – HIGH SCHOOL****GENERAL GUIDELINES****1.1 GENERAL**

- A. Refer to Section 8500, Technology Systems, for additional information.

**1.2 SECTION INCLUDES**

- A. Sound Reinforcement System
- B. Stage/Production Intercom System
- C. Assistive Listening System
- D. Monitor/Effects Foldback System
- E. Backstage Monitor/Cue System

**1.3 QUALITY ASSURANCE**

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. TIA/EIA-607 Telecommunications Grounding.
- D. ***Eleventh*** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. Americans with Disabilities Act (ADA).
- F. Federal Communications Commission Part 15.
- G. Sound System Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006.
- H. Audio Systems Design and Installation (Giddings) 1990.

**1.4 SYSTEM WARRANTY**

- A. The Student Dining/Auditeria Sound Reinforcement System shall be warranted by the Contractor for a period of one (1) year from date of substantial completion.

**1.5 RELATED SECTIONS**

- A. Specification section 271543–Audio-Video Communications Horizontal Cabling
- B. Specification section 274119 – Video Display Equipment

- C. Specification section 274120 – Interactive Audio-Video Equipment
- D. Specification section 274117 – Broadband Video RF Distribution System

## 1.6 MATERIALS

- A. Stationary Main Equipment Cabinet with the following rack mounted equipment:
  - 1. Mixer/Preamplifier
  - 2. Power Amplifier(s)
  - 3. Digital Signal Processor(s)
    - a. RS-232 Interface for Configuration and Tuning
    - b. Equalization Filters – graphic and/or parametric
    - c. Compressor/Limiter
    - d. Digital Delay for cluster alignment
    - e. High and Low Pass and Shelving Filters
    - f. Feedback Suppression (may be incorporated in DSP or a stand-alone unit)
    - g. Crossover (if bi-amplified speaker system is utilized)
    - h. Selectable scene presets
  - 4. AM/FM radio tuner
  - 5. Assistive Listening Transmitter (provide with ADA-compliant quantity of receivers)
  - 6. Monitor/Effects Foldback System amplification and signal processing, including feedback eliminators and equalization
  - 7. Sequencing AC Power Control System
  - 8. Passive or Active thermal control
  - 9. Microphone termination/splitting panel in Main Equipment Cabinet
- B. Program Source Cabinet
  - 1. ***i-Pod Docking Station***
  - 2. Wireless microphone receivers (minimum qty. 4) and antenna distribution system. Provide with handheld and/or lavalier microphones.
  - 3. CD/CD-R/CD-RW/MP3 Player/Recorder
  - 4. Production Intercom Wireless Base Station – Provide with a minimum of four (4) wireless belt packs and headsets
  - 5. Input/output jack panel
  - 6. AC power distribution panel
- C. House Speaker Options:
  - 1. Point source speaker or speaker cluster suspended from structure.
  - 2. Speaker cluster with delayed satellite speakers.
  - 3. Distributed full range speakers.
  - 4. Sub Woofer(s) – (optional)
- D. Monitor Speakers – floor wedge or stand-mounted – minimum qty. 2. Provide with rubber-jacketed speaker cables.
- E. Distributed Jackplates:
  - 1. Microphone jackplates (XLR-F connectors).
  - 2. Monitor/Effects speaker jackplates (Speakon style).
  - 3. Multi-pin send/return connectors at mixing locations in Control Room and at rear of audience seating area.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- F. Multi-pair “snake cable” with individually shielded pairs, connectorized at both ends.
- G. Direct box(es) for insertion of line level and laptop sound card signals into microphone jacks.
- H. Mixing Console – Minimum requirements: 24-microphone input channels; 2-stereo line level input channels; stereo and mono output busses; 4-aux output busses
- I. Hanging microphones – for use over stage (minimum qty. 2).
  - 1. Microphones, microphone stands, cords, and connectors.
- J. Handheld, lavalier or boundary microphones. (minimum qty. 2) Include floor or desk stands and cords.

**1.7 INSTALLATION**

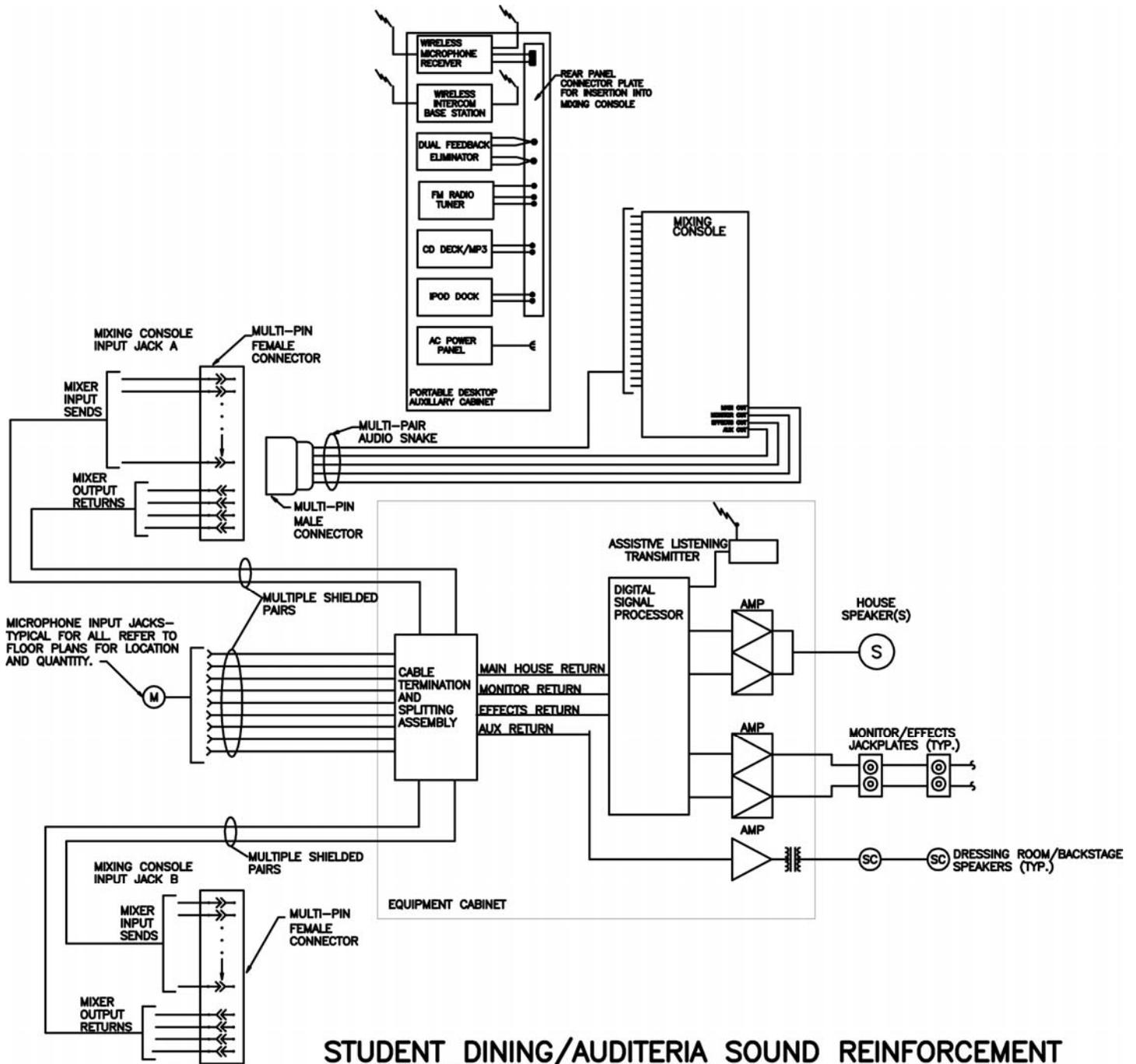
- A. Install and balance system. Adjust all sound levels for desired operation levels and evenness of coverage.
- B. Adjust all wireless equipment and verify coverage areas.
- C. Check polarity of all input jacks, signal chains, and speakers.
- D. Check gain structure.
- E. Connect FM Tuner to external, building mounted FM Antenna Distribution System. Ground antenna in accordance with NEC and TIA/EIA-607.  
–OR–  
Receive radio reception from Distributed Broadband RF system.
- F. Ground equipment cabinet and associated equipment to cabinet-mounted telecommunications grounding buss bar in accordance with NEC and TIA/EIA-607.
- G. Install in accordance with manufacturer’s installation instructions.

**1.8 PERFORMANCE TESTING**

- A. Frequency response: 80Hz – 14kHz +/- 3 dB.
- B. Loudness: At least 96dB-SPL program level with an additional 6 dB Crest factor.
- C. Evenness of coverage: Variation of less than +/- 3dB (400Hz to 4000Hz) at all seats.

**1.9 TRAINING**

- A. Provide eight (8) hours training for District’s personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training



### STUDENT DINING/AUDITERIA SOUND REINFORCEMENT SYSTEM DIAGRAM – HIGH SCHOOL

SCALE: NONE (RE: 27 51 21)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

END OF SECTION

## SECTION 275122

## STUDENT DINING / CAFETERIA SOUND REINFORCEMENT SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Sound Reinforcement System
- B. Assistive Listening System

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. TIA/EIA-607 Telecommunications Grounding.
- D. **Eleventh** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. Americans with Disabilities Act (ADA).
- F. Federal Communications Commission Part 15.
- G. Sound System Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006.
- H. Audio Systems Design and Installation (Giddings) 1990.

## 1.4 SYSTEM WARRANTY

- A. The Student Dining/Cafeteria Sound Reinforcement System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 RELATED SECTIONS

- A. Specification Section 271543–Audio-Video Communications Horizontal Cabling
- B. Specification Section 274119 – Video Display Equipment
- C. Specification Section **274120** – Interactive Audio-Video Equipment
- D. Specification Section **274117** – Broadband Video RF Distribution System

**1.6 MATERIALS**

- A. Stationary Main Equipment Cabinet with the following rack mounted equipment:
1. Mixer/Preamplifier (minimum of 8 channels)
  2. Power Amplifier(s)
  3. Digital Signal Processor(s)
  4. RS-232 Interface for Configuration and Tuning
  5. Equalization Filters – graphic and/or parametric
  6. Compressor/Limiter
  7. Digital Delay for cluster alignment
  8. High and Low Pass and Shelving Filters
  9. Feedback Suppression (may be incorporated in DSP or a stand-alone unit).
  10. Crossover (if bi-amplified speaker system is utilized)
  11. Selectable scene presets
  12. AM/FM radio tuner
  13. ***i-Pod Docking Station***
  14. CD/CD-R/CD-RW/MP3 Player/Recorder
  15. Wireless microphone receivers (Minimum Qty. 1) and antenna distribution
  16. Assistive Listening Transmitter (provide with ADA-compliant quantity of receivers)
  17. Sequencing AC Power Control System
  18. Passive or Active thermal control
- B. Speaker Options:
1. Point source speaker or speaker cluster suspended from structure.
  2. Speaker cluster with delayed satellite speakers.
  3. Distributed full-range speakers.
- C. Distributed Jackplates
1. Microphone input jackplates (XLR-F connectors).
  2. Balanced, auxiliary-input, jack plate assemblies.
- D. Microphones, microphone stands, cords, and connectors (minimum qty. 4).

**1.7 INSTALLATION**

- A. Install and balance system. Adjust all sound levels for desired operation levels and evenness of coverage.
- B. Adjust all wireless equipment and verify coverage areas.
- C. Check polarity of all speakers and adjust all microphone and source input levels.
- D. Connect FM Tuner to external, building mounted FM Antenna and Distribution System. Ground Antenna in accordance with NEC and TIA/EIA-607.  
–OR–  
Receive radio reception from Distributed Broadband RF system as specified in another spec section.
- E. Ground equipment cabinet and associated equipment to cabinet-mounted telecommunications grounding busbar in accordance with NEC and TIA/EIA-607

## COMMUNICATIONS

## CHAPTER 9: SPECIFICATIONS

- F. Install in accordance with manufacturer's installation instructions and recommendations.

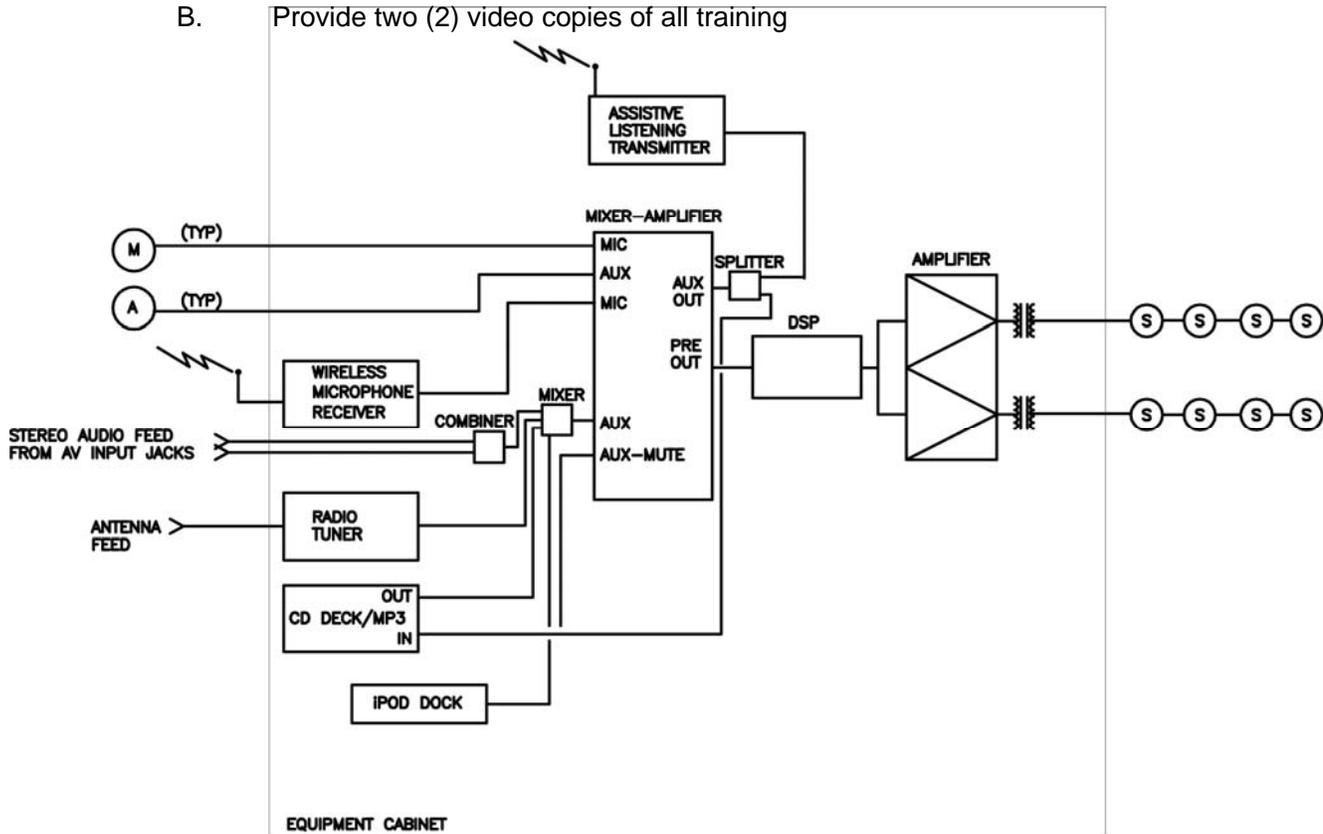
### 1.8 PERFORMANCE TESTING

- A. Frequency response: 80Hz – 14kHz +/- 3 dB.
- B. Loudness: At least 90 dB-SPL program level with an additional 6 dB Crest factor.
- C. Evenness of coverage: Variation of less than +/- 3dB (400Hz to 4000Hz) at all seats.

### 1.9 TRAINING

- A. Provide eight (8) hours training for District's personnel on the operation and maintenance of the system.

- B. Provide two (2) video copies of all training



## STUDENT DINING/CAFETERIA SOUND REINFORCEMENT SYSTEM DIAGRAM

SCALE: NONE (RE: 27 51 22)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

END OF SECTION

## SECTION 275123

## CENTRAL SOUND AND PAGING SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This section defines the general design requirements for a uniform Central Sound and Paging System that shall be followed for all OSFC Technology construction projects.
- B. The basis of design is a full-function, microprocessor-based, two-way intercommunications/zoned paging/program distribution system ***interfaced with and operated by the telephone system (specified elsewhere)***.
- C. ***An optional one-way zoned paging system, interfaced and operated by the telephone system (specified elsewhere) shall require an OSFC variance.***
- D. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Central Sound and Paging System and all related components.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 – National Electrical Code
- B. Underwriter's Laboratory
- C. TIA/EIA-607 Telecommunications Grounding
- D. ***Eleventh*** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM)
- E. Americans with Disabilities Act (ADA)
- F. Federal Communications Commission Part 15
- G. Sound Systems Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006
- H. Audio Systems Design and Installation (Giddings) 1990

## 1.4 SYSTEM WARRANTY

- A. The Central Sound and Paging System shall be warranted by the Contractor for a period of one (1) year from date of substantial completion.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

## 1.5 RELATED SECTIONS

- A. Specification section 274117 – Broadband Video RF Distribution System
- B. Specification section 275313 – Clock Systems
- C. Specification section 273113 – **IP-Enabled PABX System**  
OR Specification section 273123 – IP-Only PABX System

1.6 MICROPROCESSOR-BASED TWO-WAY INTERCOM / PAGING / PROGRAM DISTRIBUTION SYSTEM (**Base Design**)

- A. PABX System Interface
- B. Administrative communications console – located in main office or at equipment headend
- C. Microprocessor-based with RS-232 Interface for setup and/or control
- D. Minimum eight (8) paging and time tone distribution zones
- E. Internal time-tone schedule programming and software
- F. Synchronization with clock system
- G. Input signal prioritization
- H. Dedicated home-run speaker circuits from each classroom or special function room (gymnasiums, dining rooms, multi-purpose rooms, **exterior spaces**, etc.). **Call button cabling is included in baseline system whether the call button is installed or not. Extend to speaker location if call button is not installed.**
- I. **Base Line** - Call origination switches or handsets in each classroom with annunciator display in central school reception office. **Variance required if District elects not to include. Technology Designer to review system with District, determine need for conduit/box rough-ins for future if District elects not to include in project via variance.**

1.7 ONE-WAY ZONED PAGING SYSTEM (**Optional System Requires Variance**)

- A. PABX System Interface
- B. Microprocessor-based, zoned paging/program distribution system
- C. Minimum of six (6) paging zones
- D. Distribution of class-change time tones as scheduled by Clock System
- E. Input signal prioritization

- F. One-Way Zoned Paging System Options:
1. High impedance, constant voltage system with centrally located power amplifiers and passive speakers with 25-volt transformers. Each classroom speaker circuit to be individually wired and extended to headend equipment. Corridor and common area speakers to be grouped according to zones.
  2. Low-voltage, amplified speakers with central power supplies and star-wired CAT3 cabling system terminated on 110-style cross-connect blocks, located on the backboard in main Equipment Room (ER). Each speaker wired with dedicated, individual home-run cable. Use pair 1 for paging signal and pairs 2-4 for power.
- G. Central paging power supplies based on system load. Connect to Main Equipment Room (ER) UPS unit, powered by building emergency generator circuit(s).

