1. **PART 1 - GENERAL**

1.1. The following revisions and/or clarifications shall be made to the Bidding Requirements and Contract Documents. Revise and amend the Documents for the above named project in accordance with this Addendum. The bid shall reflect these addendum changes and each bidder shall make reference in their bid to this addendum.

1.2. All Bidding Requirements and Contract Documents shall apply to this addendum as originally indicated in the applicable portions of the contract documents, unless otherwise modified by this addendum.

2. **PART 2 - PROJECT MANUALS**

2.1. **REVISIONS TO BIDDING/CONTRACT REQUIREMENTS**

2.1.1. Information For Bidders, page 4, Paragraph #20: Clarification that the required California Contractor’s License Classification for this work is “B”, General Contractor.

2.1.2. Information For Bidders, pages 7 – 9, “Bid Form”: Clarification that since there is a duplicate Bid Form in Section V, the preference will be for Bidders to use the forms in this section, however use of the other form will not be cause for rejection of bids. Bidder shall acknowledge receipt of all addenda in either form.

2.1.3. Section II, General Conditions, page 3, “Time for Completion and Liquidated Damages”: Clarification that the Work shall be completed by the Contractor no later than “12-months after Notice to Proceed”.

2.2. **REVISIONS TO SPECIFICATIONS**

2.2.1. Specification Section 09 30 13, Ceramic Tile:

2.2.1.1. Paragraph 2.1.4 and Addendum #1, Section 2.2.3.1.1.2, Clarification: Provide an allowance to install all perimeter fascia tile on the new addition with Dal-Tile series “Veranda Solids” or equal, 13” x 13", solid colorbody porcelain, color to be selected by Architect.
2.2.2. Specification Section 09 60 10, Concrete Slab Moisture Control Coating:

2.2.2.1. Paragraphs 3.3 & 3.4, Clarification: Provide slab preparation, including shot blasting existing and new concrete slabs and steps, and install new Koester floor sealer system to all slabs and steps to receive finish flooring.

2.2.3. Specification Section 09 84 33, Surface-Mounted Acoustical Treatments:

2.2.3.1. Paragraph 2.2.1, Clarification: AVL Systems (800) 228-7842, Prime 7-2D diffuser is approved as an alternate to specified product, comply with specified requirements.

2.2.3.2. Paragraph 2.3.1, Clarification: AVL Systems (800) 228-7842, Pyramid diffuser with 12” depth is approved as an alternate to specified product.

2.2.3.3. Paragraph 2.4.1, Clarification: AVL Systems (800) 228-7842, AcousTech sound absorptive panels is approved as an alternate to specified product.

2.2.3.4. Paragraph 2.6.1, Clarification: AVL Systems (800) 228-7842, DiSorb diffuser modules is approved as an alternate to specified product.

2.2.3.5. Paragraph 2.8.1, Clarification: AVL Systems (800) 228-7842, Prime 7-2D diffuser is approved as an alternate to specified product, comply with specified requirements.

2.2.4. Specification Section 23 09 00, Instrumentation and Control for HVAC:

2.2.4.1. Replace this section with attached revised spec with changes indicated.

2.2.5. Specification Section 23 09 93, Sequence of Operations for HVAC Controls:

2.2.5.1. Replace this section with attached revised spec with changes indicated.

2.2.6. Specification Section 23 34 16, Centrifugal HVAC Fans:

2.2.6.1. Replace this section with attached revised spec with changes indicated.

2.2.7. Specification Section 23 52 16, Condensing Boilers:

2.2.7.1. Replace this section with attached revised spec with changes indicated.

2.2.8. Specification Section 27 05 00, Structure Cabling Infrastructure:

2.2.8.1. Paragraph 2.2, A, 2: Provide rack mounted fiber termination equipment per VVC Cabling Infrastructure Standards, page 54 and as attached in this addendum.

2.2.8.2. Paragraph 2.2, A, 4: Provide rack mounted rack or enclosure per VVC Cabling Infrastructure Standards.

2.2.8.3. Paragraph 2.2, A, 4, g: Provide power strips per VVC Cabling Infrastructure Standards, page 62.

2.2.8.4. Paragraph 2.2, A, 4, h: Provide surge protection for all racks per VVC Cabling Infrastructure Standards, page 62.
2.2.8.5. Paragraph 2.3, A: Revise to run fiber cable to the existing Technology building #21 via existing pullbox #9 and existing conduit pathway to the data center. The conduit route within the Technology building exists via conduit risers from the raised floor down to the IDF in basement.

2.2.8.6. Paragraph 2.3, C: Provide 12 strand – 6 single and 6 multimode fiber feed.

2.2.8.7. Paragraph 2.3, Clarification: Provide plenum rated cable under the raised floor.

2.2.8.8. Add “VVC Cabling Infrastructure Standards” attached as supplemental specs to this section.

3. PART 3 - DRAWINGS

3.1. GENERAL INFORMATION DRAWINGS
3.1.1. No further clarifications at this time.

3.2. CIVIL DRAWINGS
3.2.1. No further clarifications at this time.

3.3. ARCHITECTURAL DRAWINGS
3.3.1. D2.1.1, Demolition Plan:
3.3.1.1. Demo existing interior partition walls around existing practice rooms 10, 11, 12 & 13 for installation of new partition walls per A2.1.1 and wall type A1/A9.1.1 for new practice rooms 3A, 3B, 4 & 5. Existing studs were cut for abatement and new full-height walls are required in new remodel. Provide framing for new doors 3A and 5.

3.3.1.2. Demo work of existing exterior doors with transom above per keynote F.03, the intent is to cut and protect existing transom windows above, and weld new frames to existing frames, however if the contractor prefers to demo transom window and replace with new, this option is also acceptable.

3.3.2. A1.2.1, Site Plan:
3.3.2.1. Contractor shall carefully move and protect any existing large rock boulders around the project site that interfere with construction activities, and replace to existing locations before project completion. Move boulders as required for new passenger loading area to location determined by the college. Provide new boulders if any are damaged with like kind.

3.3.2.2. Contractor shall carefully uproot, box and store two (2) existing Ocotillo trees around existing accessory building prior to demolition, and move to maintenance yard at lower campus. Replace with like kind if damaged.

3.3.3. A4.1.1, Reflected Ceiling Plan:
3.3.3.1. Clarification to existing and new ceiling soffits in music labs 1 & 6: Provide new soffit per detail 6/A9.5.2 above door 6C. Patch and repair any holes or damage to remainder of existing exposed soffit finishes and paint typical. Fill all existing soffits in Lab 6 with insulation per sheet F4.1.2.

3.4. STRUCTURAL DRAWINGS
3.4.1. No further clarifications at this time.
3.5. MECHANICAL DRAWINGS
3.5.1. No further clarifications at this time.

3.6. PLUMBING DRAWINGS
3.6.1. No further clarifications at this time.

3.7. ELECTRICAL DRAWINGS
3.7.1. Sheet E3.1, Electrical Power Plan:
   3.7.1.1. Add exterior power outlets per attached sketches ESK-1 and ESK-2.

3.7.2. Sheet E4.1, Electrical Lighting Plan:
   3.7.2.1. Add exterior lighting fixtures per attached sketch ESK-3.

3.7.3. Sheet E7.1, Electrical Details:
   3.7.3.1. Detail F, Clarification: The IDF riser shall be fiber as required to support the outlets within the existing Music Building and per VVC Cabling Infrastructure Standards (attached).

END OF ADDENDUM #2

Enclosures:
(Note that these are listed here for clarity only. Refer to narrative above for detailed descriptions of revisions related to these enclosures.)

I) New Project Manual Documents Issued:
   a) Revised Specification Section 23 09 00, Instrumentation and Control for HVAC
   b) Revised Specification Section 23 09 93, Sequence of Operations for HVAC Controls
   c) Revised Specification Section 23 34 16, Centrifugal HVAC Fans
   d) Revised Specification Section 23 52 16, Condensing Boilers
   e) Specification Section 27 05 00, Supplemental: VVC Cabling Infrastructure Standards, 83 pages.

II) New 8-1/2 x 11 Drawings Issued:
   a) ESK-1
   b) ESK-2
   c) ESK-3

End of Enclosures
SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
   A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
   B. Related Sections include the following:
      1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
      2. Division 23 Section "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.3 DEFINITIONS
   A. DDC: Direct digital control.
   B. I/O: Input/output.
   C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
   D. MS/TP: Master slave/token passing.
   E. PC: Personal computer.
   F. PID: Proportional plus integral plus derivative.
   G. RTD: Resistance temperature detector.

1.4 SYSTEM PERFORMANCE
   A. Comply with the following performance requirements:
      1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.

6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.

8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
   b. Water Flow: Plus or minus 5 percent of full scale.
   c. Water Pressure: Plus or minus 2 percent of full scale.
   d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
   e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
   f. Outside Air Temperature: Plus or minus 2 deg F (1.1 deg C).
   g. Dew Point Temperature: Plus or minus 3 deg F (1.6 deg C).
   h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
   i. Relative Humidity: Plus or minus 5 percent.
   j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
   k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
   l. Airflow (Terminal): Plus or minus 10 percent of full scale.
   m. Air Pressure (Space): Plus or minus 0.01 inch wg (2.5 Pa).
   n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
   o. Carbon Monoxide: Plus or minus 5 percent of reading.
   p. Carbon Dioxide: Plus or minus 50 ppm.
   q. Electrical: Plus or minus 5 percent of reading.
1.5 SEQUENCE OF OPERATION

1.6 SUBMITTALS

A. Product Data: Include manufacturer’s technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.


4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. DDC System Hardware:

   a. Wiring diagrams for control units with termination numbers.

   b. Schematic diagrams and floor plans for field sensors and control hardware.

   c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.

9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.

10. Controlled Systems:
a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.

b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.

c. Written description of sequence of operation including schematic diagram.

d. Points list.

C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.

E. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

F. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

G. Software and Firmware Operational Documentation: Include the following:

1. Software operating and upgrade manuals.

2. Program Software Backup: On a magnetic media or compact disc, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

5. Software license required by and installed for DDC workstations and control systems.

H. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

I. Qualification Data: For [Installer] [and] [manufacturer].

J. Field quality-control test reports.

K. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.

2. Interconnection wiring diagrams with identified and numbered system components and devices.


4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with ASHRAE 135 for DDC system components.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system and with building master clock.

C. Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.

E. Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.

F. Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.

G. Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.

H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

I. Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.

J. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
K. Coordinate equipment with Division 26 Section "Motor Control Centers" to achieve compatibility with motor starters and annunciation devices.

L.H. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique pneumatic damper motor, valve motor, controller, thermostat, positioning relay.

2. Maintenance Materials: One thermostat adjusting key(s).


PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

A. Manufacturers:

1. Alerton Inc.


3. Andover Controls Corporation.


5. Carel.

6. Delta Controls Inc.

7. EDA Controls Corp.
8. Electronic Systems USA, Inc.
12. Impact Energy Controls Corp.
15. KMC Controls/Kreuter Manufacturing Company.
16. Luwa USA, Inc.; Textile Air Engineering.
17. MAMAC Systems, Inc.
18. McQuay International.
19. Pneuline Controls.
20. Sauter Controls Corporation.
22. Solidyne Corp.
25. TAC Americas, INC.
26. TCS/Basys Controls.
27. tekmar Control Systems, Inc.
29. Temco Controls Ltd., USA.
30. Tour & Andersson Control, Inc.
31. Trane; Worldwide Applied Systems Group
32. Triangle MicroSystems, Inc.
33. Voltec, Inc.
34. <Insert manufacturer's name>
B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

D. Control system shall include the following:

1. Building intrusion detection system specified in Division 28 Section “Intrusion Detection.”

2. Building clock control system specified in Division 27 Section “Clock Systems.”

3. Building lighting control system specified in Division 26 Section “Network Lighting Controls.”

4. Fire alarm system specified in Division 28 Section “Fire Detection and Alarm.”

2.3 DDC EQUIPMENT

A. Network Control Engine

1. The Network Control Engine (NCE) shall be a fully user-programmable, supervisory controller. The NCE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

2. The Network Control Engine (NCE) shall be a fully user-programmable, digital controller that includes a minimum of 33 I/O points.

3. Automation Network – The NCE shall reside on the automation network and shall support a subnet of 32 Field controllers.

4. User Interface – Each NCE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

   a. The web based UI software shall be imbedded in the NCE. Systems that require a local copy of the system database on the user’s personal computer are not acceptable.

   b. The NCE shall support a minimum of two (2) concurrent users.

   c. The NCE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NCE.

   d. Systems that support UI Graphics from a central database or require the graphics to reside on the user’s personal computer are not acceptable.

   e. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
1) Configuration

2) Commissioning

3) Data Archiving

A. Monitoring

Operator Workstation: [One] [Two] <Insert number> PC-based microcomputer(s) with minimum configuration as follows:

1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

2. Processor: [Intel Pentium 4] <Insert name>, <Insert clock speed> MHz.

3. Random Access Memory: [512] <Insert number> MB.

4. Graphics: Video adapter, minimum [1280 x 1024] [1600 x 1200] <Insert value> pixels, [64] <Insert number> MB video memory, with TV out.