### 1.8 COMPONENTS COMMON TO ALL SYSTEMS:

- A. PROGRAM SOURCE CABINET - Locate a wall-mounted or desktop cabinet in the central school reception office area and place within the cabinet:
1. ***i-Pod Docking Station (optional)***
  2. CD player or changer
  3. AM/FM radio connected to the building antenna/RF distribution system
  4. Monitor speaker panel for program cueing and preview
  5. Connect audio outputs to audio inputs on the paging adapter (when applicable)
- B. EMERGENCY/EVACUATION ALARM TONE PANEL
1. Locate in central school reception office area – either as a stand-alone wall-mounted device or within Program Source Cabinet.
  2. Minimum of three (3) clearly labeled switches to activate distinct tones: EMERGENCY, EVACUATION, ALL-CLEAR.
  3. Assign highest priority level
- C. ALL-CALL PAGING MICROPHONE
1. Locate in central school reception office area. Use of receptionist's telephone handset is permissible, if acceptable to the school.
- D. Locate a minimum of one (1) paging speaker or horn in all building rooms, including Mechanical areas. Base the quantity of speakers/horns on the required signal level and the size of the area to be covered.
- E. Speaker and horn types:
1. Flush-mounted ceiling speakers with all metal protective dome enclosures and ceiling bridge support.
  2. Surface-mount wall or ceiling speakers
  3. Compression driver paging horns in gymnasiums, shop areas, mechanical rooms, exterior of building (weather-proof type) and other areas with high ambient sound levels.
  4. Wall mounted volume controls in meeting rooms and other District specified areas.

## COMMUNICATIONS

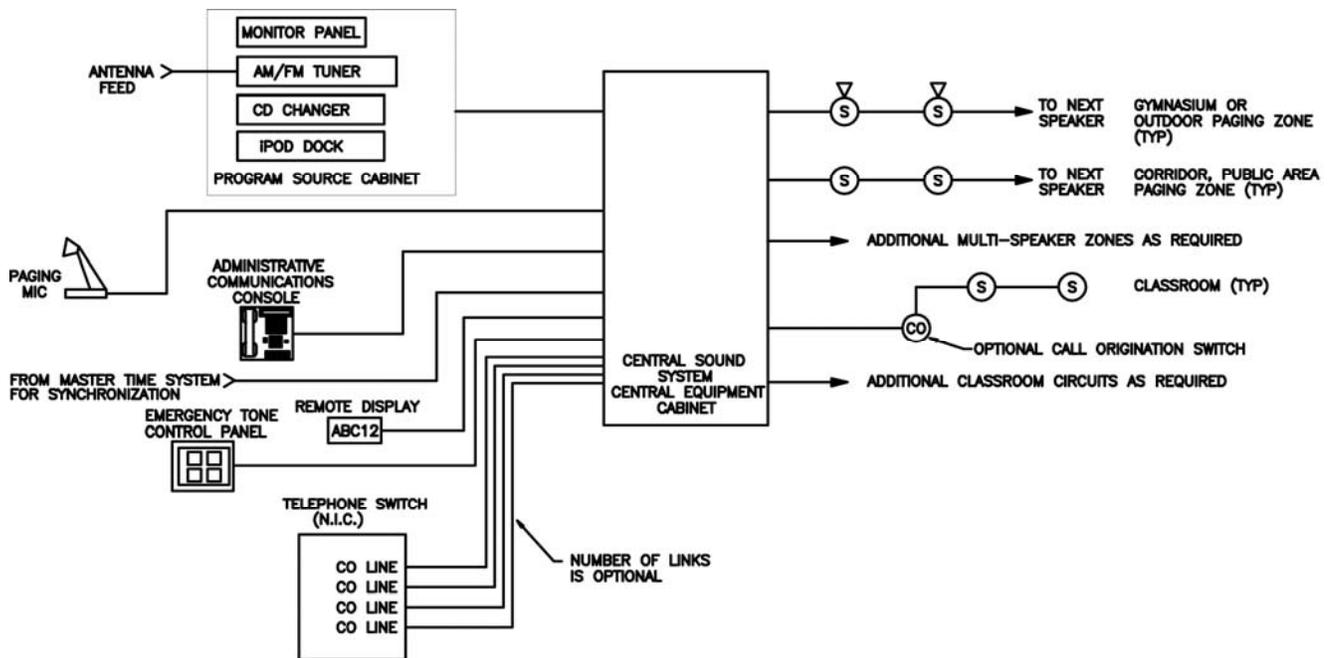
## CHAPTER 9: SPECIFICATIONS

### 1.9 INSTALLATION

- A. Install and balance the paging system volume levels according to ambient noise levels.
- B. Integrate with Telephone System PABX for access to zone paging and intercom (if applicable) functions.
- C. Establish building paging zones as directed by the School District.
- D. Provide programming and setup of paging zones, signal priorities, and bell (time tone) schedule.
- E. Connect to building antenna (if applicable) and ground in accordance with NEC and TIA/EIA-607.
- F. Install in accordance with manufacturer's installation instructions and recommendations.

### 1.10 TRAINING

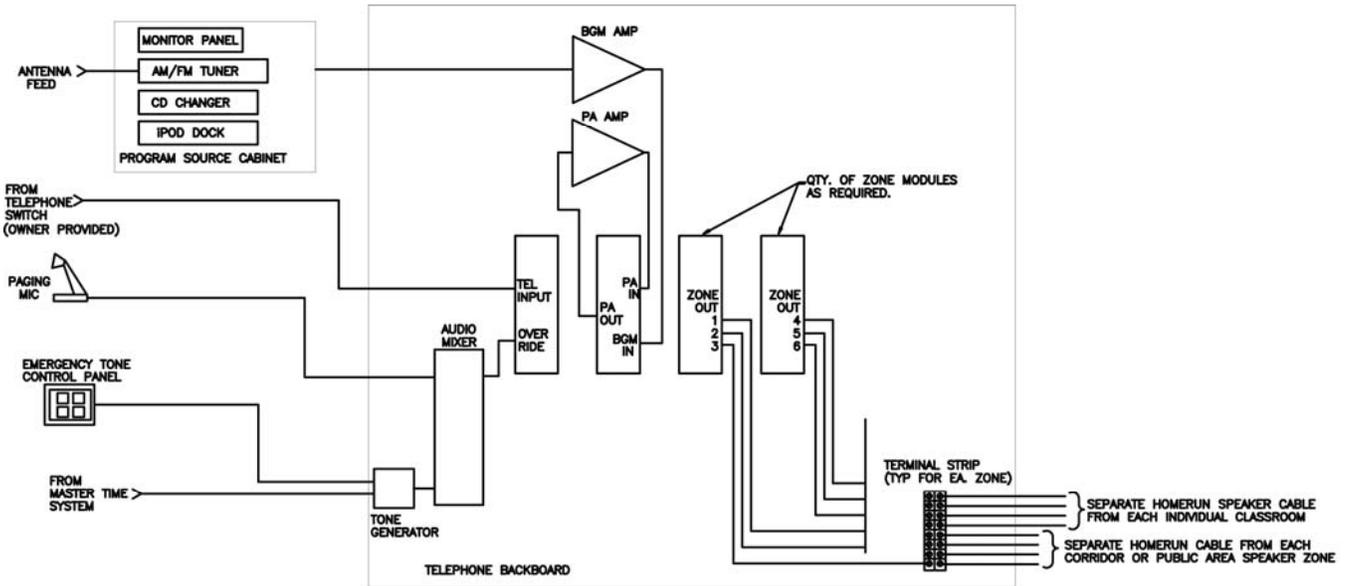
- A. Provide eight (8) hours training for school and district personnel on the operation, programming, and maintenance of the system.
- B. Provide two (2) video copies of all training.



## CENTRAL SOUND/INTERCOM SYSTEM DIAGRAM (BASELINE SYSTEM)

SCALE: NONE (RE: 27 51 23A)

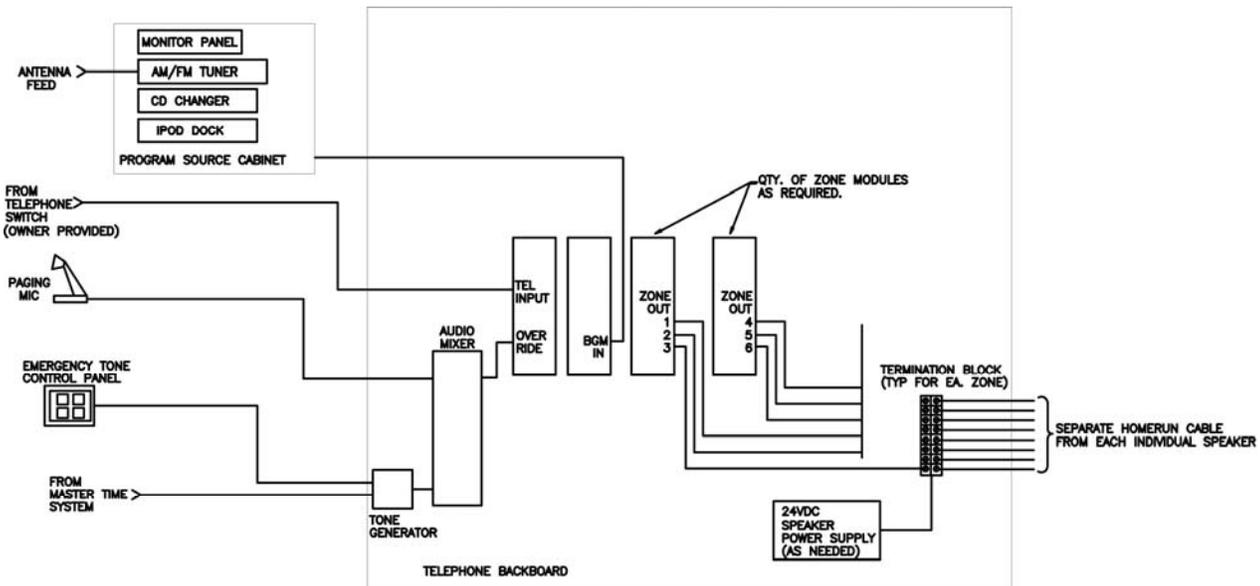
NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.



**CENTRAL SOUND PAGING/PROGRAM DISTRIBUTION SYSTEM DIAGRAM – PASSIVE SPEAKERS**

SCALE: NONE (RE: 27 51 23B) (OPTIONAL – REQUIRES VARIANCE)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.



**CENTRAL SOUND PAGING/PROGRAM DISTRIBUTION SYSTEM DIAGRAM – POWERED SPEAKERS**

SCALE: NONE (RE: 27 51 23C) (OPTIONAL – REQUIRES VARIANCE)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

END OF SECTION

## SECTION 275124

## GYMNASIUM SOUND REINFORCEMENT SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This section defines the general design requirements for a uniform Gymnasium Sound Reinforcement System that shall be followed for all OSFC Technology construction projects – High School, Middle School, and Elementary School facilities.
- B. The variations as related to school type are defined in Parts 2 and 3 of this guideline.
- C. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Gymnasium Sound Reinforcement System and all related components.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. TIA/EIA-607 Telecommunications Grounding.
- D. ***Eleventh*** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. Americans with Disabilities Act (ADA).
- F. Federal Communications Commission Part 15.
- G. Sound System Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006.
- H. Audio Systems Design and Installation (Giddings) 1990.

## 1.4 SYSTEM WARRANTY

- A. The Gymnasium Sound Reinforcement System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 RELATED SECTIONS

- A. Specification section 274117 – Broadband Video RF Distribution System

## 1.6 MATERIALS

- A. Stationary Main Equipment Cabinet with the following rack mounted equipment:
1. Mixer/Preamplifier
  2. Power Amplifier(s)
  3. Digital Signal Processor(s)
    - a) RS-232 Interface for Configuration and Tuning
    - b) Equalization Filters – graphic and/or parametric
    - c) Compressor/Limiter
    - d) Digital Delay for cluster alignment
    - e) High and Low Pass and Shelving Filters
    - f) Feedback Suppression (may be incorporated in DSP or a stand-alone unit)
    - g) Crossover (if bi-amplified speaker system is utilized)
    - h) Selectable scene presets
  4. AM/FM radio tuner
  5. Assistive Listening Transmitter (provide with ADA-compliant quantity of receivers)
  6. Sequencing AC Power Control System
  7. Passive or Active thermal control
- B. Mobile Equipment Cabinet shall contain the following equipment for mic level signal insertion into a wall or floor mounted microphone jack:
1. Rack-mounted mixer with mic level output
  2. Wireless microphone receiver with handheld and/or lavalier microphone
  3. **CD/CD-R/CD-RW/MP3 Player**
  4. **i-Pod Docking Station**
  5. Input/output jack panel
  6. AC power distribution panel
  7. Note: In Middle and Elementary School Gymnasium systems, the mobile equipment cabinet may be eliminated with the associated components being located in the Stationary Equipment Cabinet.
- C. Speaker cluster or distributed speakers suspended from structure.
1. Middle School and Elementary School Gymnasium speaker systems shall provide even coverage of both the entire floor area and seating areas.
  2. High School Gymnasium speaker systems shall provide switchable speaker zones as follows: Home Bleachers, Visitors Bleachers, Floor, and Mezzanine (where applicable). The zone selection shall be performed via selector switches in the Stationary Equipment Cabinet.
- D. Microphone input jack at scorer's table.
- E. Distributed mic/aux level input jacks on end walls –OR- mic level input jacks only (provide with aux/line level-to-microphones level direct box(es)).

## 1.7 INSTALLATION

- A. Install and balance system. Adjust all sound levels for desired operation levels and evenness of coverage.

**COMMUNICATIONS**

## CHAPTER 9: SPECIFICATIONS

- B. Adjust all wireless equipment and verify coverage areas.
- C. Check polarity of all speakers and adjust all microphone and source input levels.
- D. Connect FM Tuner to external, building mounted FM Antenna and Distribution System. Ground Antenna in accordance with NEC and TIA/EIA-607. –OR- Receive radio reception from Distributed Broadband RF system as specified in another spec section.
- E. Ground equipment cabinet and associated equipment to cabinet-mounted telecommunications grounding buss bar in accordance with NEC and TIA/EIA-607.
- F. Install in accordance with manufacturer's installation instructions and recommendations.

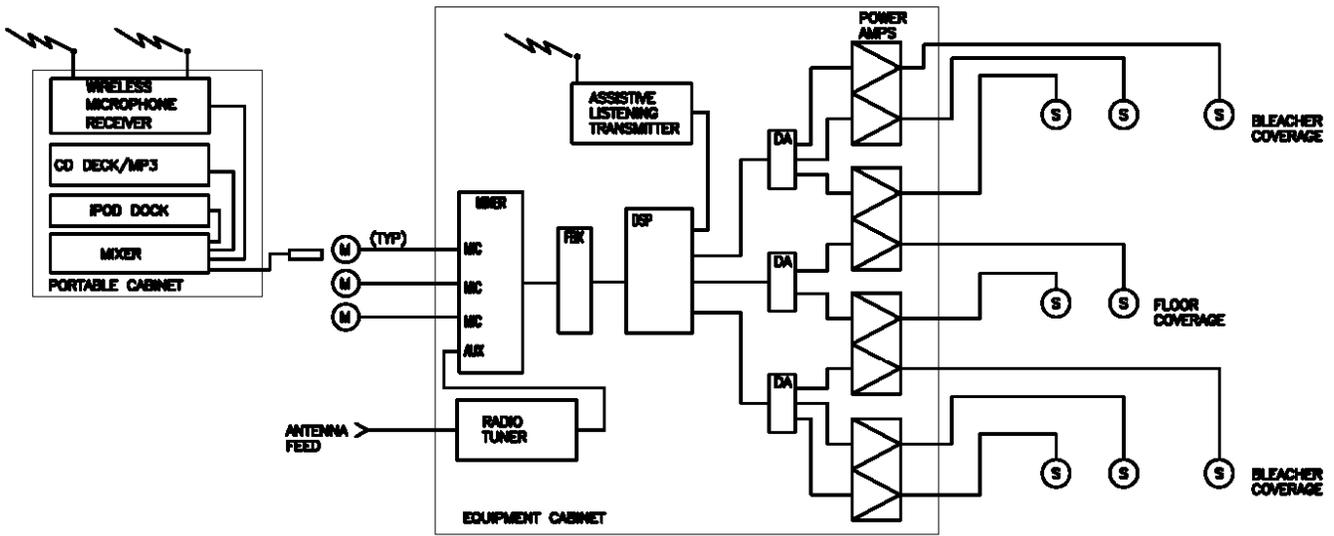
**1.8 PERFORMANCE TESTING**

- A. Frequency response: 100Hz – 14kHz +/- 3 dB
- B. Loudness: High School Varsity Gym: At least 100dB-SPL program level with an additional 6dB Crest factor; Middle, Elementary School and Auxiliary Gym: At least 90dB-SPL program level with an additional 6 dB Crest factor
- C. Evenness of coverage: Variation of less than +/- 3 dB (400Hz to 4000Hz) at all seats.

**1.9 TRAINING**

- A. Provide minimum eight (8) hours training for District's personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training.

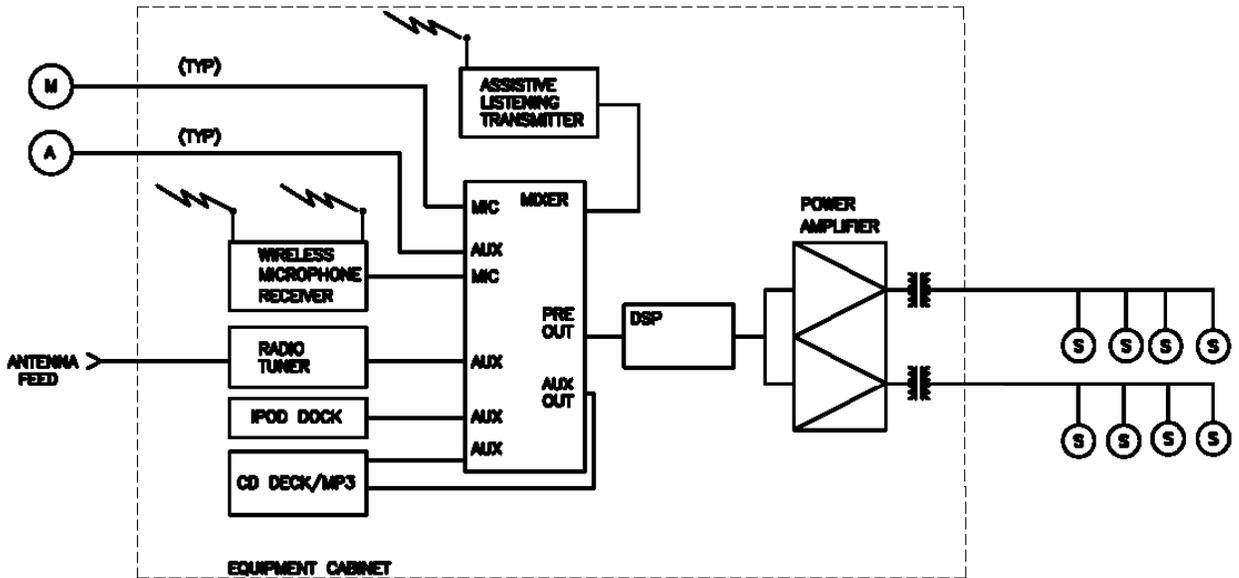
(See diagrams on next page)



**HS GYMNASIUM SOUND SYSTEM DIAGRAM**

SCALE: NONE (RE: 27 51 24A)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.



**MS/AUX GYMNASIUM SOUND SYSTEM DIAGRAM**

SCALE: NONE (RE: 27 51 24B)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

END OF SECTION

## SECTION 275125

## MUSIC ROOM AUDIO PROGRAM PLAYBACK SYSTEM - MIDDLE SCHOOL

GENERAL GUIDELINES

## 1.1 GENERAL

- A. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Music room sound system and components for playback of audio program material.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. TIA/EIA-607 Telecommunications Grounding.
- D. **Eleventh** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. American with Disabilities Act.
- F. Federal Communications Commission Part 15.
- G. Sound System Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006.
- H. Audio Systems Design and Installation (Giddings) 1990.

## 1.4 SYSTEM WARRANTY

- A. The Sound System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 MATERIALS

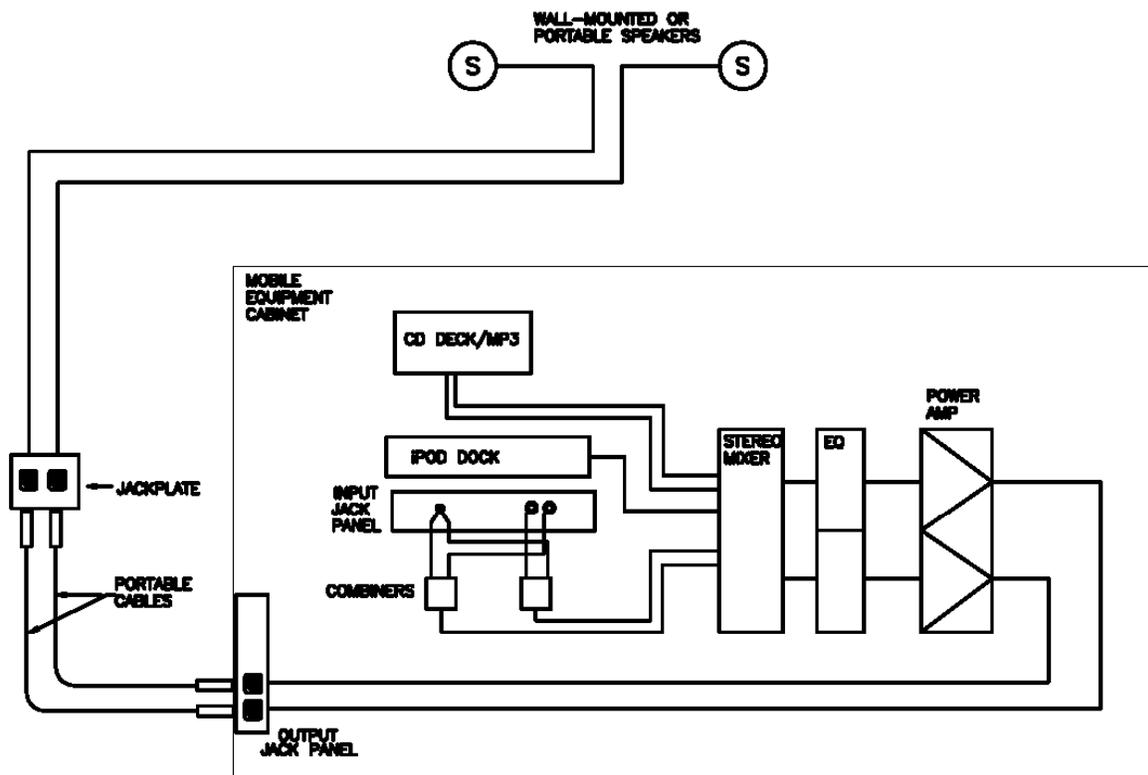
- A. Mobile or permanently mounted main equipment rack.
  - 1. Stereo Mixer or Source Selection Device – rack-mounted.
  - 2. Dual channel Amplifier.
  - 3. Dual channel octave band equalizer.
  - 4. **CD/CD-R/CD-RW/MP3 Player.**
  - 5. **i-Pod Docking Station.**
  - 6. Input Jack panel for insertion of external sources.
- B. Wall mounted or tripod mounted speakers – stereo pair.
- C. Wall-mounted speaker jack plate – for connection of amplifier in mobile rack to permanently-mounted speakers.

## 1.6 INSTALLATION

- A. Install and balance system volume levels.
- B. Check polarity of all speakers.
- C. Install in accordance with manufacturer's installation instructions and recommendations.

## 1.7 TRAINING

- A. Provide four (4) hours training for District's personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training.



NOTE: SINGLE MOBILE EQUIPMENT CABINET SHARED BETWEEN VOCAL & INSTRUMENTAL ROOMS.

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

## MS MUSIC ROOM PLAYBACK SYSTEM DIAGRAM

2009.09.08 (REV. 27 51 25)

END OF SECTION

## SECTION 275126

## MUSIC ROOM AUDIO RECORDING/PLAYBACK SYSTEM - HIGH SCHOOL

GENERAL GUIDELINES

## 1.1 GENERAL

- A. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Music room sound system and components for recording and playback of audio program material.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code.
- B. Underwriter's Laboratory.
- C. TIA/EIA-607 Telecommunications Grounding.
- D. **Eleventh** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. American with Disabilities Act.
- F. Federal Communications Commission Part 15.
- G. Sound System Engineering (Davis & Patronis) – 3<sup>rd</sup> Edition 2006.
- H. Audio Systems Design and Installation (Giddings) 1990.

## 1.4 SYSTEM WARRANTY

- A. The Sound System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 MATERIALS

- A. Mobile or permanently mounted main equipment rack.
  1. Stereo microphone mixer/pre-amplifier – rack-mounted.
  2. Recording Input patch panel for insertion of external microphones or mixing consoles.
  3. Stereo program playback mixer or source selection device – rack-mounted.
  4. Program source, playback patch panel for insertion of external playback devices.
  5. Dual channel amplifier.
  6. Dual channel, octave band equalizer.
  7. **CD/CD-R/CD-RW/MP3 Player/Recorder.**

8. ***i-Pod Docking Station.***
9. ***Optional – Digital Recorder***
10. Stereo hanging and/or floor stand microphones as required.

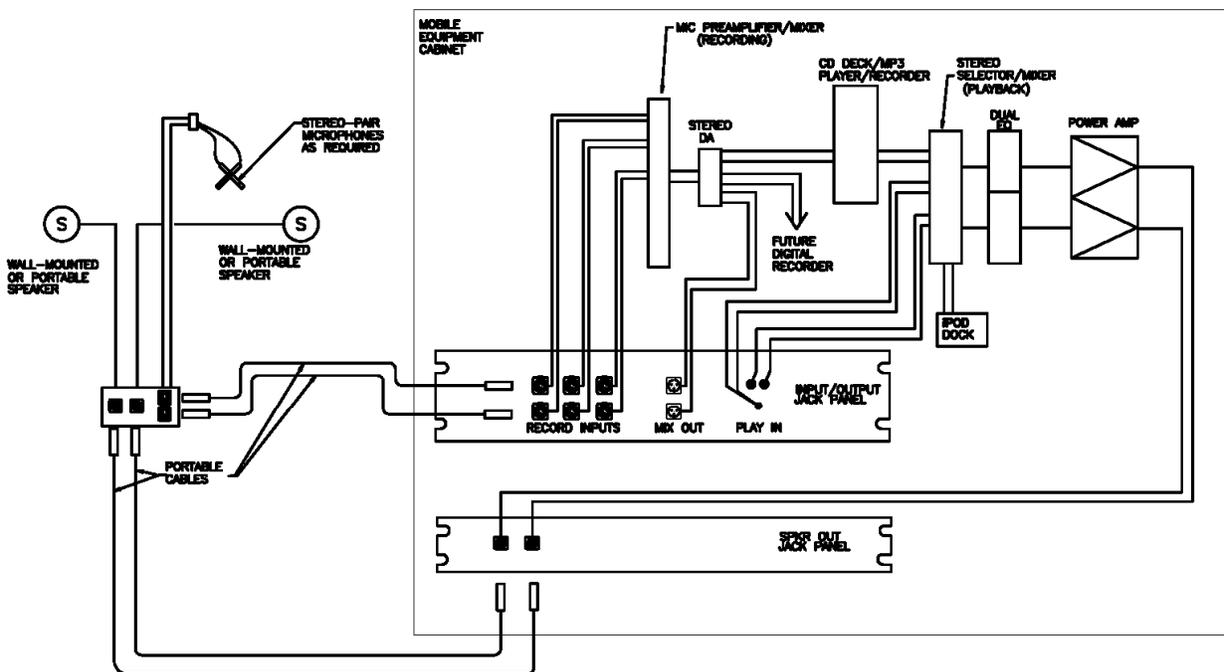
- B. Wall mounted or tripod mounted speakers – stereo pair.
- C. Wall mounted speaker jack plate – for connection of amplifier in mobile rack to permanently mounted speakers.

## 1.6 INSTALLATION

- A. Install and balance system volume levels.
- B. Check polarity of all speakers and microphones.
- C. Install in accordance with manufacturer's installation instructions and recommendations.

## 1.7 TRAINING

- A. Provide four (4) hours training for District's personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training.



### HS MUSIC ROOM RECORD/PLAYBACK SYSTEM DIAGRAM

SCALE NONE (RE: 27 51 28)

NOTE: THIS DIAGRAM IS SCHEMATIC IN NATURE ONLY. IT IS INTENDED TO SHOW GENERAL CONFIGURATION OF THE SYSTEM. MODIFY TO ACCOMMODATE DESIGN PREFERENCES, OWNER NEEDS AND PROJECT CONDITIONS.

END OF SECTION

## SECTION 275127

## CLASSROOM SOUND REINFORCEMENT SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform Classroom Sound Reinforcement System that shall be followed for all OSFC Technology construction projects.
- B. Refer to Section 8500, Technology Systems for additional information.

## 1.2 SECTION INCLUDES

- A. Classroom sound reinforcement system and components.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 – National Electrical Code.
- B. Underwriter's Laboratory.
- C. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and **Eleventh** Edition (or later).
- D. **Eleventh** Edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM).
- E. American with Disabilities Act.
- F. Federal Communications Commission Part 15.

## 1.4 SYSTEM WARRANTY

- A. The Sound System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 CLASSROOM SOUND REINFORCEMENT SYSTEM

- A. Infrared Receiver/Amplifier, equipped with:
  - 1. Minimum of 30-Watts RMS Watts total output.
  - 2. Minimum of 50-20 KHz frequency response.
  - 3. Two (2) microphone inputs with individual volume controls.
  - 4. Tone Controls or Equalizer.
  - 5. Minimum of three (3) auxiliary line inputs with individual volume controls.
  - 6. Minimum of one (1) line output for optional ADA, wireless headphone system.
  - 7. System Power Supply.
  - 8. Power Switch.
  - 9. Minimum of two (2) IR frequencies.

10. Minimum of one (1) 360 degree ceiling-mounted, 2-channel, Infrared Receiver with plenum rated cabling.
11. One (1) Infrared Lavalier or collar microphone, with NiMH rechargeable batteries and charger stand.
12. One (1) Infrared Handheld microphone, with NiMH rechargeable batteries and charger stand.
13. Minimum of four (4) acoustical ceiling mounted, 360-degree dome speakers with all metal acoustical back enclosure and ceiling tile bridge, minimum 15-Watt capacity and minimum of 65-20KHz frequency response.
14. Receiver/Amplifier must be capable of being placed in Instructor's casework or cabinet mounted with no loss of infrared signal strength.
15. Unit must provide uniform IR pickup from the Instructor throughout the classroom.
16. ***Provide means for the central paging system to mute or override the classroom sound reinforcement system when a central page occurs.***

#### 1.6 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Per Speaker, provide minimum of 16 AWG, CMP rated speaker wire. Wire gauge based on cable lengths and power ratings.
- C. Route speaker wires through associated faceplate Space speakers in classroom to provide uniform coverage.
- D. For rooms using Overhead Mounted Projectors:
  1. Provide a wall bracket/shelf for mounting Infrared Receiver/Amplifier or mounted in cabinet or casework.
  2. Provide Line Level cabling from Instructor's PC, DVD/VHS Unit and MPEG Set-Top-Box Line Outputs to Auxiliary Line Inputs on Infrared Receiver/Amplifier.
  3. Balance and adjust all volume levels.
  4. Properly phase all speakers.
- E. Add additional speakers and infrared sensors in large classrooms, as required, to maintain complete coverage.
- F. Classroom Sound Reinforcement system shall be installed in all classrooms/labs for K-12.
- G. Classroom Sound Reinforcement system shall be integrated with the classroom A/V system.

#### 1.7 TRAINING

- A. Provide four (4) hours training for District's personnel on the operation and maintenance of the system.
- B. Provide two (2) video copies of all training.

END OF SECTION

## SECTION 275313

## CLOCK SYSTEMS

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform Building-wide Synchronized Clock System that shall be followed for all OSFC Technology construction projects.
- B. The options are defined in Parts 2 and 3 of this guideline.
- C. Refer to Section 8500, Technology Systems, for additional information.

## 1.2 SECTION INCLUDES

- A. Master Clocks, Secondary Clocks and accessory components.

## 1.3 QUALITY ASSURANCE

- A. NFPA 70 – National Electrical Code
- B. Underwriter's Laboratory
- C. TIA/EIA-607 Telecommunications Grounding
- D. **Eleventh** edition (or latest) BICSI Telecommunications Distribution Methods Manual (TDMM)

## 1.4 SYSTEM WARRANTY

- A. The Clock System shall be warranted by the Contractor for a period of one (1) year from date of substantial completion.

## 1.5 RELATED SECTIONS

- A. Specification Section 275123 - Central Sound and Paging System

## 1.6 GENERAL

- A. Synchronized with the United States Atomic Clock via GPS receiver with external antenna, NTP Internet connection, **or CDMA.**
- B. Self-correcting for Daylight Savings Time changes.
- C. Analog Secondary Clocks:
  1. 12" diameter minimum, surface-mounted.
  2. Metal hour, minute, and second hands with impact resistant molded plastic case.

3. Corridors: Double-faced, securely mounted perpendicular to wall or ceiling mounted.
  4. Gymnasiums: 15" diameter minimum. Provide wire guards in gymnasiums, auxiliary gymnasiums, and locker rooms.
- D. Digital Secondary Clocks:
1. 2.3" height minimum, 4-digit, 7-segment LED display with metal case.
  2. Corridors: Double-faced with perpendicular wall or ceiling mount.
  3. Gymnasiums: 4" height minimum, 4-digit, 7-segment LED display with metal case. Provide wire guards in gymnasiums, auxiliary gymnasiums, and locker rooms.
  4. Optional Text Messaging capability.
- E. Master Clock with software-programmable, integral building bell schedule and audible tone generator with selectable tones to provide class change tones to input of Central Sound System.
1. Minimum of four (4) selectable, pre-programmed class change schedules, easily selectable from the main school office.
  2. Manual activation of audible tone from the main school office.
  3. Permanent or periodic temporary RS-232 connection to PC for data download update of class change schedules.
  4. NOTE: Where Central Sound Systems with built-in tone generator and programmable bell schedule function are utilized, the Master Clock need only to be able to synchronize time with the Central Sound System headend processor.

### 1.7 WIRELESS CLOCK SYSTEMS

- A. Battery-operated - minimum 5-year battery life
- B. Provide RF transmitters and antennas, as required to provide complete building-wide coverage.