5. Monitor: [17 inches (430 mm)] [19 inches (480 mm)] <Insert size>, LCD color.


7. Floppy-Disk Drive: 1.44 MB.

8. Hard-Disk Drive: [80 GB] <Insert capacity>.

9. CD-ROM Read/Write Drive: [48x24x48] <Insert value>.

10. Mouse: Three button, optical.


12. Operating System: [Microsoft Windows XP Professional] <Insert system name> with high-speed Internet access.

   a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

   b. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

13. Printer: Black-and-white, laser-jet type as follows:

   a. Print Head: [1200 x 1200] <Insert value> dpi resolution.


   c. Print Speed: Minimum of [120] <Insert number> characters per second.

14. Printer: Color, ink-jet type as follows:

   a. Print Head: [4800 x 1200] <Insert value> dpi optimized color resolution.

   b. Paper Handling: Minimum of [100] <Insert number> sheets.
15. Application Software:
   a. I/O capability from operator station.
   b. System security for each operator via software password and access levels.
   c. Automatic system diagnostics; monitor system and report failures.
   d. Database creation and support.
   e. Automatic and manual database save and restore.
   f. Dynamic color graphic displays with up to [10] screen displays at once.
   g. Custom graphics generation and graphics library of HVAC equipment and symbols.
   h. Alarm processing, messages, and reactions.
   i. Trend logs retrievable in spreadsheets and database programs.
   j. Alarm and event processing.
   k. Object and property status and control.
   l. Automatic restart of field equipment on restoration of power.
   m. Data collection, reports, and logs. Include standard reports for the following:
      1) Current values of all objects.
      2) Current alarm summary.
      3) Disabled objects.
      4) Alarm lockout objects.
      5) Logs.
   n. Custom report development.
   o. Utility and weather reports.
   p. Workstation application editors for controllers and schedules.
   q. Maintenance management.
16. Custom Application Software:
   a. English language oriented.
b. Full-screen character editor/programming environment.

c. Allow development of independently executing program modules with debugging/simulation capability.

d. Support conditional statements.

e. Support floating-point arithmetic with mathematic functions.

f. Contains predefined time variables.

B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

2. Processor: [Intel Pentium 4] <Insert name>, <Insert clock speed> MHz.

3. Random Access Memory: [128] <Insert number> MB.

4. Graphics: Video adapter, minimum [800 x 600] [1024 x 768] <Insert value> pixels, [64] <Insert number> MB video memory.

5. Monitor: [17 inches (430 mm)] [19 inches (480 mm)] <Insert size>, LCD color.


7. Floppy-Disk Drive: 1.44 MB.


9. CD-ROM Read/Write Drive: [48x24x48] <Insert value>.

10. Pointing Device: Touch pad or other internal device.

C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

d. Software applications, scheduling, and alarm processing.
e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:
   a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
   b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
   c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
   d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
   e. Remote communications.
   f. Maintenance management.
   g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
   a. Global communications.
   b. Discrete/digital, analog, and pulse I/O.
   c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.

2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.


7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak-to-peak.

2. Combined 1 percent line and load regulation with 100-mic sec. response time for 50 percent load changes.

3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:

1. Minimum dielectric strength of 1000 V.


3. Minimum transverse-mode noise attenuation of 65 dB.

4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

4) Commanding

5) System Diagnostics
f. Systems that require workstation software or modified web browsers are not acceptable.

g. The NCE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

5. The NCE shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

6. The NCE shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only, shall not be acceptable.

7. The NCE shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.

8. The NCE shall support the following number and types of inputs and outputs:

a. Ten Universal Inputs - shall be configured to monitor any of the following:
   1) Analog Input, Voltage Mode
   2) Analog Input, Current Mode
   3) Analog Input, Resistive Mode
   4) Binary Input, Dry Contact Maintained Mode
   5) Binary Input, Pulse Counter Mode

b. Eight Binary Inputs - shall be configured to monitor either of the following:
   1) Dry Contact Maintained Mode
   2) Pulse Counter Mode

c. Four Analog Outputs - shall be configured to output either of the following
   1) Analog Output, Voltage Mode
   2) Analog Output, Current Mode

d. Seven Binary Outputs - shall output the following:
   1) 24 VAC Triac

e. Four Configurable Outputs - shall be configured to output either of the following:
   1) Analog Output, Voltage Mode
   2) Binary Output, 24 VAC Triac Mode
9. The NCE shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   b. The SA Bus shall support a minimum of 10 devices.
   c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the NCE and the furthest connected device.

10. The NCE shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the Field Trunk or the SA Bus.

11. The NCE shall support, but not be limited to, the following applications:
   a. Central Equipment including chillers and boilers
   b. Lighting and electrical distribution
   c. Built-up air handling units for special applications
   d. Power generation and energy monitoring equipment
   e. Interfaces to security and fire detection systems

12. The NCE shall support a Local Controller Display (DIS1710) either as an integral part of the NCE or as a remote device communicating over the SA Bus.
   a. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
   b. The Display shall allow the user to view monitored points without logging into the system.
   c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
   d. The Display shall provide password protection with user adjustable password timeout.
   e. The Display shall be menu driven with separate paths for:
      1) Input/Output
      2) Parameter/Setpoint
      3) Overrides
   f. The Display shall use easy-to-read English text messages.
   g. The Display shall allow the user to select the points to be shown and in what order.
h. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.

i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line

j. The Display shall have a keypad with no more than 6 keys.

k. The Display shall be panel mountable.

13. The NCE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NCE size and capability shall be sufficient to fully meet the requirements of this Specification.

14. The NCE shall employ an industrial single board computer.

15. Each NCE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

16. The NCE shall include an integrated, hardware-based, real-time clock.

17. The NCE shall employ nonvolatile Flash memory to store all programs and data. The NCE shall employ a data protection battery to save data and power the real time clock when primary power is interrupted.

18. The NCE shall provide removable, color coded, screw terminal blocks for 24 VAC power, communication bus and I/O point field wiring.

19. Communications Ports – The NCE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator’s terminals.
   a. USB port
   b. RS-232 serial data communication port
   c. RS-485 port
   d. RJ-45 Ethernet port
   e. RJ-12 jack

20. The NCE shall support an optional internal modem with RJ-12 6-pin telephone line connector.

21. Diagnostics – The NCE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Control Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

22. Power Failure – In the event of the loss of normal power, The NCE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.

b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.


24. Field Controller Bus – The NCE shall support the following communication protocols on the Field Controller Bus:

a. The NCE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

1) The NCE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

2) The NAE shall be tested and certified as a BACnet Building Controller (B-BC).

3) A BACnet Protocol Implementation Conformance Statement shall be provided for the NCE.

4) The Conformance Statements shall be submitted 10 days prior to bidding.

5) The NCE shall support a minimum of 32 control devices.

b. The NCE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10 on the Field Controller Bus (LonWorks Network).

1) All LonWorks controls devices shall be LonMark certified.

2) The NCE shall support a minimum of 32 LonWorks enabled control devices.

c. The NCE shall support the N2 devices on the Field Controller Bus (Johnson Controls N2 Bus).

1) The NCE shall support a minimum of 32 N2 control devices.

2) The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.

3) The Bus shall employ a master/slave protocol where the NCE is the master.

4) The Bus shall employ a four (4) level priority system for polling frequency.

5) The Bus shall be optically isolated from the NCE.

6) The Bus shall support the Metasys Integrator System.

B. Field Equipment Controller (FEC)
1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
   a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
      1) The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      2) The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
      3) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
      4) The Conformance Statement shall be submitted 10 days prior to bidding.

2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall only be considered acceptable by way of this controls subcontractor including in their bid the periodic tuning of all controllers and associated systems prior to each season (tuning shall occur minimum of 4 times throughout the year). This controls subcontractor shall document tuning results and provide report to the owner and engineer of record.

4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-V5B.

5. The FEC shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Field Controller Bus - Normal Data Transmission
   g. Field Controller Bus - No Data Transmission
   h. Field Controller Bus - No Communication
   i. Sensor-Actuator Bus - Normal Data Transmission
   j. Sensor-Actuator Bus - No Data Transmission
6. The FEC shall accommodate the direct wiring of analog and binary I/O field points.

7. The FEC shall support the following types of inputs and outputs:

   a. Universal Inputs - shall be configured to monitor any of the following:
      1) Analog Input, Voltage Mode
      2) Analog Input, Current Mode
      3) Analog Input, Resistive Mode
      4) Binary Input, Dry Contact Maintained Mode
      5) Binary Input, Pulse Counter Mode

   b. Binary Inputs - shall be configured to monitor either of the following:
      1) Dry Contact Maintained Mode
      2) Pulse Counter Mode

   c. Analog Outputs - shall be configured to output either of the following:
      1) Analog Output, Voltage Mode
      2) Analog Output, Current Mode

   d. Binary Outputs - shall output the following:
      1) 24 VAC Triac

   e. Configurable Outputs - shall be capable of the following:
      1) Analog Output, Voltage Mode
      2) Binary Output Mode

8. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).

   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.

   b. The FC Bus shall support communications between the FECs and the NAE.

   c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.

   d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.

   e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
2.4 Field Devices

A. Input/Output Module (IOM)

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.

2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.

   a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
   d. The Conformance Statement shall be submitted 10 days prior to bidding.

4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-V5B.

5. The IOM shall have a minimum of 4 points to a maximum of 17 points.

6. The IOM shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      1) Analog Input, Voltage Mode
      2) Analog Input, Current Mode
      3) Analog Input, Resistive Mode
      4) Binary Input, Dry Contact Maintained Mode
      5) Binary Input, Pulse Counter Mode
   b. Binary Inputs - shall be configured to monitor either of the following:
      1) Dry Contact Maintained Mode
      2) Pulse Counter Mode
   c. Analog Outputs - shall be configured to output either of the following
      1) Analog Output, Voltage Mode
      2) Analog Output, Current Mode
   d. Binary Outputs - shall output the following:
      1) 24 VAC Triac
2.42.5 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.

5. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).

6. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

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e. Configurable Outputs - shall be capable of the following:

1) Analog Output, Voltage Mode

2) Binary Output Mode

7. The IOM shall include troubleshooting LED indicators to identify the following conditions:

a. Power On

b. Power Off

c. Download or Startup in progress, not ready for normal operation

d. No Faults

e. Device Fault

f. Normal Data Transmission

g. No Data Transmission

h. No Communication
2.5 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch (1.5-mm) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. [Provide common keying for all panels.]

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   1. Alarm Condition: Indicating light flashes and horn sounds.
   2. Acknowledge Switch: Horn is silent and indicating light is steady.
   3. Second Alarm: Horn sounds and indicating light is steady.
   4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
   1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio-interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
   1. Remote control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
   2. Proportional band shall extend from 2 to 20 percent for 5 psig (35 kPa).
   3. Authority shall be 20 to 200 percent.
   4. Air supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
5. Gages: [1-1/2 inches (38 mm)] [2-1/2 inches (64 mm)] [3-1/2 inches (89 mm)] in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

2.7.2.6 TIME CLOCKS

A. [Available] Manufacturers:

1. ATC-Diversified Electronics.
2. Grasslin Controls Corporation.
3. Paragon Electric Co., Inc.
4. Precision Multiple Controls, Inc.
5. SSAC Inc.; ABB USA.
6. TCS/Basys Controls.
7. Theben AG - Lumilite Control Technology, Inc.
8. Time Mark Corporation.

9. <Insert manufacturer's name.>

B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

C. Solid-state, programmable time control with [4][8]<Insert number> separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.8.2.7 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. [Available] Manufacturers:

a. BEC Controls Corporation.

b. Ebtron, Inc.

c. Heat-Timer Corporation.

d. I.T.M. Instruments Inc.
e. MAMAC Systems, Inc.
f. RDF Corporation.
g. <Insert manufacturer’s name.>

2. Accuracy: Plus or minus [0.5 deg F (0.3 deg C)] [0.36 deg F (0.2 deg C)] at calibration point.


4. Insertion Elements in Ducts: Single point, [8 inches (200 mm)] [18 inches (460 mm)] long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).

5. Averaging Elements in Ducts: [36 inches (915 mm) long, flexible] [72 inches (1830 mm) long, flexible] [18 inches (460 mm) long, rigid]; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).

6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).

7. Room Sensor Cover Construction: Manufacturer’s standard locking covers.
   a. Set-Point Adjustment: [Concealed] [Exposed].
   b. Set-Point Indication: [Concealed] [Keyed] [Exposed].
   c. Thermometer: [Concealed] [Exposed] [Red-reading glass] [Spiral bimetal].
   d. Color: <Insert color from manufacturer’s full range.>
   e. Orientation: [Vertical] [Horizontal].

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.


C. RTDs and Transmitters:

1. [Available ]Manufacturers:
   a. BEC Controls Corporation.
   b. MAMAC Systems, Inc.
   c. RDF Corporation.
   d. <Insert manufacturer’s name.>

2. Accuracy: Plus or minus 0.2 percent at calibration point.

4. Insertion Elements in Ducts: Single point, [8 inches (200 mm)] [18 inches (460 mm)] long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).

5. Averaging Elements in Ducts: [18 inches (460 mm) long, rigid] [24 inches (610 mm) long, rigid] [48 inches (1200 mm) long, rigid] [24 feet (7.3 m) long, flexible]; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).