### 1.8 WIRED CLOCK SYSTEMS

- A. Low-voltage power – 24V or less
- B. Central or distributed power supplies as required
- C. Optional IEEE 802.3af, Power Over Ethernet (POE) connectivity

### 1.9 INSTALLATION

- A. Securely mount the clocks flush on the walls in classrooms and office areas.
- B. Connect tone generator output to input of Central Sound System if function is not provided by that system.
- C. Synchronize time with the Central Sound System master clock if the tone generation and program schedule functions are provided by that system.
- D. Program initial bell schedules as provided by the Owner.

**COMMUNICATIONS**

- E. Located schedule selection and manual bell activation functions in main school office.

**1.10 TRAINING**

- A. Provide four (4) hours training for School/District personnel on the operation, programming, and maintenance of the system.
- B. Provide two (2) video copies of all training.

END OF SECTION

**28**

**DIVISION**

**ELECTRONIC SAFETY AND SECURITY**

## TABLE OF CONTENTS

DIVISION 28: ELECTRONIC SAFETY AND SECURITY

|               |                                                        |
|---------------|--------------------------------------------------------|
| <b>281300</b> | <b><i>Access Control System</i></b>                    |
| <b>281600</b> | <b><i>Intrusion Detection System</i></b>               |
| <b>282300</b> | <b><i>Video Surveillance System</i></b>                |
| <b>282600</b> | <b><i>Area of Refuge Intercommunication System</i></b> |
| <b>283111</b> | <b><i>Digital, Addressable Fire-Alarm System</i></b>   |

## SECTION 281300

## ACCESS CONTROL SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform Access Control System that shall be followed for all OSFC Technology construction projects.
- B. Refer to Sections 8500, Technology Systems, 28 16 00 Intrusion Detection, and 28 23 00 Video Surveillance for additional information.

## 1.2 SECTION INCLUDES

- A. Integrated Security Management (ISM) System
- B. Uninterruptible Power Supply (UPS).

## 1.3 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. NFPA 730 – Guide for Premises Security**
- C. NFPA 731 – Standard for the Installation of Electronic Premises Security Systems**
- D. National Electric Code.
- E. American with Disabilities Act.
- F. Underwriter's Laboratory.
- G. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and **Eleventh** Edition (or later).
- H. BICSI Telecommunications Distribution Methods Manual (TDMM).

## 1.4 SYSTEM WARRANTY

- A. The **Access Control** System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

## 1.5 GENERAL

- A. Furnish a new Integrated Security Management (ISM) system that provides a simple and easy-to-use graphical user interface.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

- B. The system shall provide local operational control of all access points and alarm sensors.
- C. The ISM System client and server software shall be used in conjunction with intelligent controllers to provide a distributed access control and alarms monitoring system.
- D. In the event of a communications failure between the host server and the remote controllers, the controllers shall continue to make local access control decisions and save all transactions in memory until communications are restored. At that time the controller shall upload all stored transactions to the Central Server.
- E. When a District has more than one building, the Central Server shall be located in one of the District's buildings and the other buildings shall be attached to the Central Server via the Wide Area Network. All buildings in the District shall interface to the Central Server and Control Consoles.
- F. The ISM System shall seamlessly integrate the functions of Access Control, Alarm Monitoring and Response, Digital Video Imaging and Badge Design/Creation, and Visitor Management.
- G. Access Readers supporting various technologies shall provide data from proximity card presentations or biometric authentications via a door control unit that includes the electrical interface to the reader as well as inputs for door sensors and relays for outputs.
- H. The Door Controllers shall support industry-standard Wiegand communications to the associated readers.
- I. The Door Controllers shall support bi-directional, supervised, and encrypted communications to the readers.

**1.6 HARDWARE FEATURES****A. MODULAR SYSTEM DESIGN**

- 1. Device Control Modules shall be located in the Telecommunications Rooms (TRs) and connected to the Building Controller via hardwired bus connections or via an Ethernet TCP/IP Network.
- 2. The Building Controller shall be located in the Main Equipment Room (ER) and connected to the Central Server via an Ethernet TCP/IP connection over the District's Wide Area Network (WAN). All WAN communication shall be AES encrypted.

**B. ELEVATOR CONTROL, AS APPLICABLE**

- 1. The system shall have the ability to provide elevator access control by (1) using a card reader to activate the elevator call button, (2) using a card reader in the cab to activate the correct floor selection button, or (3) a combination of both of these functions.

2. Each cardholder shall then have floor permissions assigned as part of the normal access rights. The system shall provide outputs to the elevator controls to verify which floors are authorized for each cardholder. The system shall be capable of tracking which floor was enabled/selected by that person

C. AVAILABILITY AND DISASTER RECOVERY

1. The system shall automatically synchronize any distributed databases.
2. The system shall be capable of having a redundant or clustered Central Server.
3. In the event of loss of communications with the Central Server, the Building Control Units shall revert to a survivable remote operation and continue operation until communications is restored.

1.7 SOFTWARE FEATURES

A. PERMISSIONS

1. The system shall support multiple Operator permission levels.

B. VIDEO IMAGING AND ID BADGE PRINTING

1. The system shall incorporate video imaging as a fully integrated function to customize access control cards by printing an identity badge directly onto the card.
2. The badge design and image capture capabilities shall combine with the latest technology card printers to allow the production of an ID badge pass for each cardholder at the time of registration.
3. For each cardholder both a facial image and a signature shall be able to be captured, or imported, and stored as part of the card record.
4. A comprehensive integrated badge design and printing facility shall also be provided, allowing an unrestricted number of custom badge layouts to be defined then saved with a suitable description as a reference.
5. When creating a new card record a badge preview screen shall also be included that displays the specific card's details on the selected badge design to allow confirmation prior to requesting the badge to be printed.
6. Each new cardholder record shall have the option to be flagged for future printing. Cards flagged in this manner shall be easily recalled at a later stage and processed for output to the printer in a single action.
7. The ISM System shall support any manufacturer's ID badge printer with a **current** Microsoft **platform** (depending on the workstation configuration) compatible printer driver.

8. Provide one (1) Video Camera and Badging system per District.

C. VIDEO VERIFICATION

1. Depending on the District's needs, a Video Imaging option shall be available to provide a monitoring screen that will automatically display the stored image for a card when used at a reader.
2. This screen shall operate in conjunction with a live video input from a CCTV camera viewing the selected access point, allowing the operator to verify that each card offered is in fact being used by the person to whom it was issued.
3. This screen shall also be frozen and printed to provide a hard copy evidence of any abuse observed by the operator. For District's with high security access points, the system shall be configured to not grant access until the operator has verified the stored and live images are the same person, with the door release being controlled by the system operator.

D. REPORT GENERATION

1. Extensive history reporting shall be a standard integrated feature and shall include the ability to review all system alarms, access control activity, and operator actions. These reports shall be made available for review via the operator's display screen, a printer, or to another disk media. Extensive sort parameters shall include by any of the "Personal Details" fields or Titles, for example, by "Department", and only Names commencing with "Sm\*".
2. The system shall also support generation of reports detailing the system operation such as:
  - a. Cards on site.
  - b. Hours on site.
  - c. Cardholders with access to each door.
  - d. Access rights of each cardholder.
  - e. System Configuration.
  - f. Scheduled and Conditional Commands defined.
  - g. System operator transaction history.
3. It shall be possible to replay video clips associated with events by directly interacting with the report as published to the computer screen.

E. ADDITION OF CARDHOLDERS TO THE SYSTEM DATABASE

1. The system shall provide a means of assigning access control rights to each cardholder. Access control rights determine which access points are accessible to the cardholder based on date and time of day.

2. The software shall also provide an ALTERNATE set of Access rights to a cardholder on a temporary basis. The change may be initiated at any time by an authorized operator, or automatically between specified dates. This shall provide the ability of automatically changing a card's rights between a specified date range, after which the card will revert to its normal Doors and Times. Alternate access rights shall be able to be configured for multiple date ranges.
3. Each cardholder shall either be associated with standard door timings, for door release, door open and door pre-held or be given extended timings for disabled persons or someone who has to push a cart.
4. The system shall permit individual Access Rights or Group Access Rights to be assigned.

#### F. CARDHOLDER DETAILS

1. Cardholder information shall include first and last name, card number, PIN code and valid period to provide automatic expiration. Each cardholder record shall also incorporate at least 50 user-defined personal data fields, independent of user-defined fields for visitor management.
2. Data base synchronization utilities shall be provided to synchronize the Access Control Database with the District's HR database. Removing an individual from the District's HR database shall automatically be queued for removal from the Access Control Database.

#### G. LOCATOR

1. This feature shall provide a quick method of locating cardholders by displaying the last 10-25 valid history events along with the time, date and access point used. This information shall be available for an individual or group of persons by name, card number or by personal data.

#### H. CARD WATCH FEATURE

1. It shall be possible to easily track any individual as they move around a large site by selecting a card watch. As the person uses their access control card, the system shall have the ability to automatically notify the operator of the person's presence at each location.

#### I. MASTER CARD MODE

1. Master card mode authority shall be assigned to special cardholders, such as building maintenance, principals, etc. These features should be enabled on a per reader basis. This shall allow a person when vacating an area or building to change the reader's mode of operation from normal access control to Master Card Out operation.
2. When in this condition only persons with Master card privileges shall gain access through the door, all non-Master card users are rejected regardless of their card's current access rights.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

3. This special feature shall be activated/deactivated by the Master cardholder, using a card presentation followed by a special code entered via the reader's keypad.

**J. AUTOMATIC HOLIDAY OVERRIDE**

1. The software shall be able to be programmed by the operator to recognize special or holiday dates, which in turn can be linked to operational changes in how the site is to be managed on these specific days.
2. This feature shall notify a system operator of individual holiday dates up to seven days prior provides a useful check on the date's current validity.
3. Multiple types of holiday dates shall also be provided so that partial school days or early closing requirements on specific dates can be accommodated.

**K. ALARM MANAGEMENT**

1. The system shall provide flexible alarm management.
2. The system shall support the ability to selectively choose alarms to acknowledge and/or clear.
3. Each alarm shall be capable of linking video from the CCTV digital video recorders for incident playback – fully integrated system.
4. An alarm monitor display shall support the display of alarm statistics.
5. Alarms shall be capable of being routed to specific client machines by time of day or day of week.
6. Unacknowledged alarms shall be capable of being routed to alternate client or Email address based on age and priority of alarm.
7. The display of reader door alarms shall be automatically enabled or disabled by the use of timed commands, either by reader or by a group of readers.

**L. GRAPHICAL SITE MAPS**

1. To further enhance the presentation to the operator, the system shall have the ability to import and use graphical maps. Individual building Maps shall be linked together using a tiered tree structure. To speed the location of an incident, each map level shall contain a clearly visible indicator as to which sub map the operator should select next to find the device that is in alarm.
2. The status of readers, doors, monitor points and auxiliary outputs shall be requested from any map by simply selecting the icon representing the device and its current state will be displayed.

3. Maps shall be created using standard office tools such as Paint® or drawing packages such as AutoCAD®. It shall be possible to import drawings in the following formats: JPEG, Bitmap, Windows metafile or DXF. The maps shall be prepared by the Contractor for the District.
4. Icons representing access points, monitoring points, switching outputs, alarm inputs, CCTV cameras or intercom call stations shall be placed on any map at the required location in a drag and drop manner.
5. It shall be possible to define on the map the location of readers, access doors, alarm-monitored points, output switching relays, CCTV cameras, Digital Video Recorder Cameras, Intercom call stations and alarm panel devices.
6. The map display shall allow the operator to switch the video display of any defined CCTV camera to any defined CCTV monitor. The map display shall allow the display of stored and live Digital Video Clips – fully integrated system
7. The map display shall include the option to group and display similar devices as a single icon. Once devices are grouped it shall be possible to change their status. For example, it shall be possible to unlock/lock all Building or District entrance doors by executing a single command from the map display.

M. MANUAL AND AUTOMATIC COMMANDS

1. The system shall provide for both manual and automated commands. For example it shall be possible to schedule a command to automatically lock/unlock all doors at a specified time.

N. USER CODE MODE

1. The System shall support the ability to put a keypad-equipped reader into User Code Mode. This feature shall allow a cardholder to gain access by entering a valid card's number at a reader keypad, therefore not requiring the holder to carry a card.
2. User code mode shall be enabled on a per reader basis.

O. VISITOR MANAGEMENT - **OPTIONAL**

1. Visitor Management shall be incorporated as **an optional** feature of software, **as coordinated with the School District's requirements**. Operators shall be able to pre-enroll visitors. Any operator with visitor permissions assigned the ability to pre-enroll visitors.
2. Visitor time of arrival and time of departure shall be tracked by the system. This feature shall be available even if a visitor is not issued a card or card number in the system.
3. The System shall support an optional driver's license scanner including optical character recognition to ease data entry.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

4. The System shall support capture of a business card image.
  5. The system shall include the ability to monitor the occupancy of an area.
- P. WINDOWS DAYLIGHT SAVING AUTO ADJUSTMENT
1. The system shall support automatic Daylight Savings Time Adjustment.
- Q. HISTORY ARCHIVE AND SYSTEM BACK UP
1. The system shall allow on line archiving of history logs, along with database back up of system configuration and cardholder details. This function shall be able to be automated to occur without intervention at a pre-set time.
- R. SMART CARD ENCODING
1. The system shall provide the ability to encode contactless smart cards with access control information.
  2. The system shall be capable of capturing fingerprint biometrics and storing them on a contactless smart card, which will then be read and used to verify the cardholder during an access control transaction.
  3. The fingerprint solution shall support the enrollment and use of at least two fingerprints, which shall allow the cardholder to present either finger to gain entry.
  4. On a timed or manual basis the system shall be configurable to allow entry using the smart card only, smart card plus fingerprint or smart card plus two fingerprints, thereby raising or lowering the level of security as required.
  5. The system shall allow the assignment of a fingerprint for normal entry and a different fingerprint for duress entry. The cardholder shall have the ability to trigger a silent duress alarm by presenting the duress fingerprint. This provides the cardholder with a safe way to indicate a duress condition, without alerting anyone locally that the alarm has been triggered.
  6. An option to store the fingerprint acceptance threshold in the smart card or at the reader shall be provided. By storing the threshold in the smart card, overall site security is not compromised by a poor quality fingerprint, which would normally require a low acceptance threshold to be set at the reader.
- S. DIGITAL VIDEO MONITORING AND CCTV MATRIX SWITCH CONTROL OPTION
1. For larger Districts, the system shall provide an option to interface to a CCTV matrix switcher. This component shall allow an operator with appropriate privileges to display any available video source on any available video monitor.

**T. DATA IMPORT/EXPORT**

1. The system shall support a data import/export ability to permit the District to bulk-load employee information at the beginning of a school year.

**U. BUILDING CONTROL MODULE**

1. The system shall provide a Building Control Module, to allow the definition of one or more building controls, each used to control a separate HVAC or other building system. Readers and/or motion detector inputs shall be able to be used to determine the occupancy of the area represented by the building control – a fully integrated solution.
2. The Building Control Module shall support standard BACnet communications to project the current status of building controls, monitor points, doors and the last alarm generated to third-party building systems.
3. The system shall allow manual commands to interface with (turn on or off) building controls through the BACnet protocol. It shall be possible to issue these commands from on-screen graphical maps or plans of the building.
4. The system shall allow scheduled commands to interface with (turn on or off) building controls through the BACnet protocol. It shall be possible to issue these commands automatically at any time of the day, any day of the week or holiday dates.
5. The system shall allow conditional commands to interface with (turn on or off) building controls through the BACnet protocol. It shall be possible to issue these commands automatically depending on another event occurring. For example, a cardholder could use a "card command" at an access control reader to switch an HVAC system on or off.
6. It shall be possible to view the current status of a building control from the View/Status screen in the System software.
7. The system shall allow the definition of groups of building controls, which enables, for example, a single command to switch on several building controls in one operation.

**V. GUARD TOUR OPTION**

1. This optional feature shall allow District Guard Tour patrol sequences to be created consisting of a number of designated clocking points, which the patrolling guard has to visit.
2. A guard tour sequence shall define the order in which the clocking points are to be visited and how long the guard should take to move between each clocking point location.

**W. E-MAIL ALARMS**

1. The System shall support the ability to automatically e-mail alarm condition messages.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

**X. INTERCOM INTEGRATION OPTION**

1. The system shall support a serial or other high-level connection to an intercom system. The intercom system shall be accessed by users through a call station -- typically installed outside the building at doors, parking barriers, etc.
2. Visitors or other personnel generally ask permission to gain entry at the intercom call stations.

**Y. INTRUSION DETECTION SYSTEM INTEGRATION**

1. The System shall support a high-level (serial interface) to an intrusion detection system (IDS). The IDS shall be UL 1076 listed. The System shall support events to be recorded and displayed from the IDS system on the alarm management screen and in the transaction history reports – fully integrated system.

**1.8 CARD READERS**

- A. Furnish Wiegand compatible Card Readers at all Controlled Access Entrances, Elevators, Food Storage areas and Technology Rooms, as required by the District.
- B. All Card Readers shall be Proximity Type (no Card swipe type readers) and may include optional Biometric readers as required by the District.
- C. All Card readers shall include a keypad for duress entry or PIN Number entry.

**1.9 POWER SUPPLIES**

- A. All system Power supplies shall be centrally located in the Technology Rooms and connected to the Technology Room Generator Powered, UPS units.

**1.10 INSTALLATION**

- A. The Administrator Terminal shall be connected to the remote terminals before connecting to any card reader processors.
- B. The Contractor shall coordinate with the District's locksmith if converting from mechanical to electric locks.
- C. The Contractor shall install the appropriate cable from the CPU to readers, door contacts, request-to-exit devices, and electric locks at each door and/or gate.
- D. All communications cables shall be kept away from power circuits.
- E. The Contractor shall install the power supply(s) for electric locks in locations where they will not interfere with other operations.
- F. The Contractor shall do nothing to modify a UL. rated door or frame that would void the UL label or fire rating.

- G. All cables shall be labeled with self-laminating, machine-printed, wrap-around labels.

#### 1.11 INITIAL PROGRAMMING AND CONFIGURATION

- A. Contractor shall provide initial programming and configuration of the Integrated Security Management (ISM). Programming shall include defining hardware, doors, monitor points, clearance codes, time codes, door groups, alarm groups, operating sequences, camera call-ups, and the like. Input of all program data shall be by Contractor. Contractor shall consult with Security Consultant and District to determine operating parameters.
- B. The Contractor shall develop and input system graphics, such as maps and standby screens. The District shall provide floor plan drawings as the basis for the creation of maps. Development of maps shall include the creation of icons for all doors, monitor points, and tamper circuits. Owner shall provide floor plan drawings, in the form of AutoCAD .DWG or .DXF files, as the basis for the creation of maps.
- C. The District, with the cooperation and assistance of Contractor, will input the cardholder data for each access card.

#### 1.12 TRAINING

- A. The Contractor shall provide complete operator training on the Security Management System. Training shall consist of a minimum of thirty-two hours of classroom instruction, plus two (2) hours of individual hands-on training. Hands-on training shall include the opportunity for each person to operate the system, and to practice each operation that an operator would be expected to perform.
- B. Provide two (2) video copies of all training.

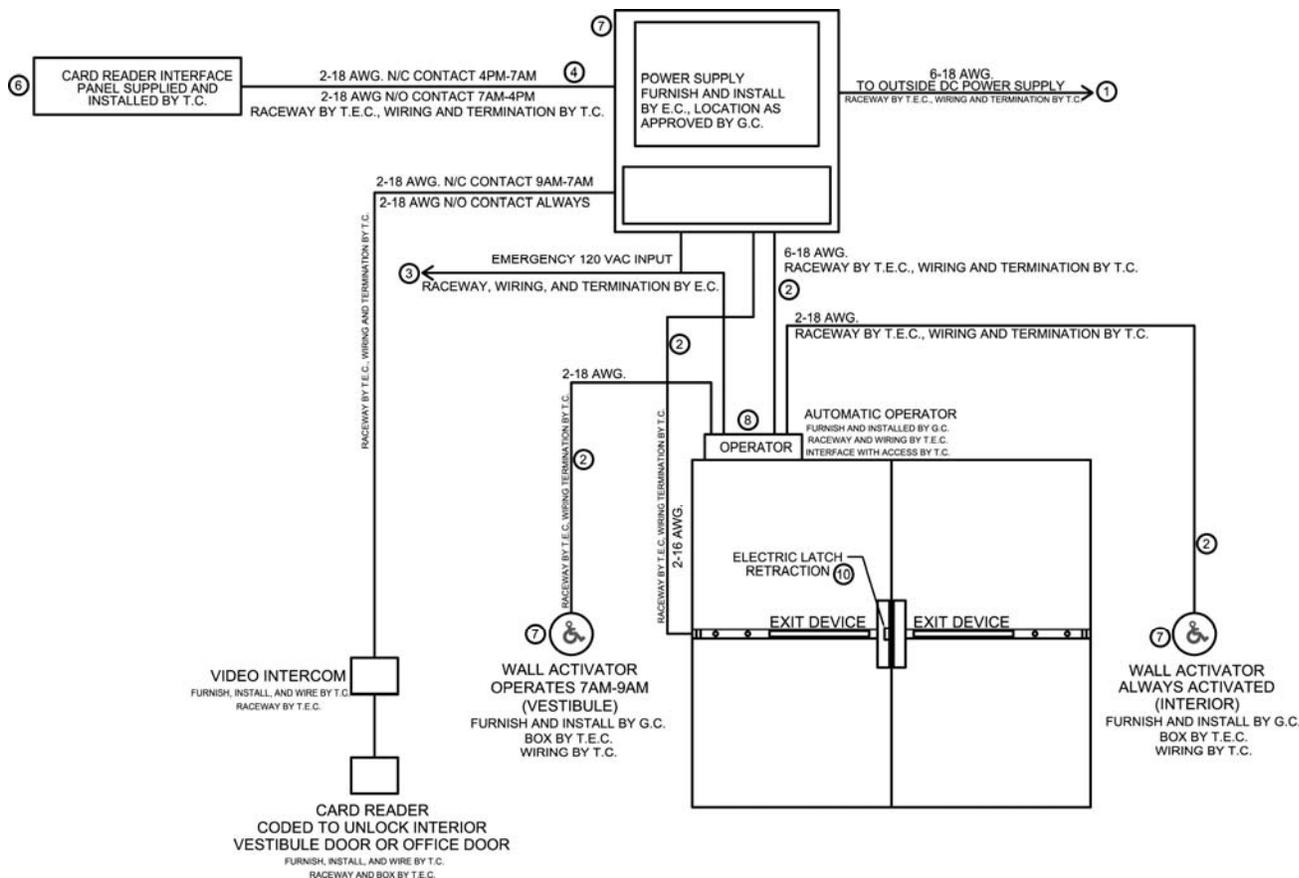
#### 1.13 SEQUENCING

- A. The following figures provide recommendations for the sequencing and operation of the Access Control for the building's main doors. Suggested breakdown of tasks by trade are also provided. The Designer should consult with the District to determine final operating parameters.

(please see following diagrams)





**TYPICAL DOOR 2****Door 2:**

This door will be unlocked between 7 a.m.-9 a.m. and both push plates will work.

After 9 a.m. the door will be locked and the vestibule push plate will not work but the interior push plate will still unlock the panic bar and open the door.

There will need to be one set of contacts to the inside door to control the locking and unlocking of the panic bar between 7 a.m.-9 a.m.

This door can be opened by card reader at all times.

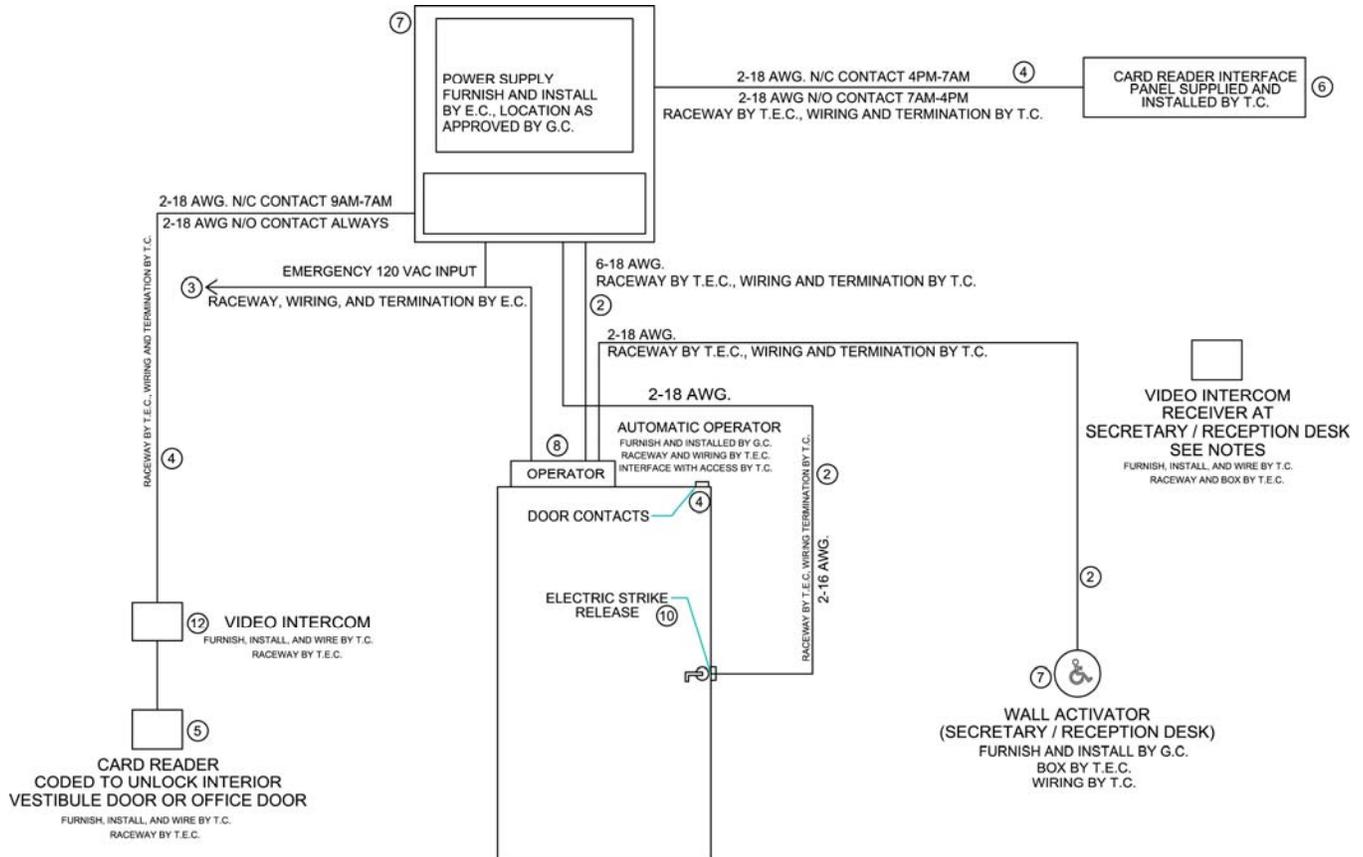
All interior vestibule doors have electric latch retraction and are connected to building security.

All interior vestibule doors lock from 9 a.m.-4 p.m.

All interior doors can be opened from inside the building at all hours via panic hardware.

Lock out of doors can be overridden during fire drills or other events.

All components shall be installed in one location as designated by G.C., 8" above ceiling (typical).

**TYPICAL DOOR 3****Door 3:**

This door is locked at all times.

Entry is only allowed via card reader or by push plate located at the office personnel's desk.

Visitors must first be identified at the video intercom located in the vestibule by the office personnel through their video receiver.

There is a push plate inside the office to let visitors out when they are leaving.

There are no push plates inside the vestibule to let people into the office.

All visitors must be identified prior to gaining access to the rest of the building.

The security/receptionist has control over releasing the door strike to unlock the door or releasing the strike and activating automatic door operator, depending on which button is pressed on the intercom receiver.

All components should be installed in one location as designated by G.C., 8" above ceiling (typical).

END OF SECTION

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## SECTION 281600

## INTRUSION DETECTION SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform Intrusion Detection System that shall be followed for all OSFC Technology construction projects.
- B. Refer to Sections 8500, Technology Systems, 28 13 00 Electronic Access Control and 28 23 00 Video Surveillance for additional information.

## 1.2 SECTION INCLUDES

- A. Intrusion Detection System.
- B. Uninterruptible Power Supply (UPS).

## 1.3 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. NFPA 730 – Guide for Premises Security**
- C. NFPA 731 – Standard for the Installation of Electronic Premises Security Systems**
- D. National Electric Code.
- E. American with Disabilities Act.
- F. Underwriter’s Laboratory.
- G. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and **Eleventh** Edition (or later).
- H. BICSI Telecommunications Distribution Methods Manual (TDMM).
- I. UL 1610 -- Central-Station Burglar-Alarm Units.
- J. UL 1023 -- Standard for Safety Household Burglar-Alarm System Units.
- K. UL 609 -- Standard for Safety Local Burglar Alarm Units and Systems.
- L. UL 365 -- Standard for Safety Police Station Connected Burglar Alarm Units and Systems.
- M. UL 985 -- Household Fire Warning System Units.
- N. Products -- Factory Mutual approved.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

**1.4 SYSTEM WARRANTY**

- A. The Intrusion Detection System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

**1.5 SYSTEM OPERATION**

- A. Upon entering a valid access code via a system control keypad, the system shall disarm the applicable zones, disarm the alarm system, and log the transaction pertaining to time, date, and user.
- B. The Intrusion Detection System shall provide the following functions:
1. A system control panel, control keypads, magnetic door contacts, motion sensors, and alert sirens.
  2. Provide interconnection to the District provided dedicated telephone connection for monitored response to after-hours alarms. Consider cellular backup system.
  3. Provide interconnection to the central control panel for monitoring all applicable doors with door contacts.
  4. System shall be fully integrated with the building's Access Control and CCTV System.
  5. The System shall be integrated with the building lighting system and shall activate the corridor lights and other selected areas in the event of alarm activation.
  6. The System shall be supervised, i.e. power failure, line cuts and communication failures shall signal the monitoring station(s) of the problem.
  7. The fire system flow and tamper points shall be attached to the system.
  8. The System shall provide monthly reports, detailing as a minimum:
    - a. Alarm System usage.
    - b. Door Openings.
    - c. Door Closings.
    - d. Alarm Conditions.
- C. The System shall be programmed to accept individual access codes from authorized employees. Codes shall not be shared.

## 1.6 EXTERIOR ENTRANCE / EXIT DOOR

## A. KEYPAD

1. A keypad shall be mounted within six (6) feet of the entrance on the inside of the facility.
2. The keypad shall utilize a minimum of a two (2) line, 32-character LCD display and an integral multi-tone speaker.
3. The keypad shall contain an internal diagnostics program allowing for system troubleshooting without disabling the system.
4. The keypad shall allow for the use of three dedicated keys to function as panic keys.
5. Keypads shall have a keypad activated duress code feature.
6. All keypads shall be interfaced with the Control Panel.

## B. DOOR CONTACT

1. A magnetic door contact switch shall be installed at each exterior door to provide door open/closed status to the system.
2. The contact switch shall be installed recessed into the doorframe where applicable.

## C. CENTRAL CONTROL PANEL

1. Provide one Central Control Panel, which shall be equipped with a lock and transparent door panel.
2. The Central Control Panel shall provide the required input zones, operate on 24V D.C., indicate ground fault, and activate audio and visual devices.
3. The Central Control Panel shall have a battery charging system and battery(s).
4. Connect the Central Control Panel to the Main Equipment Room, **generator powered**, UPS Units.
5. Provide necessary auxiliary contacts (alarm and trouble), for sending signals to the digital communication system.
6. Provide necessary auxiliary contacts to power the exterior bell.
7. The Central Control Panel shall provide a telephone digital communication actuation and supervisory circuit.
8. Connect Central Control Panel to the District provided telephone line(s).

## D. P.I.R. MOTION SENSOR

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

1. The system shall be provided with passive infrared motion detectors.
  2. The sensors shall be microprocessor controlled and contain a false alarm protection feature.
  3. The sensors shall provide a minimal coverage pattern of 50 feet by 50 feet to 120 feet by 12 feet based on interchangeable lenses. Select lenses based on coverage area required.
  4. Short, medium and long-range motion detectors shall be selected as required to suit the area to be covered.
  5. The sensors shall be capable of mounting either on a ceiling, wall surface or in a corner.
  6. Install sensors on all floors of the facility, in corridors and all rooms with outside access.
  7. Each entry point shall be backed up by Motion Detectors.
  8. Locate motion Detectors to provide full coverage and minimize false alarms.
  9. Provide single or dual technology motion detectors based on application.
  10. Dual Technology sensors shall employ both Microwave and Passive Infrared.
- E. ALARM SIREN
1. The system shall be provided with an external alarm siren(s) (horn) and strobe light as required.
  2. The alarm sirens and strobes shall be housed in a tamper proof, weather resistant metal enclosures.

**1.7 INSTALLATION**

- A. The system wiring and installation shall comply with all applicable codes and drawings, and shall be installed in accordance with the manufacturer's recommendations.
- B. All wiring shall be color-coded and labeled at each end with self-laminating, machine-printed labels.
- C. All wiring shall be installed in metallic raceways and shall comply with the latest edition of the National Electric Code (NEC).

**1.8 MOUNTING HEIGHTS**

- A. All mounting heights shall comply with the Americans with Disability Act (ADA).
- B. Mount Motion Detectors to provide maximum coverage, and minimal false alarms. Do not obstruct viewing angle.

**1.9 TRAINING**

- A. Provide a minimum of four (4) hours training on the operation of the system.
- B. Provide two (2) video copies of all training.

END OF SECTION

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## SECTION 282300

## VIDEO SURVEILLANCE SYSTEM

GENERAL GUIDELINES

## 1.1 GENERAL

- A. This Section defines the general design requirements for a uniform Video Surveillance System that shall be followed for all OSFC Technology construction projects.
  - 1. Figure 1 describes a Typical District-Wide Analog CCTV System.
  - 2. Figure 2 describes a Typical District-Wide ALL IP CCTV System.
  - 3. Refer to Sections 8500, Technology Systems, 28 13 00 Electronic Access Control and 28 16 00 Intrusion Detection for additional information.

## 1.2 SECTION INCLUDES

- A. Integrated Video Surveillance System
- B. Uninterruptible Power Supply (UPS).

## 1.3 QUALITY ASSURANCE

- A. National Fire Protection Association.
- B. NFPA 730 – Guide for Premises Security**
- C. NFPA 731 – Standard for the Installation of Electronic Premises Security Systems**
- D. National Electric Code.
- E. American with Disabilities Act.
- F. Underwriter's Laboratory.
- G. FCC Class B.
- H. NEMA Type 4AX.
- I. NEMA Type 1.
- J. NTSC/EIA.
- K. ISO/IEC 14496-2 MPEG-4.
- L. H.264.

## ELECTRONIC SAFETY AND SECURITY

## CHAPTER 9: SPECIFICATIONS

- M. Latest ANSI TIA/EIA-568, 569, 606, 607 Standards and **Eleventh** Edition (or later).
- N. BICSI Telecommunications Distribution Methods Manual (TDMM).

### 1.4 SYSTEM WARRANTY

- A. The Video Surveillance System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.