7. Room Sensor Cover Construction: Manufacturer’s standard locking covers.
   a. Set-Point Adjustment: [Concealed] [Exposed].
   b. Set-Point Indication: [Concealed] [Keyed] [Exposed].
   c. Thermometer: [Concealed] [Exposed] [Red-reading glass] [Spiral bimetal].
   d. Color: <Insert color from manufacturer’s full range.>
   e. Orientation: [Vertical] [Horizontal].

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.


D. Humidity Sensors: Bulk polymer sensor element.

1. [Available] Manufacturers:
   a. BEC Controls Corporation.
   b. General Eastern Instruments.
   c. MAMAC Systems, Inc.
   d. ROTRONIC Instrument Corp.
   e. TCS/Basys Controls.
   f. Vaisala.
   g. <Insert manufacturer’s name.>


3. Room Sensor Range: 20 to 80 percent relative humidity.

4. Room Sensor Cover Construction: Manufacturer’s standard locking covers.
   a. Set-Point Adjustment: [Concealed] [Exposed].
b. Set-Point Indication: [Concealed] [Keyed] [Exposed].

c. Thermometer: [Concealed] [Exposed] [Red-reading glass] [Spiral bimetal].

d. Color: <Insert color from manufacturer’s full range.>

e. Orientation: [Vertical] [Horizontal].

5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of [32 to 120 deg F (0 to 50 deg C)] [minus 22 to plus 185 deg F (minus 30 to plus 85 deg C)] [minus 40 to plus 170 deg F (minus 40 to plus 76 deg C)].

7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. [Available ]Manufacturers:
   a. BEC Controls Corporation.
   b. General Eastern Instruments.
   c. MAMAC Systems, Inc.
   d. ROTRONIC Instrument Corp.
   e. TCS/Basys Controls.
   f. Vaisala.
   g. <Insert manufacturer’s name.>

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
   a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
   b. Output: 4 to 20 mA.
   c. Building Static-Pressure Range: 0 to 0.25-inch wg (0 to 62 Pa).
   d. Duct Static-Pressure Range: 0 to 5-inch wg (0 to 1240 Pa).

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.

4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. **Differential-Pressure Switch (Air or Water):** Snap acting, with pilot-duty rating and with suitable scale range and differential.

6. **Pressure Transmitters:** Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

**F. Room Sensor Cover Construction:** Manufacturer's standard locking covers.

1. **Set-Point Adjustment:** [Concealed] [Exposed].

2. **Set-Point Indication:** [Concealed] [Keyed] [Exposed].

3. **Thermometer:** [Concealed] [Exposed] [Red-reading glass] [Spiral bimetal].

4. **Color:** <Insert color from manufacturer's full range.>

5. **Orientation:** [Vertical] [Horizontal].

**G. Room sensor accessories include the following:**

1. **Insulating Bases:** For sensors located on exterior walls.

2. **Guards:** [Locking; heavy-duty, transparent plastic; mounted on separate base] [Metal wire, tamperproof] [Locking, solid metal, ventilated].

3. **Adjusting Key:** As required for calibration and cover screws.

### 2.9 PNEUMATIC SENSORS

**A. Pneumatic Transmitters:** Vibration and corrosion resistant.

1. **Space-Temperature Sensors:** Linear-output type, 50 to 100 deg F (10 to 38 deg C) range, with blank locking covers matching room thermostats.

2. **Room Return-Air Temperature Sensors:** Linear-output type with bimetal sensing element and corrosion-proof construction, 50 to 100 deg F (10 to 38 deg C) range, designed to be mounted in light troffers.

3. **Duct-Mounted or Immersion-Type Temperature Sensors:** Range as required for 3- to 15-psig (21- to 103-kPa) output signal.

4. **Temperature Transmitters:** Rigid-stem type with bimetal sensing elements unless averaging is required, 3- to 15-psig (21- to 103-kPa) output signal.
   a. **Averaging-Element Sensors:** Single- or multiple-unit capillary elements.
   b. **Tamperproof Sensors:** Corrosion-resistant construction, suitable for mounting on vibrating surface with exposed capillary protected with temperature-compensated armor or protective tubing.
   c. **Pipe-Mounted Temperature-Sensing Elements:** Rod-and-tube type; with separable wells filled with heat-conductive compound.
   d. **Outdoors:** Provide bulb shield with mounting bracket.
5. **Space and Duct Humidity Transmitters:** One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3- to 15-psig (21- to 103-kPa) output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.

   a. **Space Mounting:** With covers to match thermostats.

6. **Differential-Pressure Transmitters:** One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type, with range of 0 to 50 psig (0 to 344 kPa), and 3- to 15-psig (21- to 103-kPa) output signal.

7. **Differential-Air-Pressure Transmitters:** One pipe, direct acting, double bell, unidirectional with suitable range for expected input, and temperature compensated.

   a. **Accuracy:** 5 percent of full range and 2 percent of full scale at midrange.

   b. **Output Signal:** 3 to 15 psig (21 to 103 kPa).

**B. Digital-to-Pneumatic Transducers:** Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional current or voltage to 0 to 20 psig (0 to 140 kPa).

1. **Available Manufacturers:**

   a. **BEC Controls Corporation.**

   b. **MAMAC Systems, Inc.**

   c. **Insert manufacturer’s name.**

C. **Pneumatic Valve/Damper Position Indicator:** Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.

**2.102.8 STATUS SENSORS**

A. **Status Inputs for Fans:** Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. **Status Inputs for Pumps:** Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.

C. **Status Inputs for Electric Motors:** Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. **Voltage Transmitter (100- to 600-V ac):** Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. **Power Monitor:** 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. **Current Switches:** Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. [Available] Manufacturers:
   a. BEC Controls Corporation.
   b. I.T.M. Instruments Inc.
   c. BEC Controls Corporation.
   d. I.T.M. Instruments Inc.
   e. [Insert manufacturer's name.]

2.112.9 GAS DETECTION EQUIPMENT

A. [Available] Manufacturers:
   1. B. W. Technologies.
   2. CEA Instruments, Inc.
   3. Ebtron, Inc.
   4. Gems Sensors Inc.
   5. Greystone Energy Systems Inc.
   7. INTEC Controls, Inc.
   8. I.T.M. Instruments Inc.
   9. MSA Canada Inc.
   10. QEL/Quatrosense Environmental Limited.
   11. Sauter Controls Corporation.
   12. Sensidyne, Inc.
   13. TSI Incorporated.
   15. Vulcain Inc.
   16. [Insert manufacturer's name.]
B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at [50 and 100] ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.12 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Available Manufacturers:
   a. Air Monitor Corporation.
   b. Wetmaster Co., Ltd.
   c. Insert manufacturer’s name.

2. Casing: Galvanized-steel frame.

3. Flow Straightener: Aluminum honeycomb, 3/4-inch (20-mm) parallel cell, 3 inches (75 mm) deep.

4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.13 THERMOSTATS

A. Available Manufacturers:

1. Erie Controls.


4. Sauter Controls Corporation.

5. tekmar Control Systems, Inc.

6. Theben AG – Lumilite Control Technology, Inc.

7. Insert manufacturer’s name.
B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches ["FAN ON-OFF"] ["FAN HIGH-LOW-OFF"] ["FAN HIGH-MED-LOW-OFF"].

2. Mount on single electric switch box.

C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.

2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.

4. Instant override of set point for continuous or timed period from 1 hour to 31 days.

5. Short-cycle protection.

6. Programming based on [weekday, Saturday, and Sunday] [every day of week].

7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.

8. Battery replacement without program loss.

9. Thermostat display features include the following:
   a. Time of day.
   b. Actual room temperature.
   c. Programmed temperature.
   d. Programmed time.
   e. Duration of timed override.
   f. Day of week.
   g. System mode indications include "heating," "off," "fan auto," and "fan on."

D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

F. Remote Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
   1. Bulbs in water lines with separate wells of same material as bulb.
   2. Bulbs in air ducts with flanges and shields.
   3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
   4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
   5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
   6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
   2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

H. Pneumatic Room Thermostats: [One] [Two] [Three] pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required. Factory calibrated at 2.5 psig/deg F (17.2 kPa/deg C).
   1. Factory Calibration: 2.5 psig/deg F (17.2 kPa/deg C).
   2. Range: 45 to 85 deg F (7 to 30 deg C).
   3. Sensitivity Adjustment Range: 1 to 4 psig/deg F (7 to 27.6 kPa/deg C).
   4. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
   5. Limits: Field adjustable, to limit setting cooling set point below 75 deg F (24 deg C), and heating set point above 75 deg F (24 deg C).
   6. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
      a. Set-Point Adjustment: [Concealed] [Exposed].
      b. Set-Point Indication: [Concealed] [Keyed] [Exposed].
      c. Thermometer: [Concealed] [Exposed] [Red-reading glass] [Spiral bimetal].
d. Color: [Insert color from manufacturer’s full range.]

e. Orientation: [Vertical] [Horizontal]

7. Room thermostat accessories include the following:

a. Insulating Bases: For thermostats located on exterior walls.

b. Thermostat Guards: [Locking; heavy-duty, transparent plastic; mounted on separate base] [Metal wire, tamperproof] [Locking, solid metal, ventilated].

c. Adjusting Key: As required for calibration and cover screws.

d. Aspirating Boxes: For flush-mounted aspirating thermostats.

e. Set-Point Adjustment: 1/2-inch (13-mm) diameter, adjustment knob.

I. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

J. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

K. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic - reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m).

2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

L. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic - reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet (6 m).

2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

M. Heating/Cooling Valve Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse-acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.14 HUMIDISTATS

A. [Available] Manufacturers:

1. MAMAC Systems, Inc.

2. ROTRONIC Instrument Corp.

3. [Insert manufacturer’s name.]
B. **Pneumatic Room Humidistats:** Wall-mounting, proportioning type with adjustable throttling range: $[20 \text{ to } 90 \%], [55 \text{ to } 95 \%], [25 \text{ to } 65 \%]$ percent operating range, and cover matching room thermostat cover.

C. **Duct-Mounting Humidistats:** Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

D. **Pneumatic Duct-Mounting Humidistats:** Proportioning type with adjustable throttling range: $[20 \text{ to } 90 \%], [55 \text{ to } 95 \%], [25 \text{ to } 65 \%]$ percent operating range, in galvanized-steel duct box.

### 2.15 Actuators

A. **Electric Motors:** Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2. **Permanent Split-Capacitor or Shaded-Pole Type:** Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

3. **Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65):** Size for running torque of 150 in. x lb (16.9 N x m) and breakaway torque of 300 in. x lb (33.9 N x m).

4. **Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65):** Size for running and breakaway torque of 150 in. x lb (16.9 N x m).

5. **Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m):** Size for running torque of 150 in. x lb (16.9 N x m) and breakaway torque of 300 in. x lb (33.9 N x m).

6. **Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m):** Size for running and breakaway torque of 150 in. x lb (16.9 N x m).

B. **Electronic Actuators:** Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. [Available] Manufacturers:
   a. Belimo Aircontrols (USA), Inc.
   b. [Insert manufacturer’s name.]

2. **Valves:** Size for torque required for valve close off at maximum pump differential pressure.

3. **Dampers:** Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.

c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.

d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.

e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.


5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.


8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.

9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

10. Temperature Rating: [Minus 22 to plus 122 deg F (Minus 30 to plus 50 deg C)] [40 to 104 deg F (5 to 40 deg C)] F.

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).

12. Run Time: [12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds].

C. Pneumatic Valve Operators: Rolling-diaphragm, spring-loaded, piston type with spring range as required and start-point adjustment and positioning relay. Operator shall maintain full shutoff at maximum pump differential pressure.

D. Pneumatic Damper Operators: Rolling-diaphragm, piston type with adjustable stops and spring return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Where actuators operate in sequence, provide pilot positioners.

1. Pilot Positioners: With the following characteristics:

   a. Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).

   b. Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).

   c. Linearity: Plus or minus 10 percent of output signal span.

   d. Hysteresis: 3 percent of span.
e. Response: 0.25-psig (1723-Pa) input change.


g. Maximum Control Air-Supply Pressure: 60 psig (410 kPa).

2. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 deg F (10 to 60 deg C) unless located in return-air plenums.

3. Inlet-Vane Operators: High pressure, with pilot positioners.

2.462.11 CONTROL VALVES

A. [Available] Manufacturers:


2. Erie Controls.

3. Hayward Industrial Products, Inc.


5. Neles-Jamesbury.

6. Parker Hannifin Corporation; Skinner Valve Division.

7. Pneuline Controls.

8. Sauter Controls Corporation.

9. <Insert manufacturer's name.>

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class [125] [250] bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.

a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.

b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
4. Sizing: \([3\text{-psig} \text{ (21-kPa)}][5\text{-psig} \text{ (35-kPa)}] < \text{insert value} > 3\text{-psig}\) maximum pressure drop at design flow rate or the following:
   b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
   c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Steam system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

   a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
   b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.

4. Sizing: For pressure drop based on the following services:
   a. Two Position: 20 percent of inlet pressure.
   b. Modulating \([15\text{-psig} \text{ (103-kPa)} \text{ Steam}]\): 80 percent of inlet steam pressure.
   c. Modulating \([16\text{-to 50-psig} \text{ (110- to 350-kPa)} \text{ Steam}]\): 50 percent of inlet steam pressure.
   d. Modulating \([\text{More Than 50-psig} \text{ (350-kPa)} \text{ Steam}]\): As indicated.