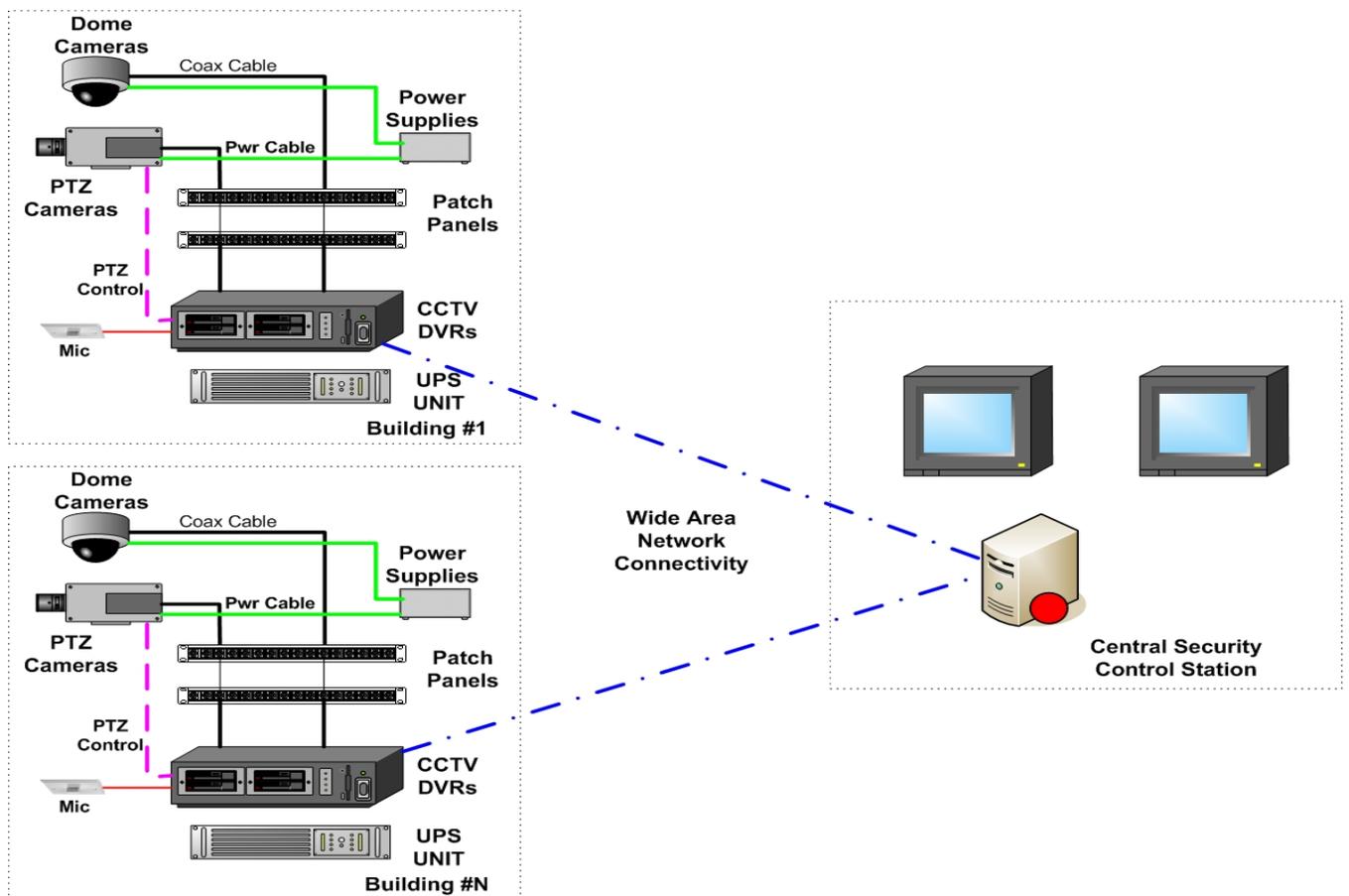


Figure 1 – Typical District-Wide Analog CCTV System

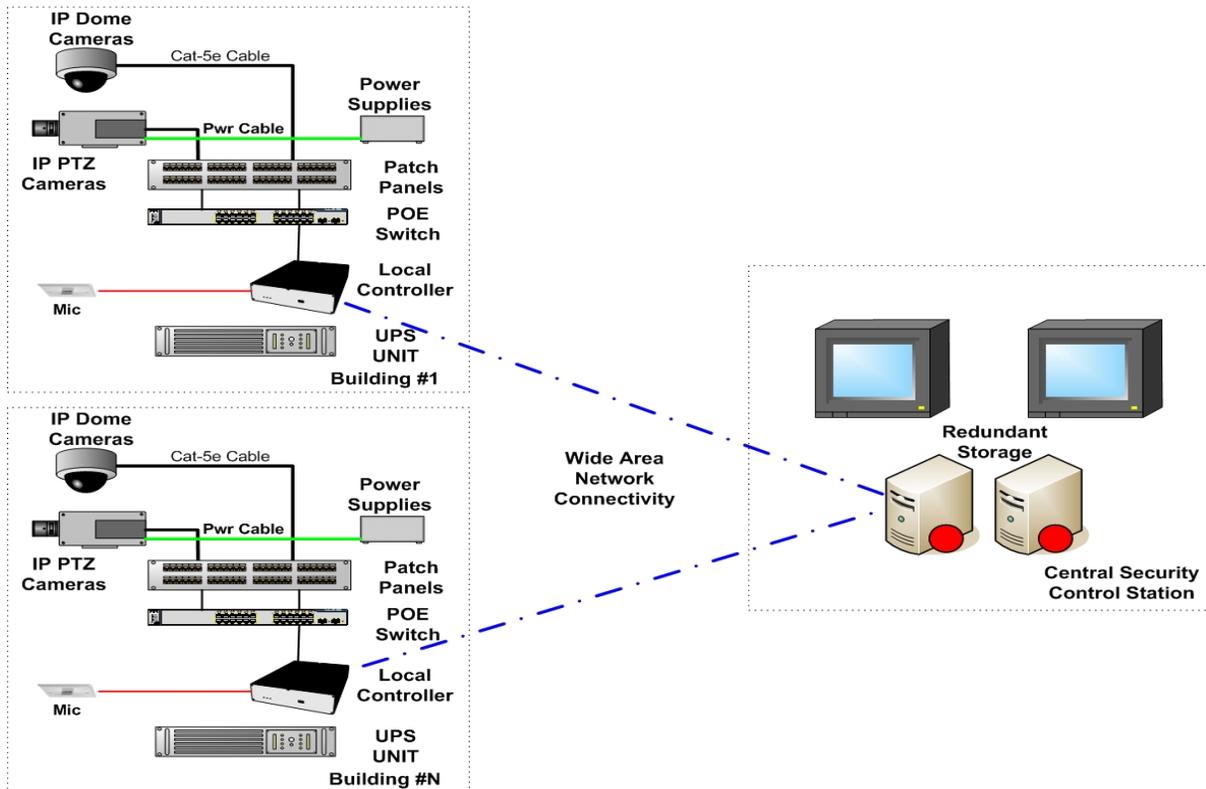


Figure 2 – Typical District-Wide ALL IP CCTV System

### 1.5 GENERAL

- A. Furnish a new Integrated Video Surveillance System that provides a simple and easy-to-use graphical user interface.
- B. The system shall provide local and central operational control and viewing of all cameras
- C. For Districts with existing Analog Systems, consider upgrading the system to a Hybrid Analog /IP system or continue to supply Analog Systems as shown in Figure 1 above.
- D. For Districts without an imbedded base of CCTV Systems, consider deploying the ALL IP System as shown in Figure 2 above, since this is the current trend in CCTV systems.
- E. All IP systems provide mega pixel technology that permits greater image resolution and detail, and enable advanced video analysis and recognition technologies. All IP Systems require less storage, simplify cabling and eliminate the need for analog cameras and DVRs.
- F. All IP cameras permit digital pan, tilt and zoom and can create multiple window videos. They permit video analysis and intelligence at the camera before the video is degraded by transmission distortion. In short, analog cameras and DVRs are being replaced by more effective and less costly ALL IP systems. Consider utilizing ALL IP or Hybrid IP/Analog technology.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

- G. Analog Cameras may be cabled with standard RG-59 Coax cable and Separate/Siamese Power Cable or may be cabled with UTP Category-5 cable and Baluns depending on the District's preference.
- H. Hybrid Designs may use IP Cameras, POE Ethernet Switches and Local DVR units per building.
- I. When a District has more than one building, the Central Server and Viewing Station shall be located in one of the District's buildings and the other buildings shall be attached to the Central Server via the Wide Area Network. All buildings in the District shall interface to the Central Server and Control Consoles and shall function as a single unified system.
- J. The Video Surveillance System shall seamlessly integrate with the Access Control and Intrusion Detection Systems.
- K. The Systems shall be located in the Main Equipment Room (ER) and connected to generator-powered UPS Units. Backup power shall be provided for both cameras and recording equipment.
- L. Provide sufficient cameras to cover the entire school and surrounding lots.
- M. As a minimum provide fixed focus camera coverage for:
  - 1. All entrances/exit doors.
  - 2. Hallways.
  - 3. Restroom entrance/exit doors.
  - 4. Loading docks.
  - 5. Kitchen areas.
  - 6. Lunch lines.
  - 7. Cafeteria.
  - 8. Auditoriums.
  - 9. Playgrounds.
  - 10. Bus pickup/delivery.
  - 11. Parking lots.
  - 12. Athletic Areas.
- N. As a minimum provide additional PTZ camera coverage for:
  - 1. All outside building corners.
  - 2. Parking lots.
  - 3. Playgrounds.
  - 4. Bus Drop-Off.
  - 5. Building Services Areas.
- O. Mount external cameras to the side of the building for most situations. Use pole mounting for special circumstances, as required.
- P. Connect a minimum of one building mic to the CCTV Recording system. Locate the Mic in the Central Office area (typical). Connect the audio output from the building paging system to the CCTV recorder. Consider connecting the audio output from the PABX E911 calling system to the CCTV recorder.

- Q. Systems shall be monitored with a 19-inch (minimum) LCD color monitor in the Central Office area. – supply monitors based on system camera requirements. An additional 19-inch (minimum) LCD color monitor should be mounted on the ceiling at the public entrance to show that cameras are being used in the public areas. Post the appropriate signs advising the public that audio/video recording is taking place in the facility.

### 1.6 CAMERAS

- A. All cameras shall be contained in smoked-dome, impact and vandal-resistant enclosures. Consider bulletproof enclosures for high crime areas.
- B. Compatible lenses specific to each placement and required field of view will be used.
- C. Typical lenses shall range from 2.3 mm (wide) to 12 mm (long range). Consider using vari-focal lenses (typical 3.6 – 8 mm) for fine-tuning.
- D. All analog cameras shall use 1/3 inch, CCD technology and provide progressive scan only – no interlaced scan cameras shall be used.
- E. Coordinate lens type with CCD sensor size.
- F. Place multiple cameras in hallways and avoid single cameras covering a long hallway.
- G. Limit camera spacing to 75 feet maximum.
- H. Camera placement guidelines:
1. Avoid backlight (this problem can occur when attempting to capture an image from behind a window, etc.). **Utilize wide dynamic range cameras in these applications.**
  2. Always use auto iris lenses for outdoor applications.
  3. Avoid direct sunlight – try to position the camera the same direction as the sun.
  4. Avoid viewing too much sky – it results in too much contrast.
  5. Avoid reflections.
- I. Cameras shall have integral motion detectors for changing the frame per second recording rate, depending on system set up.
- J. Coordinate placement of all cameras with District and a Qualified Security Professional.
- K. All analog cameras shall meet the following minimum specifications:
1. An effective minimum pixel density of 704 (H) and 480 (V).
  2. Video output signal from 1.0 to 1.2 V p-p at 75 ohms, adjustable.
  3. Signal to Noise ratio of at least 50 dB.
  4. 0.4 Lux sensitivity.
  5. 30 fps.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

- L. All cameras shall be equipped with an auto-iris, automatic gain control and automatic white balance.
- M. All cameras shall be centrally powered from associated Telecommunication Room, **generator powered**, UPS Unit.
- N. All exterior PTZ cameras shall be contained in a pendant style, vandal proof, exterior enclosure with integral heater module.
- O. All PTZ cameras shall meet the following minimal features:
1. 22X Optical Zoom, 10X Digital Zoom.
  2. Window Blanking.
  3. 64 Presets.
  4. 0.5° Preset Accuracy.
  5. 140°/second Pan Speed.
  6. Rotating Discreet Liner.
  7. One Dynamic Window Blanking Area.
  8. Proportional Pan and Tilt.
  9. Programmable Zoom Speeds.
  10. 360 Degree scan.
  11. Day/Night Operation.
    - a. 0.08 lux at ½ sec shutter (Color).
    - b. 0.30 lux at 1/60 sec shutter (B/W).
    - c. 0.013 lux at ½ sec shutter (B/W).
  12. 30 fps – NTSC.
- P. All analog cameras shall operate on 75 ohm RG-59 coax or Category-5e UTP (supply Baluns and line conditioners as required).
- Q. Provide fiber-optic interfaces for all external, pole-mounted cameras.
- R. All IP cameras shall meet the following minimal features:
1. Powered via 802.3af Power-Over Ethernet using standard Category-5e cable.
  2. Optional additional power for External PTZ cameras.
  3. MPEG-4 Advanced Simple Profile (ASP) and Simple Profile (SP).
  4. Audio capabilities with optional mic.
    - a. G711 PCM.
    - b. G.726 ADPCM.
    - c. MP3.
  5. Optional DSP for video intelligence and recognition techniques.
  6. Mega pixel sensor.
  7. Digital Pan/Zoom.
  8. CCD sensor – ¼-inch minimum.
  9. Integrated PZT control over one Category-5e cable.
  10. IR Cut Filter for low-light conditions.
  11. SNMP support for management.
  12. HTTPS for encrypted Communications.
  13. Built-in Web Server.
  14. Fixed IP address.
  15. 30 fps – NTSC.

- S. Designs may use Analog or IP Cameras; however, Analog cameras should be limited to existing installations.

### 1.7 DIGITAL VIDEO RECORDER (DVR)

- A. Existing installations may still use individual Digital Video Recorders (DVRs) for District compatibility. New installations should consider centralized Digital Storage Servers with Satellite Collectors in Individual Buildings.
- B. The DVR shall provide a high quality, 1- to 16-channel recorder capable of storage and playback of images from 1 to 16 camera inputs. ***DVR shall support a minimum of 7.5 fps from each attached camera simultaneously.***
- C. The DVR shall be able to record full-screen video images continuously, upon motion detection, or according to a time schedule to its internal hard drives.
- D. The DVR shall have the capability to simultaneously record, archive background images, and allow multiple user network viewing and playback with no loss of performance.
- E. Internal DVR hard drives shall provide for ***30 days*** of storage at an average rate of 5 fps per camera, ***CIF resolution.***
- F. All recording to the hard drive shall have a digital signature applied to the disk file including time, date and camera info.
- G. The DVR shall support simultaneous audio recording and playback on at least one channel in real time.
- H. The DVR shall have video motion search to allow recorded searches on the hard disks, based on movement in a particular area of the image.
- I. The DVR shall provide a list of the activity events that occurred within a defined area.
- J. The DVR shall have a standard Ethernet connection and The Ethernet connection shall allow live and recorded viewing on a networked PC using a manufacturer's Network Viewer or via web pages over a standard Internet browser.
- K. The DVR shall support file export of digitally signed images over the network.
- L. The DVR shall provide a user-friendly, paged menu system that is controlled from the face of the DVR and viewable on a composite monitor that can be connected to the DVR's main monitor output.
- M. The DVR central Viewing station shall be completely integrated with the Intrusion Detection and Access Control Systems.

### 1.8 CENTRAL STORAGE

- A. Newer installations shall use a Centralized Digital CCTV Storage system.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

- B. Interface the Centralized Digital CCTV Storage System with DVRs in remote buildings or Remote Video Servers.
- C. The Centralized Storage Systems shall function as the main depository for CCTV Videos. Remote Video Servers shall transmit the CCTV Video to the Central Servers.
- D. The Centralized Storage System shall have the following minimum features:
  1. Live video review of up to 32 concurrent cameras per client PC attached to the Server.
  2. Managed, indexed storage of MPEG-4 video from Remote Video Servers and selected IP cameras.
  3. Event-based recording that is fully integrated with the Intrusion and Access Control Systems.
  4. Internal redundant hard drives that shall provide for **30 days** of storage.
  5. All recording to the hard drives shall have a digital signature applied to the disk file including time, date and camera info.
  6. Alarm Management, including video loss alarms.
  7. Graphical Maps with interactive video control.
  8. Review stored video from DVR, IP camera archive and video servers.
  9. Instant Replay of recently recorded videos.
  10. Record Now feature -- allows security-monitoring personnel to initiate recording.
  11. Flexible event presentation of videos.
  12. Integrated HTML Web Page support in virtual matrix for remote viewing.
  13. Several Operator permission Levels for Individual Cameras and Videos.
  14. PTZ Control support.
  15. Management Reports.
  16. Support for multiple client PCs – minimum 6.
  17. Activity logging.
  18. Configuration Change and Operator Activity Reporting.
  19. Seamless integration with Intrusion Detection System and Access Control System.
  20. Support for various Storage and archiving functions.
  21. Connect to the Central Video Servers via IP.
  22. Provide support for legacy Analog and new IP cameras.

## 1.9 REMOTE VIDEO SERVERS

- A. Remote Video Servers shall have the following minimum features:
- B. Store and Forward capability - Store data at the edge of the LAN/WAN and only forward over the network when required.
- C. Event based recording for intrusion or access control activity.
- D. Provide local storage of video streams in the event of WAN communication failure to the Central Storage Servers.
- E. Complete control over frame rate, video resolution and other settings on a timed and trigger basis.
- F. MPEG-4 compression technology.

- G. Integrated with Access Control and Intrusion Detection Systems.
- H. PTZ support.
- I. Motion detection support.
- J. Integrated web server for configuration.
- K. Video loss alarm capability.

#### 1.10 INSTALLATION

- A. The system wiring and installation shall comply with all applicable codes and drawings, and shall be installed in accordance with the manufacturer's recommendations.
- B. All wiring shall be color-coded and labeled at each end with self-laminating, machine-printed labels.
- C. All wiring and component installations shall comply with the latest edition of the National Electric Code (NEC).

#### 1.11 TRAINING

- A. Provide a minimum of eight (8) hours training on the operation of the system.
- B. Provide two (2) video copies of all training.

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## SECTION 282600

## AREA OF REFUGE INTERCOMMUNICATION SYSTEM

- 1.1 General
  - A. This section defines the general design requirements for an ADAAG compliant Area of Refuge Assistance Intercommunications System that shall be followed for all OSFC Technology projects where applicable.
  - B. Coordinate requirements and device locations with the project architect.
- 1.2 Section Includes
  - A. Area of Refuge Intercommunication System
- 1.3 Quality Assurance
  - A. National Fire Protection Association
  - B. National Electric Code
  - C. American with Disabilities Act
  - D. Underwriter's Laboratory
  - E. Products – Factory Mutual approved
- 1.4 System Warranty
  - A. The Area of Refuge Intercommunication System shall be warranted by the contractor for a period of one (1) year from date of substantial completion.
- 1.5 System Operation
  - A. The Area of Refuge Intercommunication System is used to call for assistance from Areas of Refuge as defined in the Americans with Disabilities Act.
  - B. When a call is placed from a remote station, it is annunciated at the master station with both audible and visual signals and displayed on an alpha-numeric display. The alpha-numeric display shall indicate the name and location of the calling station. Once a call is acknowledged at the Master Station, the remote station provides visual and audible confirmation. The Master Console controls the direction of the talk circuit.
  - C. A call may only be canceled from the Master Console after it has been acknowledged. After the call has been canceled from the Master Console, the indicators extinguish and communication is terminated.

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

- D. The Master Console may initiate audio communication with a Remote Call Station at any time by dialing the station number on its keypad or by pressing the button associated with the station. The Master Console may also page a group of Remote Call Stations to broadcast evacuation information. In the event of circuit trouble with any Remote Call Station, the Master Console will display the location and number of the station and "Trouble."
- 1.6 System Head-end
- A. Provide a multi-station, ADAAG compliant Area of Refuge Assistance 2-way intercommunications system. System shall consist of a wall mounted master station and remote call in stations as indicated on the drawings. The System shall be micro-processor based and utilize multiplexing technology.
- 1.7 Call in Stations
- A. The call in stations shall utilize common bus architecture with no home runs. Multiple stations and masters may be on one main.
- B. The station has a flush mounting for standard electrical multi-gang wall box, weather/vandal resistant 11-gauge brushed stainless steel panel with tamperproof hardware, speaker/microphone for voice communication, a call button and two LED indicator. The panel resists damage from common cleaning agents. Supervision of the station is indicated at the Master Console.
- 1.8 Master Station
- A. Ultra compact console with spill-proof keypad, backlit display panel, low-light readability, alpha-numeric display of station number and name, handset privacy or hands-free communication, auto-answer by lifting handset or scroll to any call, group voice page, digital volume keys, call tones with mute for calls in progress, programmable station name.
- B. Master station may be either desk mounted or flush wall mounted with appropriate hardware.
- 1.9 Telephone Interface
- A. Telephone Interface – the PBX telephone interface connects a call from a remote station to a PBX telephone system. The interface allows calls from remote stations to be forwarded to outside telephones. Interface is used in conjunction with the Master Station
- 1.10 Installation
- A. The system wiring and installation shall comply with all applicable codes and drawings, and shall be installed in accordance with the manufacturer's recommendations.
- B. All wiring shall be color coded and labeled at each end with self-laminating, machine printable labels.

- C. All wiring shall be installed in metallic raceways from rough-in boxes to above accessible ceilings. Cabling installed open above accessible ceilings shall be supported with manufacturers and approved cable support systems and shall comply with the latest edition of the National Electric Code (N.E.C.).
  - D. All equipment shall follow manufacturer's guidelines for mounting heights and installation methods.
- 1.11 Testing
- A. Verify proper operation of system
- 1.12 Training
- A. Provide a minimum of eight (8) hours training including system programming, trouble shooting and basic operation.
  - B. Provide two (2) video copies of all training.

END OF SECTION

## SECTION 283111

## DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for fire-alarm control unit, manual fire-alarm boxes, system smoke detectors, heat detectors, notification appliances, magnetic door holders, remote annunciator, addressable interface device, and digital alarm communicator transmitter.

## 1.2 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code
- B. Underwriter's Laboratory

## 1.3 FIRE-ALARM CONTROL UNIT

- A. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
- B. Addressable initiation devices that communicate device identity and status.
- C. Addressable control circuits for operation of mechanical equipment.
- D. Alphanumeric Display and System Controls
- E. Circuits:
  - 1. Initiating device, notification appliance, and signaling line circuits: NFPA 72, Class B.
- F. Elevator Recall:
  - 1. Smoke detectors shall initiate automatic elevator recall.
- G. Heat detectors in alarm installed in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
- H. Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- I. Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Primary Power: 24-V dc obtained from a 120-V emergency generator branch circuit and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
- K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  - 1. Batteries: Sealed lead calcium
  - 2. Capacity: Comply with NFPA 72

**1.4 MANUAL FIRE-ALARM BOXES**

- A. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

**1.5 SYSTEM SMOKE DETECTORS**

- A. General Requirements for System Smoke Detectors:
  1. Comply with UL 268; operating at 24-V dc, nominal.
  2. Detectors do not require resetting or readjustment after actuation to restore them to normal operation. Integral visual-indicating light: LED type indicating detector has operated and power-on status.
- B. Photoelectric Smoke Detectors:
  1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.
  1. Detector address shall be accessible from fire-alarm control unit and shall be able identify the detector's location within the system and its sensitivity setting.

**1.6 HEAT DETECTORS**

- A. Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 degrees Fahrenheit or a rate of rise that exceeds 15 degrees Fahrenheit per minute unless otherwise indicated.
- C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 degrees Fahrenheit.

**1.7 NOTIFICATION APPLIANCES**

- A. Horns: Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with a clear polycarbonate lens.
- C. Flashing shall be in a temporal pattern, synchronized with other units.

**1.8 NOTIFICATION APPLIANCE CIRCUIT POWER SUPPLY UNITS**

- A. Power-limited design, complying with UL 864 and listed and labeled by an NRTL.
- B. Primary Power: 24-V dc obtained from a 10-v emergency generator branch circuit and a power-supply module.
- C. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
  1. Batteries: Sealed lead calcium.
  2. Capacity: Comply with NFPA 72

**ELECTRONIC SAFETY AND SECURITY**

## CHAPTER 9: SPECIFICATIONS

## 1.9 MAGNETIC DOOR HOLDERS

- A. Units equipped for wall mounting complete with matching doorplate.
- B. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.

## 1.10 REMOTE ANNUNCIATOR

- A. Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
- B. Alphanumeric display with LED indicating lights.

## 1.11 NON-ELECTRIC GRAPHIC ANNUNCIATOR

- A. Framed plexiglass floor plan display with room numbers assigned by Owner.
  - 1. Color image printed on the reverse side of a polycarbonate Lexan laminated to a rigid backing with a removable adhesive for future replacement.
  - 2. Graphics shall show location of fire-alarm control unit, "YOU ARE HERE", detection devices and nomenclature.
  - 3. Mounting: Adjacent to remote annunciator.

## 1.12 ADDRESSABLE INTERFACE DEVICE

- A. Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to the following:
  - 1. Elevator controller to initiate elevator recall.
  - 2. Circuit-breaker shunt trip for power shutdown.
  - 3. Theatrical lighting controller for panic lighting.
  - 4. Heating, ventilating, and air-conditioning equipment controllers for power shutdown.
  - 5. Smoke dampers for closing.
  - 6. Magnetic door holders, electric locks, coiling doors and grilles for releasing.
  - 7. Building management system for equipment shutdown and alarm notification.

## 1.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632 and be listed and labeled by an NRTL.

## 1.14 DEVICE GUARDS

- A. Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection in gymnasiums and locker rooms.

## 1.15 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.

- B. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch.
- C. Mounting height of appliances shall comply with Americans with Disability Act.
- D. Grounding: Ground fire-alarm control unit and associated circuits.
- E. *Wiring shall be installed in conduit in compliance with Allowable Conduit Schedule in section 260533.***

END OF SECTION

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**31**

**DIVISION**

**EARTHWORK**

TABLE OF CONTENTS

DIVISION 31: EARTHWORK

|               |                             |
|---------------|-----------------------------|
| <b>311000</b> | <b><i>Site Clearing</i></b> |
| 312000        | Earth Moving                |

## SECTION 311000

## SITE CLEARING

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for removal of vegetation at the site, including stripping of sod and soil for site clearing.

## 1.2 SITE CLEARING

- A. Clearing and grubbing obstructions, trees, shrubs, and other vegetation, including removal of stumps, roofs, and debris.
- B. Provide temporary erosion- and sedimentation-control measures.

LEED SUGGESTIONS

- 2.1 As a prerequisite for LEED certification, an erosion- and sedimentation-control plan is required for the project. This plan must comply with the more stringent of either the “2003 EPA Construction General Permit” or local erosion- and sedimentation-control standards and codes. According to the EPA, the permit applies to construction sites greater than 1 acre except for smaller sites that are part of a larger common plan of development or sale. However, for LEED certification, the requirements are applied to all projects for this prerequisite.

END OF SECTION

## SECTION 312000

## EARTH MOVING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for grading, excavation, embankments, and sedimentation and erosion control. Earth moving for foundations, structures, pavement, ditches, culverts, drains, and utilities.

**1.2 MATERIALS**

- A. Satisfactory Soils: ASTM D 2487 soil classification groups **and Geotechnical Engineer.**
- B. **Engineered Fill: Graded mixture of gravel, crushed stone, and sand with 90% passing a 1-1/2-inch sieve and not more than 12% passing a No. 200 sieve.**
- C. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- D. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
  - 1. Aggregates used for subsurface storage of storm water or for use with underdrains shall be washed limestone, washed gravel, or river rock. In all cases the aggregates shall be 100 percent crushed.
- E. Topsoil: Shall be fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds, and other litter or stones larger than 1/2 inch.
  - 1. Provide 6 inches minimum topsoil.
- F. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- G. Sand: ASTM C33; Clean, general purpose sand, free of organic and deleterious materials.
- H. **Geotextiles: Subsurface drainage geotextile and separation geotextile.**
- I. Geogrid.
- J. **Controlled Low-Strength Material.**

**1.3 EXCAVATION**

- A. **Explosives: Not allowed.**

**1.4 FIELD QUALITY CONTROL**

- A. Special Inspector and Testing Agency: Owner engaged.**

**LESSONS LEARNED**

- 2.1 During the design process, several professionals on the Design Team might need to revise this section to coordinate Specification Sections within the project manual. Besides input from the Architect and the Geotechnical Engineer, the Civil, Structural, Mechanical, Plumbing, and Electrical Engineers might share editing and review obligations. Each Design Professional's responsibilities and scope of service depends on the agreement with the Prime Consultant or the Owner.**
- A. Assigning specification-review responsibility can be overlooked during the design process. Review may be inferred or expected without expressly stating this in the various agreements, particularly where the agreement is directly with the Owner. Clearly delineate the responsibilities for editing and reviewing this Section in consultants' agreements.**
- 2.2 A dewatering system should be designed to keep the excavation continuously stable and dry. For deep excavations, ground-water extraction must be carefully controlled. For this purpose, piezometers measuring hydrostatic pressure are installed at various depths in sufficient number to detect the important piezometric water level changes resulting from removing the ground water.**
- 2.3 Adjacent Structures: Occasionally, settlement of adjacent structures might be attributed to dewatering. Existing structures founded on weak, compressible soils or on saturated, loose sand could settle. The condition of structures, type of foundation, and water table elevations immediately adjacent to the project should be determined before dewatering. If dewatering and excavation will lower the water table significantly at such structures, underpinning precautions may be necessary.**
- 2.4 Typically, the type of damage produced by dewatering is caused by settlement, particularly differential settlement. Settlement under walls, foundations, and stone and concrete masonry can cause cracking in these structures and in finishes. Buildings with deep foundations will usually be less affected by dewatering than those with shallow foundations; older buildings are usually more affected than newer ones.**

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**32**

**DIVISION**

**EXTERIOR IMPROVEMENTS**

## TABLE OF CONTENTS

DIVISION 32: EXTERIOR IMPROVEMENTS

|               |                            |
|---------------|----------------------------|
| 321216        | Asphalt Paving             |
| <b>321313</b> | <b>Concrete Paving</b>     |
| 321314        | Pervious Concrete Pavement |
| 321443        | Porous Unit Paving         |
| 321816        | Playground Surfacing       |
| 323113        | Fences and Gates           |
| <b>329200</b> | <b>Turf and Grasses</b>    |

## SECTION 321216

## ASPHALT PAVING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for base course and pavements above base course including conventional pavements for walks, roads, parking lots, and recreation areas. Also includes bituminous base courses, bituminous binder courses, and bituminous surface courses; tack coats.

**1.2 QUALITY ASSURANCE**

- A. Road and paving materials and methods shall be in accordance with the State of Ohio Department of Transportation (ODOT), "Construction and Material Specifications", latest edition.
- B. Pavement markings within public right-of-ways shall be in accordance with US Manual on Uniform Traffic Control Devices.

**1.3 COMPACTED AGGREGATE**

- A. Aggregate base shall consist of stone, gravel, or slags with composition and gradation described as "Item 304," and conforming to requirements of 703.04 of the State of Ohio Department of Transportation (ODOT), "Construction and Material Specifications."

**1.4 PAVING MATERIALS**

- A. Bituminous Base Course: ODOT "Item 301".
- B. Binder Course Asphalt Concrete: ODOT "Item 448".
- C. Surface Course Asphalt Concrete: ODOT "Item 448".
- D. Tack Coat: Emulsified asphalt.

**1.5 AUXILIARY MATERIALS**

- A. ***Paving Geotextile: Non-woven polypropylene.***
- B. ***Pavement-Marking Paint.***
- C. ***Wheel Stops: Precast concrete or solid, recycled plastic with galvanized-steel dowels.***

**1.6 FIELD QUALITY CONTROL**

- A. ***Testing: By Owner-engaged agency.***

END OF SECTION

## SECTION 321313

## CONCRETE PAVING

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for rigid cement concrete pavements above base course including conventional and modified pavements for walks, roads, parking lots, and service areas.

## 1.2 QUALITY ASSURANCE

- A. Quality Standard: ACI 301.

## 1.3 MATERIALS

- A. Concrete: ASTM C 150.
  - 1. Normal-weight aggregate.
  - 2. Air-entraining admixture.
  - 3. Color pigment (optional).
  - 4. Finish: Broom finish.
- B. Wire Mesh: Welded plain steel wire fabric.
- C. Reinforcing Bars: Deformed steel bars.
- D. Fabricated Bar Mats: Steel bar or rod mats.
- E. Joint Dowel Bars: Plain steel bars.
- F. Detectable Warnings.
- G. *Fiber Reinforcement: Synthetic fiber.***

## 1.4 FIELD QUALITY CONTROL

- A. Testing: By Owner-engaged agency.

END OF SECTION

## SECTION 321314

## PERVIOUS CONCRETE PAVEMENT

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for pervious concrete paving.

## 1.2 QUALITY ASSURANCE

- A. State of Ohio Department of Transportation (ODOT), "Construction and Material Specifications".

## 1.3 PRODUCTS

- A. Stormwater Detention Layer or Groundwater Recharge Bed
  - 1. Test Subgrade
    - a. Field Method: ASTM D 3385.
  - 2. Coarse Aggregate for Stormwater Detention Layer: ODOT Item 703.1, AASHTO size No. 2.
  - 3. Choker Base Coarse Aggregate for Stormwater Detention Layer: ODOT Item 703.1, AASHTO size No. 57.
  - 4. Impervious Liner.
  - 5. Filter Fabric.
  - 6. Isolation Joint Material.
  - 7. Curing Materials.
- B. Pervious Concrete Pavement
  - 1. Cement: ASTM 150 or ASTM C 595.
  - 2. Supplementary Cementitious Materials
    - a. Fly Ash
    - b. Ground Granulated Blast-Furnish Slag.
  - 3. Admixtures
    - a. Air Entraining Admixture.
    - b. Chemical Admixtures
      - 1) Mid-range water reducing admixtures or high range water-reducing admixtures.
      - 2) Extended set control admixtures or water-reducing/retarding admixtures.
      - 3) Viscosity modifying admixtures.
  - 4. Aggregates for Pervious Concrete: ASTM C33 and ODOT Item 703.02, No. 67, 7, 8, and 89 or 9.
  - 5. Water.
  - 6. Mixture Proportions: Appendix 6 of ACI 211.3R.

## 1.4 FIELD QUALITY CONTROL

- A. Owner engaged.

**EXTERIOR IMPROVEMENTS****LEED SUGGESTIONS**

- 2.1 Pervious Paving: Credit for Sustainable Sites, SS 6.1 for stormwater design awards one point for stormwater management practices that reduce runoff to meet certain criteria. Pervious paving can be used as part of a stormwater management design to obtain this point.

**LESSONS LEARNED**

- 3.1 Pervious paving, also called porous paving, gap-graded paving, permeable paving, or enhanced porosity paving, can be used as part of a stormwater management design to reduce stormwater runoff and replenish aquifers.
- 3.2 Most concrete paving is produced from dense mixes of well-graded aggregate sizes that interlock with each other, making a stable low-porosity mass. This paving is designed to shed rather than absorb water. Pervious paving uses an open-graded aggregate mix with a large percentage of one-sized coarse aggregate, also called gap-graded or uniformly graded aggregate. Fine aggregates are typically not used in the mixes. The course of porous paving is placed over a reservoir of uniformly graded clean aggregate. Stormwater flows through the pervious paving into the reservoir, which has about 40% voids to store runoff and allow it time to infiltrate through subgrade soils.
- 3.3 Because paving structures that absorb or allow passage of water are fairly sophisticated systems, care must be taken in their design, detailing, and construction. If subgrades do not drain quickly enough under cold conditions, trapped water may freeze and damage paving. Passage of water may also allow more dissolved salts to reach embedded reinforcing, thereby increasing the opportunity for salt damage.

END OF SECTION

## SECTION 321443

## POROUS UNIT PAVING

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for porous paving consisting of concrete pavers set in aggregate setting beds.

## 1.2 MATERIALS

- A. Concrete Grid Pavers.
- B. Solid Interlocking Concrete Pavers of shapes that provide openings between units.
- C. Edge Restraints: Plastic or aluminum.
- D. Curbs: Precast concrete.
- E. Graded Aggregate for Subbase: Open graded for stormwater storage.
- F. Graded Aggregate for Base: Well graded.
- G. Leveling Course: Sand or crushed stone.
- H. Paver Fill: Crushed stone.