5. Flow Characteristics: Modified linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.

E-D. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: [Wafer] [Lug] [Grooved].

2. Disc Type: [Nickel-plated ductile iron] [Aluminum bronze] [Elastomer-coated ductile iron] [Epoxy-coated ductile iron].

3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

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**F.E.** Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.

2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.

3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

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**G.F.** Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.

2. Thermostatic Operator: [Wax] [Liquid]-filled [Integral] [Remote] sensor with [Integral] [Remote] adjustable dial.

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**2.172.12 DAMPERS**

**A. Available Manufacturers:**

1. Air Balance Inc.

2. Don Park Inc.; Autodamp Div.

3. TAMCO (T. A. Morrison & Co. Inc.).

4. United Enertech Corp.

5. Vent Products Company, Inc.

6. <Insert manufacturer’s name>

**B. Dampers:** AMCA-rated, [parallel] [opposed]—blade design; 0.108-inch (2.8 mm) minimum thick, galvanized-steel or 0.125-inch (3.2 mm) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch (1.6 mm) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).

1. Secure blades to 1/2-inch (13 mm) diameter, zinc-plated axles using zinc-plated hardware, with [oil-impregnated sintered bronze] [nylon] blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).

3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

2.18 AIR SUPPLY

A. [Available] Manufacturers:
   1. Drainview Products.
   2. Pneuline Controls.
   3. [Insert manufacturer's name.]

B. Control and Instrumentation Tubing: Copper tubing complying with ASTM B 88, Type K (ASTM B 88M, Type A) or ASTM B 280 Type ACR.
   1. Fittings: Cast-bronze solder fittings complying with ASME B16.18; or wrought-copper solder fittings complying with ASME B16.22, except forged-brass compression-type fittings at connections to equipment.
   2. Joining Method: Soldered or brazed.

C. Control and Instrumentation Tubing: ASTM D 2737 Type FR plenum-rated polyethylene, flame-retardant, nonmetallic tubing rated for 30 psig (207 kPa) and ambient temperature range of 10 to 150 deg F (minus 13 to plus 65 deg C) with flame-retardant harness for multiple tubing.
   1. Fittings: Compression or push-on polyethylene fittings.

D. Tank: ASME storage tank with drain test cock, automatic moisture removal trap, tank relief valve, and rubber-cork vibration isolation mounting pads.

E. Duplex Air Compressor: Capacity to supply compressed air to temperature-control system.
   1. Pressure control with adjustable electric contacts, set to start and stop both compressors at different pressures.
   2. Electrical alternation set with motor starters and disconnect to operate compressors alternately or on time schedule.

F. Simplex Air Compressor: Tank-mounting compressor with capacity to supply compressed air to temperature-control system, with starter and disconnect.
   1. Pressure control with adjustable electric contacts, set to start and stop compressor.

G. Compressor Type: [Reciprocating] [Scroll].
H. Size compressor and tank to operate compressor not more than [20] [30] minutes during a 60-minute period.

I. Compressor Accessories: Low-resistance intake air filter, and belt guards.

J. System Accessories: Air filter rated for 97 percent efficiency at rated airflow, and combination filter/pressure-reducing station or separate filter and pressure-reducing station.

K. Refrigerated Air Dryer: Self-contained, refrigerated air dryer complete with heat exchangers, moisture separator, internal wiring and piping, and with manual bypass valve.
   2. Refrigeration Unit: Hermetically sealed, operating to maintain dew point of 13 deg F (minus 11 deg C) at 20 psig (140 kPa), housed in steel cabinet with access door and panel.
   3. Accessories: Air-inlet temperature gage, air-inlet pressure gage, on-off switch, high-temperature light, power-on light, refrigerant gage on back, air-outlet temperature gage, air-outlet pressure gage, and with contacts for remote indication of power status and high-temperature alarm.

L. Desiccant Dryer: Obtains dew point in pneumatic air piping between compressor and tank at least 15 deg F (minus 9 deg C) below inlet-air dew point at design conditions.

M. Pressure Gages: Black letters on white background, 2-1/2 inches (64 mm) in diameter, flush or surface mounting, with front calibration screw to match sensor, and having a graduated scale in psig (kPa).

N. Instrument Pressure Gages: Black letters on white background, 1-1/2 inches (38 mm) in diameter, stem mounted, with suitable dial range.

O. Diaphragm Control and Instrument Valves: 1/4-inch (6-mm) forged-brass body with reinforced polytetrafluoroethylene diaphragm, stainless-steel spring, and color-coded phenolic handle.

P. Gage Cocks: Tee or level handle, bronze, rated for 125 psig (860 kPa).

Q. Relays: For summing, reversing, and amplifying highest or lowest pressure selection; with adjustable I/O ratio.

R. Switches: With indicating plates and accessible adjustment; calibrated and marked.

S. Pressure Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve.

T. Particle Filters: Zinc or aluminum castings with 97 percent filtration efficiency at rated airflow, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.

U. Combination Filter/Regulators: Zinc or aluminum castings with elastomeric diaphragm, balanced construction to automatically prevent pressure buildup, and producing flat reduced-pressure curve; with threaded pipe connections, quick-disconnect service devices, and aluminum or plastic bowl with metal guard and manual drain cock.


V. Airborne Oil Filter: Filtration efficiency of 99.9 percent for airborne lubricating oil particles of 0.025 micron or larger.

W. Pressure Relief Valves: ASME rated and labeled.
   1. High Pressure: Size for installed capacity.
   2. Low Pressure: Size for installed capacity of pressure regulators and set at 20 percent above low pressure.

X. Pressure Reducing Stations: Two parallel pressure regulators.

2.192.13 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that [conditioned] power supply is available to control units and operator workstation.

B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. Mount compressor and tank unit on [elastomeric mounts] [spring isolators with 1-inch (25 mm) static deflection] [restrained spring isolators with 1-inch (25-mm) static deflection]. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer’s written instructions and seismic-control requirements.
   1. Pipe manual and automatic drains to nearest floor drain.
   2. Supply instrument air from compressor units through filter, pressure reducing valve, and pressure relief valve, with pressure gages and shutoff and bypass valves.

D. C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices [48 inches (1220 mm)] [60 inches (1530 mm)] <Insert dimension> above the floor.

   1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. D. Install guards on thermostats in the following locations:
1. Entrances.

2. Public areas.

3. Where indicated.

F-E. Install automatic dampers according to Division 23 Section "Air Duct Accessories."

G-F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H-G. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."

I-H. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

J. Install steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping."

K-L. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

L-J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

M-K. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

3.3 PNEUMATIC PIPING INSTALLATION

A. Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.

1. Install copper tubing with maximum unsupported length of 36 inches (915 mm), for tubing exposed to view.

2. Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install terminal single-line connections, less than 18 inches (460 mm) in length, with copper or polyethylene tubing run inside flexible steel protection.

C. In concealed locations such as pipe chases and suspended ceilings with easy access, install [copper] [polyethylene bundled and sheathed] [polyethylene tubing in electrical metallic] tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

D. In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.

1. Protect embedded copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6 inches (150 mm) above finished slab and 6 inches (150 mm) into slab. Pressure test tubing before and after pour for leak and pinch.
2. Install polyethylene tubing in electrical metallic tubing extending 6 inches (150 mm) above floor line; pull tubing into electrical metallic tubing after pour.

E. Install tubing with sufficient slack and flexible connections to allow for vibration of piping and equipment.

F. Purge tubing with dry, oil-free compressed air before connecting control instruments.

1. Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.

G. Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.

H. Pressure Gages or Test Plugs: Install on branch lines at each receiver controller and on signal lines at each transmitter, except individual room controllers.

3.43.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

   1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

   2. Install exposed cable in raceway.

   3. Install concealed cable in raceway.

   4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

   5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

   6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

   7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
3.53.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

4. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35 kPa) loss.

5. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7 kPa) loss.

6. Test calibration of pneumatic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

7. Test each point through its full operating range to verify that safety and operating control set points are as required.

8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

9. Test each system for compliance with sequence of operation.

10. Test software and hardware interlocks.

C. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.

2. Check instruments for proper location and accessibility.

3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.

4. Check instrument tubing for proper fittings, slope, material, and support.

5. Check installation of air supply for each instrument.

6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.

8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.

10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.

11. Check DDC system as follows:
   a. Verify that DDC controller power supply is from emergency power supply, if applicable.
   b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
   c. Verify that spare I/O capacity has been provided.
   d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.63.5 ADJUSTING

A. Calibrating and Adjusting:
   1. Calibrate instruments.
   2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
   3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.

4. Control System Inputs and Outputs:
   a. Check analog inputs at 0, 50, and 100 percent of span.
   b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
   c. Check digital inputs using jumper wire.
   d. Check digital outputs using ohmmeter to test for contact making or breaking.
   e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
   b. Manually operate flow switches to verify that they make or break contact.

6. Pressure:
a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.

b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.

b. Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.73.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 09 00
SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
B. Related Sections include the following:
   1. Division 23 Section "Instrumentation and Control for HVAC" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS
A. DDC: Direct digital control.
B. VAV: Variable air volume.

1.4 HEATING CONTROL SEQUENCES
A. Heating-Water Supply Temperature Control:
   1. Input Device: [Thermostat][Thermistor temperature sensor][Resistance temperature sensor]. Temperature Sensor.
   2. Output Device: Control valve.
   3. Action: Modulate control valve to maintain heating-water supply temperature.
   4. Display:
      a. Heating-water supply temperature.
      b. Heating-water supply temperature set point.
      c. Control-valve position.

B. Heating-Water Supply Temperature Reset:
   1. Input Device: [Electric, outdoor-air-reset controller][Outdoor-air sensor].2
2. Output Device: [Unitary controller] [DDC system software].

3.2. Action: Reset heating-water supply temperature in straight-line relationship with outdoor-air temperature for the following conditions:

a. \[195^{\circ}F (90^{\circ}C)\] heating water when outdoor-air temperature is \[305^{\circ}F (35^{\circ}C)\] or above (adjustable).

b. \[130^{\circ}F (54^{\circ}C)\] heating water when outdoor-air temperature is \[75^{\circ}F (24^{\circ}C)\].

c. \[150^{\circ}F (65^{\circ}C)\] temperature \[160^{\circ}F\] minimum, heating-water temperature.

4.3. Display:

a. Outdoor-air temperature.

b. Heating-water supply temperature.

c. Heating-water supply temperature set point.

4. Alarms: Send signal to BMS if Boiler Room flammable gas levels exceed 400ppm.

C. Control Primary Circulating Pump(s):

1. Input Device: [Thermostat] [DDC system].

2. Output Device: [Starter] [DDC system command to starter] relay.

3.2. Action: Energize pump(s) at outdoor-air temperatures below \[65^{\circ}F (18^{\circ}C)\] or when fan coil units call for heating.

4.3. Display:

a. Outdoor-air temperature.

b. Operating status of primary circulating pump(s).

4.5 CENTRAL REFRIGERATION EQUIPMENT SEQUENCES

A. Start and Stop Condenser-Water Pump(s):

1. Enable: Allow pump to start when water is in cooling tower:


b. Output Device: Hard wired through motor starter [DDC system binary output].

c. Action: Confirm water in cooling-tower sump.

2. Enable: When outdoor-air temperature conditions are met:
a. Input Device: [Space thermostat] [DDC system outdoor-air temperature].
b. Output Device: Hard wired through motor starter; [DDC system binary output].
c. Action: Confirm outdoor-air temperature is above 50 deg F (10 deg C).

3. Enable: When demand conditions are met:
   a. Input Device: DDC system software demand.
   b. Action: Confirm cooling demand from ventilation system(s).

4. Initiate:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Energize pump(s).

5. Display:
   a. Low-level cooling-tower sump alarm.
   b. Outdoor-air temperature.
   c. Cooling (software) demand indication.
   d. Time and time schedule.
   e. Condenser-water pump(s) on-off status.
   f. Condenser-water pump(s) on-off indication.

B. Start and Stop Chilled-Water Pump(s):
   1. Input Device: Flow switch in condenser-water circuit.
   2. Output Device: [Starter] [DDC system command to starter] relay.
   3. Action: Energize pump(s).
   4. Display:
      a. Chilled-water flow indication.
      b. Chilled-water pump(s) on-off status.
      c. Chilled-water pump(s) on-off indication.

C. Start and Stop Cooling-Tower Fans(s):
   1. Input Device: Flow switch in condenser-water circuit.
   2. Output Device: [Starter] [DDC system command to starter] relay.
3. Action: Energize fan(s).

4. Display:
   a. Condenser-water flow indication.
   b. Cooling-tower fan(s) on-off indication.

D. Start and Stop Refrigeration Machine(s):

1. Input Device: Flow switch in condenser-water circuit.
3. Action: Energize refrigeration machine(s) internal control circuit.
4. Display:
   a. Condenser-water flow indication.
   b. Chilled-water flow indication.
   c. Refrigeration machine on-off indication.
   d. Chilled-water supply and return temperature.
   e. Chilled-water temperature control-point adjustment.

E. Start and Stop Chiller(s):

1. Input Device: Flow switches in condenser-water and chilled-water circuit.
3. Action: Energize chiller internal control circuit.
4. Display:
   a. Condenser-water flow indication.
   b. Chilled-water flow indication.
   c. Chiller(s) on-off status.
   d. Chiller(s) on-off indication.
   e. Chilled-water supply and return temperature.
   f. Chilled-water temperature control-point adjustment.