LEED SUGGESTIONS

- 2.1 Porous paving can reduced stormwater runoff, compared to nonporous paving, by increasing infiltration. The effectiveness of porous paving for providing stormwater infiltration can be further increased by providing a highly porous base course, and possibly subbase, to store stormwater until the underlying soil can absorb it. Stormwater runoff carries pollutants from paved surfaces directly into streams and scours exposed soil surfaces, causing silt buildup downstream and degrading water quality. Infiltrated stormwater is filtered by subsurface soil layers, removing pollutants. It also recharges aquifers, resulting in steadier stream flows; peak flows are absorbed and then released during times of low flow. Porous paving may also help reduce heat buildup resulting from the absorption of solar energy by pavement materials, thereby helping to reduce the urban heat island effect.
- 2.2 LEED Credit SS 6.1 provides one point for stormwater management practices that reduce runoff to meet certain criteria, and LEED Credit SS 6.2 provides one point for removing suspended solids and phosphorous from stormwater runoff. Porous paving can be used as part of a stormwater management design that can obtain both of these points. LEED Credit SS 7.1 also provides a point for using an open-grid paving system that is less than 50% impervious for at least 50% of the parking lot area. Although porous pavers are more than 50% impervious, using them for more than 50% of the parking lot area can provide an equivalent pervious area, which complies with the intent of the credit.

**EXTERIOR IMPROVEMENTS****LESSONS LEARNED**

- 3.1 Traffic loads are usually a primary design consideration. Where light loads are expected, such as in parking areas and possibly including access aisles, grid-type pavers that will allow maximum water infiltration may prove suitable. Where heavy vehicular loads are expected such as in drive aisles, especially those that will carry frequent truck traffic, solid paving or porous paving with minimal open area may be required.
- 3.2 Consider snow removal needs; critical areas that must be kept clear of snow at all times might better be paved with a smooth material such as concrete or asphalt.
- 3.3 Subgrade preparation is also important for a successful installation. Remove vegetation and organic materials from the area to be paved. Remove soft spots containing poor subgrade material, and refill them with suitable material properly compacted. Refer to the project's geotechnical report for specific compaction requirements.
- 3.4 Drainage: Surface and subsurface drainage is of major importance. Exterior paving is usually sloped at least 1/4 inch per foot (2%), but porous pavers may be sloped as little as 1/8 inch per foot (1%). Porous paving should typically have at least a minimal slope so that during heavy rains, when water cannot infiltrate the paving as fast as it falls, water will not build up on the surface. Paving should be sloped away from buildings, retaining walls, and other elements capable of collecting surface water. Localities with impervious soils may require subsurface drains to allow excess water to flow out of the subbase and base course.

END OF SECTION

## SECTION 321816

## PLAYGROUND SURFACING

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for surfaces for exterior recreational activities.

**1.2 QUALITY ASSURANCE**

- A. Impact Attenuation: According to ASTM F 1292.
- B. Accessibility of Surface Systems: According to ASTM F 1951.
- C. Minimum Characteristics for Organic Loose-Fill Surfaces: According to ASTM F 2075.

**1.3 PLAYGROUND SURFACE SYSTEMS**

- A. Engineered Wood Fibers: Random-sized wood fibers, in manufacturer's standard fiber size, approximately 10 times larger than wide; containing no bar, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.

**B. Accessories**

1. **Edgings.**
2. **Stabilizing Mats.**
3. **Drainage / Separation Geotextile.**
4. **Weed-Control Barrier.**

**LESSONS LEARNED**

**2.1 *Organic loose-fill systems include wood chips, wood mulch, and engineered wood fibers and should be installed over graded soil or compacted drainage fill with an interlayer of geotextile fabric that may also include premolded drainage matrix. The perimeter curb of the playground surface usually contains the loose material within the equipment area. Engineered wood fibers should be tested according to ASTM F 2075, Specification for Engineered Wood Fiber for Use as a Playground Safety Surface under and around Playground Equipment, for the presence of contaminants such as toxic substances and for consistently sized wood particles. Wood-based, loose-fill materials are flammable and subject to compaction, decomposition, and pulverization. This surface is less abrasive than sand and not as likely to be fouled by animals.***

**2.2 *Manufacturers test the resilience of their products according to ASTM F 1292. Loose-fill sand, gravel, wood chips, and wood mulch are not furnished by playground surface system manufacturers, so product testing is not done for specific CH design depths. Field testing according to ASTM F 1292 can also be done at the completion of installation or periodically during the service life of the installation to verify performance.***

**EXTERIOR IMPROVEMENTS**

- A. *The International Play Equipment Manufacturers Association provides a third-party product certification service to validate a member manufacturer's certification of compliance with ASTM F 1292.*
- 2.3 *Testing for accessibility is done according to ASTM F 1951, Specification for Determination of Accessibility of Surface Systems under and around Playground Equipment. This standard is designed to measure the amount of effort required to propel a wheelchair across the surface for straight and turning movement. The test is primarily directed at loose-fill surfaces to show comparison with the same movements over a smooth, hard surface. Some loose-fill systems will require additional surface mats over the accessible route to play equipment required by the Americans with Disabilities Act (ADA) to meet this standard. Accessible routes are also discussed in 36 CFR 1191, Americans with Disabilities Act (ADA) Accessibility Guidelines; Play Areas. Sloping surfaces should be limited to 2%.*
- 2.4 *Testing loose-fill wood systems for the presence of toxic substances such as heavy metals, metal scraps such as nails, and correct particle size is done according to ASTM F 2075. This test is done by engineered wood fiber manufacturers but is not generally conducted for wood chips or wood mulch.*

END OF SECTION

## SECTION 323113

## FENCES AND GATES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for fences for protective, security, and right-of-way purposes; also pipe gates.

**1.2 QUALITY ASSURANCE**

- A. Comply with Chain Link Fence Manufacturers Institute "Product Manual".

**1.3 MATERIALS**

- A. Fabric: ASTM A 392, CLFM 1 CLF 2445
  - 1. Aluminum-coated steel, ASTM A 491, Type I, 0.40 ounce per square foot.
  - 2. Size: 2 inch mesh, 9 gauge steel.
- C. Framework: ASTM F 1043.
- D. Gates: Swinging type.
  - 1. Chain link pedestrian (single gate leaf) and vehicular (double gate leaf with gate keepers).
  - 2. Pipe gate.
  - 3. Mechanical yard gate.
- E. Framing and Fittings: ASTM F 626.

END OF SECTION

**EXTERIOR IMPROVEMENTS**

## CHAPTER 9: SPECIFICATIONS

## SECTION 329200

## TURF AND GRASSES

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for application of seed, sod, or plants; fertilizer; lime and mulch; and maintenance until acceptance.

## 1.2 QUALITY ASSURANCE

- A. Topsoil Analysis: Furnish a soil analysis made by a qualified independent soil testing agency stating percentages or organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant nutrient content of topsoil.

## 1.3 MAINTENANCE

- A. Begin maintenance of lawns immediately after each area is planted and continue until acceptable lawn is established, but not for less than the following periods:
  1. Seeded Lawns: 60 days after date of Contract Completion.
    - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during next planting season.
  2. Sodded Lawns: 30 days after date of Contract Completion.

1.4 **MATERIALS**

- A. **Seed or Turfgrass Sod**
- B. **Planting Soils**
- C. **Mulch**
- D. **Erosion-Control Materials**
- E. **Grass-Paving Materials**

LEED SUGGESTIONS

- 2.1 **Grass paving is cellular, three-dimensional “eggcrate” matting specifically designed for locations load-bearing strength for occasional vehicular or heavy pedestrian traffic on turfgrass is anticipated. It will protect vegetation root systems from soil compaction that can restrict growth or kill plants. To obtain higher load-bearing capability, these units are often installed over a specially prepared base course as determined by the manufacturer. Load-bearing capacity can exceed 5000 psi (34.5 MPa).**
- 2.2 **Seldom-used “green-space” areas for overflow parking or fire lines are good use for grass paving. Where anticipated loads are significant or greater traction is needed, the use of concrete grid-type pavers should be considered.**

END OF SECTION

**33**

**DIVISION**

**UTILITIES**

## TABLE OF CONTENTS

DIVISION 33: UTILITIES

|               |                                        |
|---------------|----------------------------------------|
| 330513        | Manholes and Structures                |
| 331000        | Water Utilities                        |
| 333000        | Sanitary Sewerage Utilities            |
| <b>334000</b> | <b><i>Storm Drainage Utilities</i></b> |
| <b>334600</b> | <b><i>Subdrainage</i></b>              |

## SECTION 330513

## MANHOLES AND STRUCTURES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for manufactured units and components for utility services including hydrants, manholes, meters, utility boxes, and valves.

**1.2 HYDRANTS**

- A. Yard Hydrants: As approved by Local Fire Department.
  - 1. Hydrants within 20 feet of playgrounds shall be protected.

**1.3 MANHOLES**

- A. Precast Concrete Manholes: ASTM C 478.
- B. Manhole Steps: Ductile iron, cast aluminum, or steel reinforced plastic.
- C. Drainage castings: Gray iron, ASTM A 48, Class 35 B to meet or exceed AASHTO axle loading specifications for specific site location, with lettering. Lettering shall be "STORM" or "SANITARY" as applicable.

**1.4 METERS**

- A. Water Meter: AWWA C700 or utility company water meter.
- B. Meter Box: Cast iron body and cover with lettering.

**1.5 UTILITY BOXES**

- A. Valve Pits and Meter Pits: Reinforced concrete with ladder and cast iron manhole frame and cover.

**1.6 VALVES**

- A. Nonrising stem gate valves 3 inches and larger, AWWA C500.
- B. Rising stem gate valves 3 inches and larger, AWWA C500 or AWWA C509.
- C. Nonrising stem gate valves 2 inches and smaller, MSS SP-80.
- D. Valve Accessories: Cast iron valve boxes, curb stops, and service boxes for curb stops.
- E. Tapping sleeve and tapping valve for new connections larger than 2 inches.
- F. Service clamps and corporation stops for new connections 2 inches and smaller.

END OF SECTION

## SECTION 331000

## WATER UTILITIES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for site water distribution systems for domestic consumption, fire fighting, and irrigation.

**1.2 SYSTEM PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressures: The following are minimum pressure requirements for piping and specialties, unless otherwise indicated:
  1. Potable Water Service: 160 psig (1100 kPa).
  2. Fire Protection Water Service: 150 psig (1035 kPa).
  3. Fire Protection Water Service, Downstream from Fire Department Connections: 250 psig (1725 kPa).

**1.3 QUALITY CONTROL**

- A. Comply with NSF 61, "Drinking Water System Components - Health Effects," for materials for potable water.
- B. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," for materials, installation, tests, flushing, and valve and hydrant supervision.
- C. Water main testing shall be performed in accordance with local agency jurisdiction. Pressure testing – comply with AWWA (American Water Works Association) guidelines.
- D. Utility Compliance: Comply with regulations pertaining to water distribution systems.

**1.4 MATERIALS**

- A. Ductile Iron Pipe 4 to 12 Inches: AWWA C151, Class 52 minimum.
  1. Lining: AWWA C104, cement mortar, seal coated.
  2. Gaskets: AWWA C111.
  3. Ductile iron and cast iron fittings, AWWA C110 or AWWA C153, 250 psi minimum pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.
- B. Ductile Iron Pipe Greater Than 12 Inches: AWWA C151, Class 51 minimum.
  1. Lining: AWWA C104, cement mortar, seal coated.
  2. Gaskets: AWWA C111.
  3. Ductile iron and cast iron fittings, AWWA C110 or AWWA C153, 250 psi minimum pressure rating; AWWA C104 cement mortar lining; AWWA C111 rubber gaskets.
- C. Couplings: ASTM A 126, gray iron sleeve assembly with followers, rubber gaskets, bolts, nuts, and enamel paint finish.

- D. Valves
1. Nonrising stem gate valves 3 inches and larger, AWWA C500.
  2. Rising stem gate valves 3 inches and larger, AWWA C500 or AWWA C509.
  3. Nonrising stem gate valves 2 inches and smaller, MSS SP-80.
  4. Valve Accessories: Cast iron valve boxes, curb stops, and service boxes for curb stops.
  5. Tapping sleeve and tapping valve for new connections larger than 2 inches.
  6. Service clamps and corporation stops for new connections 2 inches and smaller.
- E. Anchorages
1. Clamps, Straps, and Washers: ASTM A 506, steel.
  2. Rods: ASTM A 575, steel.
  3. Rod Couplings: ASTM A 197, malleable iron.
  4. Bolts: ASTM A 307, steel.
  5. Cast Iron Washers: ASTM A 126, gray iron.
  6. Concrete Reaction Backing: ASTM C 150, Type I Portland cement for 3000 psi, 28-day minimum compressive strength.
- F. Fire Service Main Accessories
1. Hose House: 16 gauge steel with red baked enamel finish, hoses, and nozzles.
  2. Alarm Devices: UL 753 and FM approved including water flow indicators, supervisory switches, and pressure switches.

END OF SECTION

## SECTION 333000

## SANITARY SEWERAGE UTILITIES

**GENERAL GUIDELINES****1.1 SECTION INCLUDES**

- A. Qualitative requirements for site sanitary sewerage construction to buildings and municipal sanitary mains.

**1.2 PERFORMANCE REQUIREMENTS**

- A. Gravity Flow, Nonpressure Piping Pressure Ratings: At least equal to system test pressure.
- B. Force Main Pressure Ratings: At least equal to system operating pressure, but not less than 150 psig (1035 kPa).

**1.3 PIPE AND FITTINGS**

- A. Provide one of the following for Gravity Systems:
  - 1. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35 for solvent cement or elastomeric gasket joints.
  - 2. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for rubber gasket joints.
  - 3. ABS Sewer Pipe and Fittings: ASTM D 2751, for solvent cement or elastomeric gasket joints (4 and 6 inch only).
  - 4. Gaskets: Compatible with pipe materials joined.
- B. Provide the following for Forced Main Systems:
  - 1. Piping shall be PVC D18, Class 150, C-900 AWWA piping with push-on joints. Piping and fittings shall meet ASTM D 1784 and ASTM 3139.

**1.4 MANHOLES**

- A. Precast Concrete Manholes: ASTM C 478.
- B. Manhole Steps: Ductile iron, cast aluminum, or steel reinforced plastic.
- C. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, heavy duty-ductile iron with lettering.

**1.5 CLEANOUTS**

- A. PVC with cast iron adapter.

END OF SECTION

## SECTION 334000

## STORM DRAINAGE UTILITIES

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative Requirements for:
1. Site storm drain construction to buildings and municipal storm drainage.
  2. Storm drainage piping for surface, or a combination of surface and subsurface water.
  3. Structures for access to underground pipe.
  4. Conduit, chambers, and units for drain pipe, catch basins, inlets, and underground water detention chambers.

## 1.2 PIPE AND FITTINGS

- A. Provide one of the following:
1. Ductile Iron Pressure Pipe: AWWA C151, Class 52 for push-on joints.
  2. Reinforced Concrete Sewer Pipe and Fittings: ASTM C 76, Class III, Wall B, for rubber gasket joints.
  3. Polyvinyl Chloride (PVC): ASTM D 3034, SDR 35, or ASTM F 949 for solvent cemented or gasketed joints.
  4. Aluminized Steel: Type 2 per AASHTO M36 or ASTM A 760 with gasketed joints or bell and spigot joints.
  5. Polyethylene Pipe: AASHTO M252 or M294; Type S or Type SP **or** **ASTM F 2648; solid or perforated.**
  6. **Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers: ASTM F 2418.**
- B. For diameter greater than 24 inches, pipe shall be concrete, aluminized steel, or HDPE.

## 1.3 CLEANOUTS

- A. Cast iron.

## 1.4 CATCH BASINS FOR STORM SEWERAGE SYSTEM

- A. Precast Concrete Catch Basins: ASTM C 478 or ASTM C 858.
- B. Catch Basin Steps: Ductile iron, cast aluminum, or steel reinforced plastic.
- C. Catch Basin Frames and Grates: ASTM A 536, Grade 60-40-18, heavy-duty ductile iron.
- D. PVC plastic body catch basins: H-20 DOT rated for roadway applications with a minimum 6" concrete collar and ductile iron frame and grate and meet all applicable ASTM standards and environmental regulations.**

## 1.5 DRAINAGE STRUCTURES

- A. Curb Inlets: Precast concrete, stone, or brick conforming to utility standards.

- B. Outfalls for Storm Sewerage System: Cast-in-place reinforced concrete pipe, head wall apron, tapered sides, and rip rap.
- C. Dry Wells for Storm Sewerage System: ASTM C 858, precast reinforced perforated concrete rings with cast-in-place concrete floor and lift-off concrete cover.
- D. Slot Drain: Interlocking precast polymer concrete modular units with grates, channel caps, and related accessories.
- E. Stormwater Collection Chambers: Polypropylene (PP) chambers with open bottom, buried chambers of corrugated wall construction used for collection, detention, and retention of stormwater runoff per ASTM F2418.**
- F. Curb inlets: PVC plastic body catch basins: H-20 DOT rated for roadway applications with a minimum 6" concrete collar and ductile iron frame and grate and meet all applicable ASTM standards and environmental regulations.**

END OF SECTION

## SECTION 334600

## SUBDRAINAGE

GENERAL GUIDELINES

## 1.1 SECTION INCLUDES

- A. Qualitative requirements for subdrains for interception and removal of water from pavements and structures.

## 1.2 SUBDRAINAGE

- A. Drainage Pipe - ***Provide one of the following:***
  - 1. Perforated PVC pipe, ASTM D 2729.
  - 2. ***Perforated PE pipe, AASHTO M 252, Type SP or AASHTO M 294, Type CP.***
  - 3. ***Solid Wall PVC pipe, ASTM D 3034.***
  - 4. ***Solid Wall PE pipe, AAHSHTO M 252 or AASHTO M 294, Type S.***
- B. ***Drainage Panels: Molded-sheet, mesh fabric or net fabric drainage panels.***
- C. ***Geotextile filter fabrics.***

END OF SECTION

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