F. Alternate Chiller(s):

1. Input Device: Electric alternator [DDC system software].
2. Output Device: [Chiller] [DDC system command to chiller] terminal strip.
3. Action: Operate chiller(s) on lead-lag, alternating each startup.
4. Action: Adding and dropping chiller(s) as follows: <Insert sequence and parameters.>
5. Display: Chiller(s) on-off indication.

G. Alarm Chiller(s) Start Failure:
1. Input Device: Chiller [control panel terminal strip contact] [software signal].
2. Output Device: [Analog control panel] [DDC system alarm].
3. Action: Signal alarm.

H. Chilled-Water Level:
1. Input Device: Expansion tank [level switch] [liquid sensor].
2. Output Device: [Electric relay signal to alarm panel] [DDC system alarm].
3. Action: Signal alarm.

I. Chilled-Water Supply Temperature:
1. Input Device: Temperature [sensor] [transmitter] in common chilled-water supply piping.
2. Output Device: [Integral chiller controls] [DDC system signal to chiller control panel].
3. Action: Maintain constant leaving chilled-water temperature [reset according to highest cooling demand].
   a. Display: Chilled-water supply temperature.

J. Condenser-Water Temperature:
1. Input Device: Temperature [sensor] [transmitter] in cooling-tower sump.
2. Output Device: [Bypass control valve] [Cooling-tower fan starter relay] [DDC system command to cooling-tower fan starter relay].
3. Action: Modulate control valve open to cooling tower and closed to bypass and cycle tower fan(s) [on and off] and to low speed and then to high speed to maintain [65 deg F (18 deg C)] [70 deg F (21 deg C)] sump temperature. [Close valve when unoccupied.]
4. Display:
a. Condenser-water sump (return) control-point temperature.
b. Condenser-water sump (return) temperature.
c. Control-valve position.
d. Cooling-tower fan(s) on-off indication.
e. Condenser-water supply temperature.

K. Cooling-Tower Sump Heater:
   1. Input Device: Sump temperature [sensor] [transmitter].
   2. Output Device: [Electric relay]; [DDC system command to electric relay]; [and solenoid valve].
   3. Action: Energize sump heater; drainage sump below low temperature.
   4. Display:
      a. Cooling-tower sump temperature.
      b. Cooling-tower sump heater on-off indication.
      c. Cooling-tower drain indication.

L. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system status, on-off.
   3. Low-level cooling-tower sump alarm.
   4. Outdoor-air temperature.
   5. Cooling (software) demand indication.
   6. Time and time schedule.
   7. Condenser-water pump(s) on-off status.
   8. Condenser-water pump(s) on-off indication.
   9. Condenser-water flow indication.
   10. Chilled-water pump(s) on-off status.
   11. Chilled-water pump(s) on-off indication.
   12. Cooling-tower fan(s) on-off indication.
   13. Chilled-water flow indication.
15. Chilled-water supply temperature.
17. Chilled-water temperature control-point adjustment.
18. Chiller(s) on-off status.
19. Chiller(s) on-off indication.
22. Condenser-water sump (return) control-point temperature.
23. Condenser-water sump (return) temperature.
24. Condenser-water control-valve position.
25. Cooling-tower fan(s) on-off indication.
26. Condenser-water supply temperature.
27. Cooling-tower sump temperature.
29. Cooling-tower dump indication.
30. Chilled-water pressure drop through chiller.
31. Entering condenser-water temperature.
32. Leaving condenser-water temperature.
33. Condenser-water pressure drop through chiller.
34. Chiller condenser-water supply and return temperature.
35. Chiller chilled-water supply and return temperature.
36. System capacity in tons.

1.6 AIR-HANDLING-UNIT CONTROL SEQUENCES

A. Start and Stop Supply Fan(s):

1. Enable: Freeze Protection:
   a. Input Device: Duct-mounted averaging element thermostat, located before supply fan.

c. Action: Allow start if duct temperature is above 37 deg F (3 deg C); signal alarm if fan fails to start as commanded.

2. Enable: High-Temperature Protection:

a. Input Device: Duct-mounted thermostat, located in return air.


c. Action: Allow start if duct temperature is below 300 deg F (150 deg C).

3. Enable: Smoke Control:

a. Input Device: Duct-mounted smoke detector, located in [return] [supply] air.


c. Action: Allow start if duct is free of products of combustion.

4. Initiate: Occupied Time Schedule:

a. Input Device: [Time clock] DDC system time schedule.


c. Action: Energize fan(s).

5. Initiate: Unoccupied Time Schedule:

a. Input Device: [Room thermostat] DDC system demand.

b. Output Device: [Room thermostat] Binary output to motor starter.

c. Action: Energize fan(s).

6. Unoccupied Ventilation:

a. Input Device: [Time clock and room thermostat] DDC system time schedule and output.

b. Output Device: [Room thermostat] DDC system binary output to motor starter.

c. Action: Cycle fan(s) during unoccupied periods.


B. Supply Fan(s) Variable-Volume Control:

1. Occupied Time Schedule:
a. Input Device: [Time clock]. [DDC system time schedule].

b. Output Device: [Time clock]. [Binary output].

c. Action: Enable control.

2. Volume Control:

a. Input Device: [Static-pressure transmitter]. [Differential-pressure switch] sensing supply-duct static pressure referenced to conditioned-space static pressure.

b. Output Device: [Receiver controller]. [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator. Set inlet guide vanes to [minimum] [closed] position when fan is stopped.

c. Action: Maintain constant supply-duct static pressure.

3. Volume Control:

a. Input Device: [Static-pressure transmitter]. [Differential-pressure switch] sensing supply-duct static pressure referenced to conditioned-space static pressure.

b. Output Device: [Receiver controller]. [DDC system analog output] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.

c. Action: Maintain constant supply-duct static pressure.

4. High Pressure:

a. Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.

b. Output Device: [Receiver controller]. [DDC system binary output] to [alarm panel]. [motor starter].

c. Action: Stop fan and signal alarm when static pressure rises above excessive static-pressure set point.

5. Display:

a. Supply-fan-discharge static-pressure indication.

b. Supply-fan-discharge static-pressure set point.

c. Supply-fan airflow rate.

d. Supply-fan [Inlet vane position] [speed].

C. Start and Stop Return Fan(s):

1. Initiate: Occupied Time Schedule:
a. Input Device: [Time clock] [DDC system time schedule].

b. Output Device: [Time clock] [Binary output] to motor starter.

c. Action: Energize fans when supply fans are energized.

2. Initiate: Unoccupied Time Schedule:

a. Input Device: [Room thermostat] [DDC system demand].

b. Output Device: [Room thermostat] [Binary output] to motor starter.

c. Action: Energize fans when supply fans are energized.

3. Unoccupied Ventilation:

a. Input Device: [Time clock and room thermostat] [DDC system time schedule and output].

b. Output Device: [Room thermostat] [DDC system binary output] to motor starter.

c. Action: Cycle fan(s) during unoccupied periods.


D. Return Fan(s) Variable-Volume Control:

1. Occupied Time Schedule:

a. Input Device: [Time clock] [DDC system time schedule].

b. Output Device: [Time clock] [Binary output].

c. Action: Enable control.

2. Volume Control:

a. Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing building static pressure referenced to outdoor static pressure.

b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator. Set inlet guide vanes to [minimum] [closed] position when fan is stopped.

c. Action: Maintain constant building static pressure.

3. Volume Control:

a. Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing building static pressure referenced to outdoor static pressure.

b. Output Device: [Receiver controller] [DDC system analog output] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
c. Action: Maintain constant building static pressure.

4. Display:
   a. Return-air static-pressure indication.
   b. Return-air static-pressure set point.
   c. Return-fan airflow rate.
   d. Return-fan [inlet vane position] [speed].
   e. Building static-pressure indication.
   f. Building static-pressure set point.

E. Return Fan(s) Variable-Volume Control:

1. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Enable control.

2. Volume Control:
   a. Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing building static pressure referenced to outdoor static pressure.
   b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator. Set inlet guide vanes to [minimum] [closed] position when fan is stopped.
   c. Action: Maintain constant building static pressure.

3. Volume Control:
   a. Input Device: [Static-pressure transmitter] [Differential-pressure switch] sensing building static pressure referenced to outdoor static pressure.
   b. Output Device: [Receiver controller] [DDC system analog output] to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
   c. Action: Maintain constant building static pressure.

4. Display:
   a. Return-fan discharge static-pressure indication.
   b. Return-fan discharge static-pressure set point.
   c. Return-fan airflow rate.
d. Return-fan inlet vane position / speed.

F. Preheat Coil:

1. Freeze Protection:
   a. Input Device: Duct-mounted averaging element thermostat, located after preheat coil.
   b. Output Device: Hard wired through motor starter; [analog alarm panel] [DDC system alarm].
   c. Action: Allow start if duct temperature is above 33 deg F (1 deg C).

2. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output] to motor starter.
   c. Action: Energize coil circulating pump(s).

3. [Supply] [Discharge] Air Temperature:
   a. Input Device: [Time clock and duct-mounted thermostat] [DDC system time schedule and electronic temperature sensor].
   b. Output Device: Modulating control valve.
   c. Action: Maintain air temperature set point of 55 deg F (13 deg C).

4. Unoccupied Time Schedule:
   a. Input Device: [Time clock and duct-mounted thermostat mounted in outdoor air] [DDC system time schedule and outdoor-air temperature].
   b. Output Device: [Time clock] [Binary output] to motor starter.
   c. Action: Energize coil circulating pump(s) when outdoor-air temperature falls below 35 deg F (2 deg C).

5. Display:
   a. Preheat-coil air-temperature indication.
   b. Preheat-coil air-temperature set point.
   c. Preheat-coil pump operation indication.
   d. Preheat-coil control-valve position.

G. Mixed-Air Control:

1. Occupied Time Schedule:
a. Input Device: [Time clock] [DDC system time schedule].

b. Output Device: [Pneumatic relay] [DDC system output].

c. Action: Enable control.

2. Minimum Position:

a. Input Device: [Time clock] [DDC system time schedule].

b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator(s).

c. Action: Open [minimum outdoor-air dampers] [outdoor-air dampers to minimum position].

3. Heating Reset:

a. Input Device: [Room thermostat] [DDC system software].

b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator(s).

c. Action: Close minimum outdoor-air dampers [Set outdoor-air dampers to minimum position].

4. [Supply] [Mixed]-Air Temperature:

a. Input Device: [Duct-mounted thermostat] [Electronic temperature sensor].

b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator(s).

c. Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of 55 deg F (13 deg C).

5. Cooling Reset:

a. Input Device: Outdoor- and return-air, duct-mounted [thermostats] [electronic temperature sensors].

b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to damper actuator(s).

c. Action: Set outdoor-air dampers to minimum position when outdoor-air [temperature exceeds return-air temperature] [enthalpy exceeds return-air enthalpy].

6. Unoccupied Time Schedule:

a. Input Device: [Time clock] [DDC system time schedule].
b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] to modulating damper actuator(s).

c. Action: Position outdoor- and relief-air dampers closed and return-air dampers open.

7. Display:
   b. Mixed-air-temperature set point.
   c. Mixed-air damper position.

H. Humidifier:

1. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule] and airflow switch.
   b. Output Device: [Pneumatic relay] [DDC system output].
   c. Action: Enable control.

2. Humidity:
   a. Input Device: [Room humidistat] [Return-air, duct-mounted humidistat] [DDC system].
   b. Output Device: [Receiver controller] [DDC system analog output] [DDC system analog output to digital-to-pneumatic transducer] [enables humidifier] [modulates control valve to maintain humidity] [cycles pump to maintain humidity] [cycles pump and modulates control valve to maintain humidity] in straight-line relationship for the following conditions:
      1) 20 percent when outdoor-air temperature is \[-30 \text{ deg F} \text{ (minus 35 deg C)}\] \(<\text{Insert temperature}\>.
      2) 40 percent when outdoor-air temperature is \[75 \text{ deg F} \text{ (24 deg C)}\] \(<\text{Insert temperature}\>.
   c. Action: Modulate outdoor-, return-, and relief-air dampers to maintain air temperature set point of \[55 \text{ deg F} \text{ (13 deg C)}\] \(<\text{Insert temperature}\>.

3. Display:
   a. Relative humidity indication.
   b. Relative humidity set point.
   c. Relative humidity control-valve position.

I. Filters: During occupied periods, when fan is running, differential air-pressure transmitters exist.
1. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Electric relay] [DDC system output].
   c. Action: Enable control.

2. Differential Pressure:
   a. Input Device: [Differential-pressure switches] [Pressure transmitter].
   b. Output Device: [Analog alarm panel] [DDC system alarm].
   c. Action: Signal alarm on low- and high-pressure conditions.

3. Display:
   a. Filter air-pressure-drop indication.
   b. Filter low-air-pressure set point.
   c. Filter high-air-pressure set point.

J. [Hydronic] [Steam] Heating Coil:

1. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Enable control.

2. [Supply] [Discharge]-Air Temperature:
   a. Input Device: [Duct-mounted thermostat] [Electronic temperature sensor].
   c. Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

3. Temperature Reset:
   a. Input Device: [Duct-mounted thermostat] [Electronic temperature sensor] in return air.
   b. Output Device: [Direct to receiver controller] [DDC system] in straight-line relationship for the following conditions:
      1) [65 deg F (18 deg C)] <Insert temperature> when return-air temperature is [70 deg F (21 deg C)] <Insert temperature>.
      2) [55 deg F (13 deg C)] <Insert temperature> when return-air temperature is [75 deg F (24 deg C)] <Insert temperature>.
c. Action: Reset supply-air temperature set point of 55 deg F (13 deg C).

4. Temperature Reset:
   a. Input Device: [Load analyzer] [DDC system] with input from room [thermostats] [temperature sensors].
   b. Output Device: [Direct to receiver controller] [DDC system].
   c. Action: Reset supply-air temperature in response to greatest heating demand.

5. Unoccupied Time Schedule:
   a. Input Device: [Time clock and room thermostat] [DDC system time schedule and output].
   b. Output Device: [Room thermostat (cycling fan)] [DDC system binary output].
   c. Action: [Enable normal control] [Return valve to normal position] when fan is cycled on.

6. Display:
   a. Fan-discharge air-temperature indication.
   b. Fan-discharge air-temperature set point.
   c. Heating-coil air-temperature indication.
   d. Heating-coil air-temperature set point.
   e. Heating-coil pump operation indication.
   f. Heating-coil control-valve position.
   g. Hot-deck air-temperature indication.
   h. Hot-deck air-temperature set point.

K. Hydronic Cooling Coil:

1. Occupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Enable control.

2. [Supply] [Discharge] Air Temperature:
   a. Input Device: [Duct-mounted thermostat] [Electronic temperature sensor].
c. Action: Maintain supply-air temperature set point of 55 deg F (13 deg C).

3. Temperature Reset:
   a. Input Device: [Duct-mounted thermostat] [Electronic temperature sensor] in return air.
   b. Output Device: [Direct to receiver controller] [DDC system] in straight-line relationship for the following conditions:
      1) [65 deg F (18 deg C)] < Insert temperature > when return-air temperature is [70 deg F (21 deg C)] < Insert temperature >.
      2) [55 deg F (13 deg C)] < Insert temperature > when return-air temperature is [75 deg F (24 deg C)] < Insert temperature >.
   c. Action: Reset supply-air temperature set point of 55 deg F (13 deg C).

4. Temperature Reset:
   a. Input Device: [Load analyzer] [DDC system] with input from room [thermostats] [temperature sensors].
   b. Output Device: [Direct to receiver controller] [DDC system].
   c. Action: Reset supply-air temperature in response to greatest heating demand.

5. Unoccupied Time Schedule:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Disable control.

6. Display:
   a. Fan-discharge air-temperature indication.
   b. Fan-discharge air-temperature set point.
   c. Cooling-coil air-temperature indication.
   d. Cooling-coil air-temperature set point.
   e. Cooling-coil control-valve position.
   f. Cold-deck air-temperature indication.
   g. Cold-deck air-temperature set point.

L. Multizone Damper Control:
   1. Occupied Time Schedule:
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2. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   b. Output Device: Damper actuator.
   c. Action: Maintain room temperature.

3. Display:
   a. Room temperature indication.
   b. Room temperature set point.
   c. Multizone damper position.

M. Coordination of Air-Handling Unit Sequences: Ensure that preheat, mixed-air, heating-coil, and cooling-coil controls have common inputs and do not overlap in function.

N. Operator Station Display: Indicate the following on operator workstation display terminal:
   1. DDC system graphic.
   2. DDC system on-off indication.
   3. DDC system occupied/unoccupied mode.
   5. Supply-fan on-off indication.
   7. Supply-fan-discharge-static-pressure set point.
   9. Supply-fan [inlet vane position] [speed].
   11. Return-air static-pressure indication.
   12. Return-air static-pressure set point.
   14. Return-fan [inlet vane position] [speed].
15. Building static-pressure indication.
16. Building static-pressure set point.
17. Preheat-coil air-temperature indication.
18. Preheat-coil air-temperature set point.
19. Preheat-coil pump operation indication.
20. Preheat-coil control-valve position.
25. Relative humidity set point.
27. Filter air-pressure-drop indication.
28. Filter low-air-pressure set point.
29. Filter high-air-pressure set point.
30. Fan-discharge-air-temperature indication.
31. Fan-discharge-air-temperature set point.
32. Heating-coil air-temperature indication.
33. Heating-coil air-temperature set point.
34. Heating-coil pump operation indication.
35. Heating-coil control-valve position.
37. Hot-deck air-temperature set point.
38. Cooling-coil air-temperature indication.
40. Cooling-coil control-valve position.
41. Cold-deck air-temperature indication.
42. Cold-deck air-temperature set point.
43. Room temperature indication.
44. Room temperature set point.
45. Multizone damper position.

4.7.1.5 TERMINAL UNIT OPERATING SEQUENCE

A. Cabinet Unit Heater, [Hydronic] [Steam]:

1. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   b. Output Device: [Room thermostat] [DDC system binary output].
   c. Action: Cycle fan to maintain temperature.

2. Low-Temperature Safety:
   c. Action: Stop fan when [return heating-water] [condensate] temperature falls below 35 deg F (2 deg C).

3. Display:
   a. Room temperature indication.
   b. Room temperature set point.

B. Cabinet Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.

C. Unit Heater, [Hydronic] [Steam]:

1. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   b. Output Device: [Room thermostat] [DDC system binary output].
   c. Action: Cycle fan to maintain temperature.

2. Low-Temperature Safety:
   c. Action: Stop fan when [return heating-water] [condensate] temperature falls below 35 deg F (2 deg C).
3. Display:
   a. Room temperature indication.
   b. Room temperature set point.

D. Unit Heater, Electric: Room thermostat cycles fan and sequences stages of heating.

E. Combustion Air Unit Heaters:

1. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   c. Action: Modulate valve to maintain temperature.

2. Display:
   a. Room temperature indication.
   b. Room temperature set point.
   c. Control-valve position.

F. Radiant Heating Cable, Electric: Room thermostat cycles power.

G. Radiant Heating Panel, Electric: Room thermostat cycles power.

H. Radiant Heating Panel, Hydronic:

1. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   c. Action: Modulate valve to maintain temperature.

2. Display:
   a. Room temperature indication.
   b. Room temperature set point.
   c. Control-valve position.

I. Two Pipe, Single-Coil, Fan-Coil Unit:

1. Occupied Time Schedule:
   a. Input Device: [Fan switch] [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
2. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor] in [room] [return air].
   c. Action: Modulate valve to maintain temperature.

3. DDC System Changeover:
   a. Input Device: [Thermostat] [Electronic temperature sensor] in supply-water on supply-water piping [DDC system].
   b. Output Device: [Hard-wired relay] [DDC system software].
   c. Action: Reverse control-valve action to switch from heating to cooling.

4. Display:
   a. DDC system graphic.
   b. DDC system on-off indication.
   c. DDC system occupied/unoccupied mode.
   d. Room temperature indication.
   e. Room temperature set point.
   f. Control-valve position.
   g. Supply-water temperature indication.

J.B. Four-Pipe, Hydronic Fan-Coil Unit:

1. Occupied Time Schedule:
   a. Input Device: [Fan switch] [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Start and stop fan, and enable control. Provide air temperature sensor over full face of coil to shut down fan, motorized dampers and water valves if the mixed air temperature falls below 40 degrees F.

2. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   c. Action: Modulate multiport control valves to maintain temperature.
3. Display:
   a. DDC system graphic.
   b. DDC system on-off indication.
   c. DDC system occupied/unoccupied mode.
   d. Room temperature indication.
   e. Room temperature set point.
   f. Control-valve position.

4. Outside Air Motorized Dampers
   a. Shall close when the associated Fan Coil Unit is not operating and shall remain closed for morning warm-up until minimum 65 degrees F space temperature is achieved (adjustable).

K. Unit Ventilator: Room thermostat modulates heating and cooling control valves; airstream thermostat modulates outdoor and return-air dampers as follows:

1. Occupied Time Schedule:
   a. Input Device: [Fan switch] [Time clock] [DDC system time schedule].
   b. Output Device: [Time clock] [Binary output].
   c. Action: Start and stop fan, move outdoor- and return-air dampers to [minimum] [maximum] outdoor-air position, and enable control.

2. Room Temperature - Valves:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   c. Action: Modulate heating-water supply control valve and chilled-water supply control valve in sequence to maintain temperature.

3. Room Temperature - Dampers:
   a. Input Device: [Thermostat] [Electronic temperature sensor] in mixed air.
   c. Action: Modulate outdoor- and return-air dampers to maintain temperature.

4. Supply-Air Temperature Limit:
   a. Input Device: [Thermostat] [Electronic temperature sensor] in discharge air.
   b. Output Device: [Pneumatic] [Electronic] control-valve operators and control damper actuators.
c. Action: Override room thermostat to control valves and dampers to prevent discharge air from dropping below a minimum set point.

5. Warm-up Cycle:
   a. Input Device: [Time clock] [DDC system time schedule].
   b. Output Device: [Hard-wired relay] [DDC system binary output].
   c. Action: Open heating-water supply control valve, close outdoor-air damper, and open return-air damper.

6. Display:
   a. DDC system graphic.
   b. DDC system on-off indication.
   c. DDC system occupied/unoccupied mode.
   d. Room temperature indication.
   e. Room temperature set point.
   f. Control-valve position.
   g. Damper position.

L. Heating Coils, [Hydronic] [Steam]:

1. Room Temperature:
   a. Input Device: [Room] [Exhaust Fan: Interlock with room thermostat] [Electronic temperature sensor].
   b. Output Device: [Pneumatic] [Electronic] [Electric] control-valve operators.
   c. Action: [Modulate] [Cycle] valve to maintain temperature.

2. Display:
   a. Room temperature indication.
   b. Room temperature set point.
   c. Control-valve position.

M. Heating Coils, Electric: Room thermostat [cycles coils] [sequences stages of heating].

N. Radiators 80 degrees F (adjustable). BMS shall monitor fan status and Convectors, [Hydronic] [Steam]:

1. Occupancy:
   a. Input Device: Occupancy sensor.
b. Output Device: DDC system binary output.

c. Action: Report occupancy and enable occupied temperature set point.

2. Room Temperature:

   a. Input Device: [Room thermostat] [Electronic temperature sensor].

   b. Output Device: [Pneumatic] [Electronic] [Electric] control-valve operators.

   c. Action: [Modulate] [Cycle] valve to maintain temperature.

      1) Occupied Temperature: 75 deg F (24 deg C).

      2) Unoccupied Temperature: 65 deg F (18 deg C).

3. Display:

   a. Room/area served.

   b. Room temperature indication.

   c. Room temperature set point.

   d. Room temperature set point, occupied.

   e. Room temperature set point, occupied standby.

   f. Room temperature set point, unoccupied.

   g. Control-valve position as percent open.

O. Radiators and Convectors, Electric: Room thermostat [cycles coils] [sequences stages of heating].

P. Constant-Volume, Terminal Air Units, [Hydronic] [Steam]:

1. Occupancy:

   a. Input Device: Occupancy sensor.

   b. Output Device: DDC system binary output.

   c. Action: Report occupancy and enable occupied temperature set point.

      1) Occupied Temperature: 75 deg F (24 deg C).

      2) Unoccupied Temperature: 65 deg F (18 deg C).

2. Room Temperature:

   a. Input Device: [Room thermostat] [Electronic temperature sensor].

   b. Output Device: [Pneumatic] [Electronic] [Electric] control-valve operators.
c. Action: [Modulate] [Cycle] valve to maintain temperature.

3. Display:
   a. Room/area served.
   b. Room occupied/unoccupied.
   c. Room temperature indication.
   d. Room temperature set point.
   e. Room temperature set point, occupied.
   f. Room temperature set point, unoccupied.
   g. Control-valve position as percent open.

Q. VAV, Terminal Air Units with [Hydronic] [Steam] Coils:

1. Occupancy:
   a. Input Device: Occupancy sensor.
   b. Output Device: DDC system binary output.
   c. Action: Report occupancy and enable occupied temperature set point.

   1) Occupied Temperature: 75 deg F (24 deg C).
   2) Unoccupied Temperature: 65 deg F (18 deg C).

2. Room Temperature:
   a. Input Device: [Room thermostat] [Electronic temperature sensor].
   b. Output Device: [Pneumatic] [Electronic] damper actuators and control-valve operators.
   c. Action: Modulate damper and valve to maintain temperature.

   1) Sequence damper from full open to minimum position, then valve from closed to fully open.

3. Display:
   a. Room/area served.
   b. Room occupied/unoccupied.
   c. Room temperature indication.
   d. Room temperature set point.
   e. Room temperature set point, occupied.
f. Room temperature set point, unoccupied.

g. Air-damper position as percent open.

h. Control-valve position as percent open.

R. Dual-Duct, VAV, Terminal Air Units:

1. Occupancy:
   a. Input Device: Occupancy sensor.
   b. Output Device: DDC system binary output.
   c. Action: Report occupancy and enable occupied temperature set point.
      1) Occupied Temperature: 75 deg F (24 deg C).
      2) Unoccupied Temperature: 65 deg F (18 deg C).

2. Room Temperature:
   a. Input Device: Room thermostat [Electronic temperature sensor].
   c. Action: Modulate dampers to maintain temperature.

S.C. Sequence when space temperature is below set point: Close VAV damper to minimum position, open hot-deck dampers and close cold-deck dampers, then open VAV damper.

D. Sequence when Toilet Exhaust Fan: Shall operate on a timed schedule (i.e. Monday-Friday 7am-8pm). Coordinate with client. BMS shall monitor fan status.

   1) Split Fan Coil Unit: Shall operate 24/7 to maintain space temperature is above set point. Close VAV damper to minimum position, close hot-deck dampers. (75 degrees F adjustable.) Condensate pump shall always be energized. BMS shall monitor unit status and open cold-deck dampers, then open VAV damper.

2. Display:
   a. Room/area served.
   b. Room occupied/unoccupied.
   c. Room temperature indication.
   d. Room temperature set point.
   e. Room temperature set point, occupied.
   f. Room temperature set point, unoccupied.
   g. VAV damper position as percent open.
h. Hot-deck damper position as percent open.
i. Cold-deck damper position as percent open.

1.8 VENTILATION SEQUENCES

A. Combustion-Air, Makeup Unit Control, Electric: Start fan when served appliance burner starts; room thermostat sequences stages of heating.

B. Combustion-Air, Makeup Unit Control, [Hydronic] [Steam]: Start fan when served appliance burner starts; room thermostat [cycles] [modulates] control valve.

C. Gravity Roof Ventilator: [Occupancy sensor] [Room thermostat] opens dampers.

D. Exhaust Fan: [Occupancy sensor] [Interlock with light switch] [Room thermostat] cycles fan.

E. Kitchen Exhaust Fan: Occupancy sensor starts fan and energizes makeup air unit.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 23 09 93
SECTION 23 34 16
CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Forward-curved centrifugal fans.
4. Plenum fans.
5. Plug fans.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on actual Project site elevations above sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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CENTRIFUGAL HVAC FANS
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1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Belts: [One] <Insert number> set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 AIRFOIL CENTRIFUGAL FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. ABB Fan Group North America.
3. Aerovent; a Twin City Fan Company.
4. Airmaster Fan Co.
5. Ammerman; General Resource Corp.
6. Bayley Fans; a division of Lau Industries, Inc.
7. Carrier Corporation.
11. CML Northern Blower Inc.
12. Howden Fan Co.
13. Industrial Air; a division of Lau Industries, Inc.
14. Loren Cook Company.
15. Madison Manufacturing.
17. New York Blower Company (The).
18. Trane.
19. <Insert manufacturer’s name.>

D. Description: Factory-fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor [and disconnect switch], drive assembly, and support structure.

E. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. Horizontally split, bolted-flange housing.
   3. Spun inlet cone with flange.
   4. Outlet flange.

F. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; [and] cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; [and special coating].

G. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan’s speed range.

   1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

   1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
   2. Roller-Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>. 
J. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with 
adapter mount and two-piece, cast-iron housing.

1. Ball-Bearing Rating Life: ABMA 9, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$].

2. Roller-Bearing Rating Life: ABMA 11, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$].

K. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [1.5] [1.4] [1.3] [1.2].

2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at 
factory.

3. Motor Pulleys: Adjustable pitch for use with motors through [5] hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.


L. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and 
gaskets.

2. Cleanout Door: [Bolted] [Quick-opening, latch-type] gasketed door allowing access to fan scroll, of same material as housing.

3. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.

4. Companion Flanges: Rolled flanges for duct connections of same material as housing.

5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.

6. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

7. Inlet Screens: Grid screen of same material as housing.

8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

10. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.


M. Motors: Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

1. Enclosure Type: Totally enclosed, fan cooled.

N. Capacities And Characteristics:

1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced-plastic] [Aluminum] [Stainless steel].

2. Special Housing Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel].

3. Wheel Size (Diameter): <Insert inches (mm).>

4. Wheel Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced-plastic] [Stainless steel].

5. Special Wheel Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel].

6. Airflow: <Insert cfm (L/s).>

7. Static Pressure: <Insert inches wg (Pa).>

8. Class: [I] [II] [III].


10. Drive Type: [Belt] [Direct].

11. Fan Rpm: <Insert value.>

12. Outlet Velocity: <Insert fpm (m/s).>


15. Electrical Characteristics:

   a. Volts: <Insert value.>

   b. Phase: <Insert value.>

   c. Hertz: <Insert value.>
d. Minimum Circuit Ampacity: <Insert value.>

e. Maximum Overcurrent Protection: <Insert value.>

16. Discharge Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

17. Inlet Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

18. Vibration Isolators: [Spring isolators] [Restrained spring isolators] <Insert type> having a static deflection of [1 inch (25 mm)] <Insert deflection>.

19. Spark Arrestance Class: [A] [B] [C].

2.2 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
C. Basis of Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] [Insert manufacturer’s name; product name or designation] or a comparable product by one of the following:

1. ABB Fan Group North America.
3. Aerovent; a Twin City Fan Company.
4. Airmaster Fan Co.
5. Ammerman; General Resource Corp.
6. Bayley Fans; a division of Lau Industries, Inc.
7. Carrier Corporation.
11. CML Northern Blower Inc.
12. Howden Fan Co.
13. Industrial Air; a division of Lau Industries, Inc.
14. Loren Cook Company.
15. Madison Manufacturing.
17. New York Blower Company (The).
18. Trane.
19. [Insert manufacturer’s name.]

D. Description: Factory-fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor [and disconnect switch], drive assembly, and support structure.

E. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontally split, bolted-flange housing.
3. Spun inlet cone with flange.
4. Outlet flange.

F. Backward-Inclined Wheels: Single-width single-inlet and double-width double-inlet construction with curved inlet flange, backplate, backward-inclined blades [welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate] and fastened to shaft with set screws.

G. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan’s speed range.

   1. Ball Bearing Rating Life: ABMA 9, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.
   2. Roller Bearing Rating Life: ABMA 11, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.

   1. Ball Bearing Rating Life: ABMA 9, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.
   2. Roller Bearing Rating Life: ABMA 11, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.

J. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball Bearing Rating Life: ABMA 9, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.
   2. Roller Bearing Rating Life: ABMA 11, L10 at $50,000 \text{ hours}$ [$120,000 \text{ hours}$] <Insert hours>.

K. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: [1.5] [1.4] [1.3] [1.2].
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Motor Pulleys: Adjustable pitch for use with motors through [5] <Insert number> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.


L. Accessories:

1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.

2. Cleanout Door: [Bolted] [Quick-opening, latch-type] gasketed door allowing access to fan scroll, of same material as housing.

3. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.

4. Companion Flanges: Rolled flanges for duct connections of same material as housing.

5. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.

6. Discharge Dampers: Assembly with [parallel] [opposed] blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

7. Inlet Screens: Grid screen of same material as housing.

8. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.


10. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.


M. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

N. Capacities And Characteristics:

1. Housing Material: [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel].

2. Special Housing Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl-ester] [Hot-dip galvanized] [Powder-baked enamel]: <Insert manufacturer’s name and trade name>.

3. Wheel Size (Diameter): <Insert inches (mm).>
4. Wheel Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced-plastic] [Stainless steel].

5. Special Wheel Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel]. <Insert manufacturer's name and trade name>.

6. Airflow: <Insert cfm (L/s)>.

7. Static Pressure: <Insert inches wg (Pa)>.

8. Class: [I] [II] [III].


10. Drive Type: [Belt] [Direct].

11. Fan Rpm: <Insert value>.

12. Outlet Velocity: <Insert fpm (m/s)>.


15. Electrical Characteristics:
   a. Volts: <Insert value>.
   b. Phase: <Insert value>.
   c. Hertz: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection: <Insert value>.

16. Discharge Sound Power:
   a. 1st Octave: <Insert dB>.
   b. 2nd Octave: <Insert dB>.
   c. 3rd Octave: <Insert dB>.
   d. 4th Octave: <Insert dB>.
   e. 5th Octave: <Insert dB>.
   f. 6th Octave: <Insert dB>.
   g. 7th Octave: <Insert dB>.
   h. 8th Octave: <Insert dB>.
17. Inlet Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

18. Vibration Isolators: [Spring isolators] [Restrained spring isolators] <Insert type> having a static deflection of [1 inch (25 mm)] <Insert deflection>.

19. Spark Arrestance Class: [A] [B] [C].

2.3 FORWARD-CURVED CENTRIFUGAL FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. ABB Fan Group North America.
3. Aerovent; a Twin City Fan Company.
4. Airmaster Fan Co.
5. Ammerman; General Resource Corp.
6. Bayley Fans; a division of Lau Industries, Inc.
7. Carrier Corporation.
11. CML Northern Blower Inc.
12. Howden Fan Co.
13. Industrial Air; a division of Lau Industries, Inc.
14. Loren Cook Company.
15. Madison Manufacturing.
17. New York Blower Company (The).
18. Trane.
19. <Insert manufacturer's name.>

D. Description: Factory-fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor [and disconnect switch], drive assembly, and support structure.

E. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   2. Horizontally split, bolted-flange housing.
   3. Spun inlet cone with flange.
   4. Outlet flange.

F. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.

G. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

   1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
2. Roller Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

   1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
   2. Roller Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

J. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
   1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
   2. Roller Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

K. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
   1. Service Factor Based on Fan Motor Size: [1.5] [1.4] [1.3] [1.2].
   2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
   3. Motor Pulleys: Adjustable pitch for use with motors through [5] <Insert number> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
   4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
   5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

L. Accessories:
   1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: [Bolted] [Quick-opening, latch-type] gasketed door allowing access to fan scroll, of same material as housing.
   3. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
   4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. **Variable Inlet Vanes:** With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.

6. **Discharge Dampers:** Assembly with [parallel] [opposed] blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.

7. **Inlet Screens:** Grid screen of same material as housing.

8. **Shaft Cooler:** Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.

9. **Spark-Resistant Construction:** AMCA 99.

10. **Shaft Seals:** Airtight seals installed around shaft on drive side of single-width fans.

11. **Weather Cover:** Enameled-steel sheet with ventilation slots, bolted to housing.

**M. Motors:** Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

1. **Enclosure Type:** Totally enclosed, fan cooled.

**N. Capacities And Characteristics:**

1. **Housing Material:** [Reinforced steel] [Shaped fiberglass-reinforced plastic] [Aluminum] [Stainless steel].

2. **Special Housing Coating:** [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel]. Insert manufacturer’s name and trade name.

3. **Wheel Size (Diameter):** Insert inches (mm).

4. **Wheel Material:** [Steel] [Galvanized steel].

5. **Special Wheel Coating:** [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel]. Insert manufacturer’s name and trade name.

6. **Airflow:** Insert cfm (L/s).

7. **Static Pressure:** Insert inches wg (Pa).

8. **Class:** [I] [II] [III].

9. **Brake Horsepower:** Insert value.

10. **Drive Type:** [Belt] [Direct].

11. **Fan Rpm:** Insert value.

12. **Outlet Velocity:** Insert fpm (m/s).
15. Electrical Characteristics:
   a. Volts: <Insert value>.
   b. Phase: <Insert value>.
   c. Hertz: <Insert value>.
   d. Minimum Circuit Ampacity: <Insert value>.
   e. Maximum Overcurrent Protection: <Insert value>.
16. Discharge Sound Power:
   a. 1st Octave: <Insert dB>.
   b. 2nd Octave: <Insert dB>.
   c. 3rd Octave: <Insert dB>.
   d. 4th Octave: <Insert dB>.
   e. 5th Octave: <Insert dB>.
   f. 6th Octave: <Insert dB>.
   g. 7th Octave: <Insert dB>.
   h. 8th Octave: <Insert dB>.
17. Inlet Sound Power:
   a. 1st Octave: <Insert dB>.
   b. 2nd Octave: <Insert dB>.
   c. 3rd Octave: <Insert dB>.
   d. 4th Octave: <Insert dB>.
   e. 5th Octave: <Insert dB>.
   f. 6th Octave: <Insert dB>.
   g. 7th Octave: <Insert dB>.
   h. 8th Octave: <Insert dB>.
18. Vibration Isolators: [Spring isolators] [Restrained spring isolators] <Insert type> having a static deflection of [1 inch (25 mm)] <Insert deflection>.
19. Spark Arrestance Class: [A] [B] [C].

2.4 PLENUM FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis of Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] [Insert manufacturer’s name; product name or designation] or a comparable product by one of the following:

1. ABB Fan Group North America.
3. Aerovent; a Twin City Fan Company.
4. Airmaster Fan Co.
5. Ammerman; General Resource Corp.
6. Bayley Fans; a division of Lau Industries, Inc.
7. Carrier Corporation.
11. CML Northern Blower Inc.
12. Howden Fan Co.
13. Industrial Air; a division of Lau Industries, Inc.
14. Loren Cook Company.
15. Madison Manufacturing.
17. New York Blower Company (The).
18. Trane.
19. [Insert manufacturer’s name.]
D. Description: Factory-fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor [and disconnect switch], drive assembly, and support structure.

E. Airfoil Wheels: Single-width-single-inlet construction with smooth-curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; [and] cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws [and special coating].

F. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.


1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
2. Roller-Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.


1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
2. Roller-Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

I. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

1. Ball-Bearing Rating Life: ABMA 9, L10 at [50,000 hours] [120,000 hours] <Insert hours>.
2. Roller-Bearing Rating Life: ABMA 11, L10 at [50,000 hours] [120,000 hours] <Insert hours>.

J. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [1.5] [1.4] [1.3] [1.2].
2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
3. Motor Pulleys: Adjustable pitch for use with motors through [5] <Insert number> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.


K. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.


L. Motors: Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

1. Enclosure Type: Totally enclosed, fan cooled.

M. Capacities And Characteristics:

1. Wheel Size (Diameter): <Insert inches (mm).>

2. Wheel Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel].

3. Special Wheel Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel].<Insert manufacturer’s name and trade name>.

4. Airflow: <Insert cfm (L/s).>

5. Static Pressure: <Insert inches wg (Pa).>

6. Class: [I] [II] [III].


8. Drive Type: [Belt] [Direct].

9. Fan Rpm: <Insert value.>

10. Outlet Velocity: <Insert fpm (m/s).>


12. Motor Rpm: <Insert value.>

13. Electrical Characteristics:

   a. Volts: <Insert value.>
b. Phase: <Insert value.>

c. Hertz: <Insert value.>

d. Minimum Circuit Ampacity: <Insert value.>

e. Maximum Overcurrent Protection: <Insert value.>

14. Discharge Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

15. Inlet Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

16. Vibration Isolators: [Spring isolators] [Restrained spring isolators] <Insert type>
having a static deflection of [1 inch (25 mm)] <Insert deflection>.

17. Spark Arrestance Class: [A] [B] [C].

2.5 PLUG FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis of Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:

1. ABB Fan Group North America.
3. Aerovent; a Twin City Fan Company.
4. Airmaster Fan Co.
5. Ammerman; General Resource Corp.
6. Bayley Fans; a division of Lau Industries, Inc.
7. Carrier Corporation.
11. CML Northern Blower Inc.
12. Howden Fan Co.
13. Industrial Air; a division of Lau Industries, Inc.
14. Loren Cook Company.
15. Madison Manufacturing.
17. New York Blower Company (The).
18. Trane.
19. <Insert manufacturer's name.>

D. Description: Factory-fabricated, assembled, tested, and finished, belt-driven centrifugal fans consisting of wheel, fan shaft, bearings, motor [and disconnect switch], drive assembly, and support structure.

E. Airfoil Wheels: Single-width-single-inlet construction with smooth curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; [and] cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws; [and special coating].
F. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.

2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.


1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.

2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.


1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.

2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.

I. Grease-Lubricated Shaft Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.

1. Ball-Bearing Rating Life: ABMA 9, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.

2. Roller-Bearing Rating Life: ABMA 11, Ll0 at 50,000 hours [120,000 hours] <Insert hours>.

J. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor Based on Fan Motor Size: [1.5] [1.4] [1.3] [1.2].

2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

3. Motor Pulleys: Adjustable pitch for use with motors through [5] <Insert number> hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.

4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.

5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

K. Accessories:

1. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.


L. Motors: Comply with requirements in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

1. Enclosure Type: Totally enclosed, fan cooled.

M. Capacities And Characteristics:

1. Wheel Size (Diameter): <Insert inches (mm)>.

2. Wheel Material: [Steel] [Aluminum] [One-piece fiberglass-reinforced plastic] [Stainless steel].

3. Special Wheel Coating: [Thermoplastic vinyl] [Epoxy] [Zinc] [Synthetic resin] [Phenolic] [Color-match enamel] [Polytetrafluoroethylene] [Vinyl ester] [Hot-dip galvanized] [Powder-baked enamel] [Insert manufacturer’s name and trade name].

4. Airflow: <Insert cfm (L/s)>.

5. Static Pressure: <Insert inches wg (Pa)>.

6. Class: [I] [II] [III].


8. Drive Type: [Belt Drive] [Direct].

9. Fan Rpm: <Insert value>.

10. Outlet Velocity: <Insert fpm (m/s)>.


12. Motor Rpm: <Insert value>.

13. Electrical Characteristics:

   a. Volts: <Insert value>.

   b. Phase: <Insert value>.

   c. Hertz: <Insert value>.

   d. Minimum Circuit Ampacity: <Insert value>.

   e. Maximum Overcurrent Protection: <Insert value>.
14. Discharge Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

15. Inlet Sound Power:
   a. 1st Octave: <Insert dB.>
   b. 2nd Octave: <Insert dB.>
   c. 3rd Octave: <Insert dB.>
   d. 4th Octave: <Insert dB.>
   e. 5th Octave: <Insert dB.>
   f. 6th Octave: <Insert dB.>
   g. 7th Octave: <Insert dB.>
   h. 8th Octave: <Insert dB.>

16. Vibration Isolators: [Spring isolators] [Restrained spring isolators] <Insert type>
    having a static deflection of [1 inch (25 mm)] <Insert deflection>.

17. Spark Arrestance Class: [A] [B] [C].

2.1 DIRECT DRIVEN UPBLAST CENTRIFUGAL EXHAUST FANS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering
   products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product
   indicated on Drawings or a comparable product by one of the following:

   1. Greenheck
2. Loren Cook Company.

3. Penbarry

D. **Description:** Factory-fabricated, -assembled, -tested, and -finished, direct driven upblast fan consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

E. **Housings:** Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.

1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.

2. Housing shall have a rigid internal support structure.

3. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.

4. Windband to include an integral rolled bead for strength.

5. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.

6. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.

7. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

8. Breather tube shall be 10 square inches in size for fresh air motor cooling, and designed to allow wiring to be run through it.

F. **Shafts:** Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.

2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

G. **Disconnect Switches:** Outdoor rated NEMA enclosure.

H. **Accessories:**

1. **Companion Flanges:** Rolled flanges for duct connections of same material as housing.

2. **Clean Out Port:** Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.

3. **Birdscreen:** Constructed of galvanized steel.

4. **Inlet Screens:** Grid screen of same material as housing.


I. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.

J. Capacities And Characteristics:

1. Housing Material: Aluminum

2. Capacities: TX-1 975 CFM @ 0.6” ESP, GX-1 200 CFM @ 0.34” ESP

3. Electrical Characteristics:
   a. Volts: 120
   b. Phase: 1
   c. Hertz: 60

4. Vibration Isolators: Double studded true isolators. No metal to metal contact. Sized to match the weight of each fan

2.62.2 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Install on roof accommodating roof pitch and in accordance with structural, mechanical and architectural details.

B. Support floor-mounting units using spring isolators restrained spring isolators <Insert device> having a static deflection of 1 inch (25 mm) <Insert deflection>. Vibration- and
seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Support suspended units from structure using threaded steel rods and [elastomeric hangers] [spring hangers] [spring hangers with vertical limit stops]. <Insert device> having a static deflection of [1 inch (25 mm)] <Insert deflection> Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F.C. Install units with clearances for service and maintenance.

G.D. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.

5. Adjust belt tension.

6. Adjust damper linkages for proper damper operation.

7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

9. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 34 16
SECTION 23 52 16
CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, [pulse-combustion] [fire-tube] [water-tube] [water-jacketed] condensing boilers, trim, and accessories for generating [hot water] [steam].

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that boiler, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

H. Other Informational Submittals:
   1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."


E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
1.6  WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Pulse-Combustion Boilers: Water-Tube Condensing Boilers: 15 years from date of Substantial Completion.

   a. Heat Exchanger Damaged by Thermal Shock: [10] <Insert number> years from date of Substantial Completion.

   b. Heat Exchanger Corrosion: [Prorated] [Nonprorated] for [five] <Insert number> years from date of Substantial Completion.

2. Warranty Period for Fire-Tube Condensing Boilers:

   a. Leakage and Materials: [10] <Insert number> years from date of Substantial Completion.

   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: [Prorated] [Nonprorated] for [five] <Insert number> years from date of Substantial Completion.

3. Warranty Period for Water-Tube Condensing Boilers: [20] <Insert number> years from date of Substantial Completion.

4. Warranty Period for Water-Jacketed Condensing Boilers:

   a. Leakage and Materials: [Eight] <Insert number> years from date of Substantial Completion.

   b. Heat Exchanger Damaged by Thermal Stress and Corrosion: [Prorated] [Nonprorated] for [five] <Insert number> years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> Drawing or a comparable product by one of the following:

   1. Fulton Boiler Works, Inc.

3.1. Hydrotherm, Inc.; a division of Mestek, Inc.

4. <Insert manufacturer's name.>

5.2. AERCO International.

6.3. Heat Transfer Products, Inc.

7. <Insert manufacturer's name.>

8. Laars Heating Systems; a division of Waterpik Technologies, Inc.

9.4. Lochinvar Corporation.

10. <Insert manufacturer's name.>

5. Triangle Tube


12. <Insert manufacturer's name.>

2.2 MANUFACTURED UNITS

A. Description: Factory-fabricated, assembled, and tested, pulse-combustion fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls.

B. Heat Exchanger: [Type 316L, stainless-steel] [Carbon-steel] primary and secondary combustion chamber. Stainless Steel

C. Pressure Vessel: Carbon steel with welded heads and tube connections.

D. Exhaust Decoupler: Fiberglass composite material in a corrosion-resistant steel box.

E. Burner: [Natural] [Propane] gas, self-aspirating and self-venting after initial start.

F. Blower: Centrifugal fan to operate only during start of each burner sequence.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

   1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosure: NEMA 250, Type 1A.


4. Insulation: Minimum 2-inch (50-mm) thick, mineral-fiber insulation surrounding the heat exchanger.

5. Draft Hood: [Integral] [External].

6. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.

7. Mounting base to secure boiler to concrete base.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

J. Mufflers: Carbon-steel intake muffler and stainless-steel exhaust.

K. Condensate Trap: Cast-iron body with stainless-steel internal parts.

L. Characteristics and Capacities:
   1. Heating Medium: [Hot water] [Steam].
   2. Design Water Pressure Rating: [15 psig (104 kPa)] [150 psig (1035 kPa)] <Insert pressure rating>.
   3. Design Steam Pressure Rating: [60 psig (415 kPa)] [100 psig (690 kPa)] [160 psig (1100 kPa)] <Insert pressure rating>.
   4. Safety Relief Valve Setting: <Insert psig (kPa)>.
   5. Entering-Water Temperature: <Insert deg F (deg C)>.
   6. Leaving-Water Temperature: <Insert deg F (deg C)>.
   7. Design Water Flow Rate: <Insert gpm (L/s)>.
   8. Minimum Water Flow Rate: <Insert gpm (L/s)>.
   9. Design Pressure Drop: <Insert psig (kPa)>.
   10. Steam Operating Pressure: <Insert psig (kPa)>.
   11. Steam Flow Rate: <Insert lb/h (kg/s)>.
   12. Minimum Efficiency AFUE: <Insert value> percent.
15. AGA Input: <Insert MBh (kW).>  
16. Gas Input: <Insert cfh (mL/s).>  

17. AGA Output Capacity: <Insert MBh (kW).>  
18. DOE Output Capacity: <Insert MBh (kW).>  


20. Blower:  
   b. RPM: <Insert value.>  

21. Electrical Characteristics:  
   a. Volts: [115] [208] [230] [460] <Insert value> V.  
   b. Phase: [Single] [Three].  
   c. Hertz: [50] [60].  
   d. Full-Load Amperes: <Insert value.>  
   e. Minimum Circuit Ampacity: <Insert value.>  
   f. Maximum Overcurrent Protection: <Insert amperage.>

2.3 MANUFACTURED UNITS  
A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.  

B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.  

C. Pressure Vessel: Carbon steel with welded heads and tube connections.  

D.C. Burner: [Natural] [Propane] gas, forced draft.  

E.D. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.  
   1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."  
      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.  

F.E. Gas Train: Combination gas valve with manual shutoff and pressure regulator.  

G.F. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
H.G. Casing:

1. Jacket: [Sheet metal] [Plastic], with snap-in or interlocking closures.

2.1. Control Compartment Enclosures: NEMA 250, Type 1A.


4. Insulation: Minimum 2-inch (50-mm-) thick, [mineral-fiber] [polyurethane-foam] insulation surrounding the heat exchanger.

5.2. Combustion-Air Connections: Inlet and vent duct collars.

6.3. Mounting base to secure boiler.

   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

I.H. Characteristics and Capacities:


2. Design Water Pressure Rating: [160 psig (1100 kPa)] <Insert value>.

3.2. Safety Relief Valve Setting: <Insert psig (kPa)>30 psig

4.3. Entering-Water Temperature: <Insert 140 deg. F (deg. C)>.

5.4. Leaving-Water Temperature: <Insert 160 deg. F (deg. C)>.

6.5. Design Water Flow Rate: <Insert 14.2 gpm (L/s)>.

7.6. Minimum Water Flow Rate: <Insert 14.2 gpm (L/s)>.

8.7. Design Pressure Drop: <Insert 6 psig (kPa)>.


10. Minimum Thermal Efficiency: <Insert value> percent.


12. AGA Input: <Insert MBh (kW)>.

13.9. Gas Input: <Insert cfh (mL/s)>175 MBH

14. AGA Output Capacity: <Insert MBh (kW)>.

15.10. DOE Output Capacity: <Insert MBh (kW)>134 MBH

47. Blower:
   a. Motor Horsepower: \(<\text{Insert value.}>\)
   b. RPM: \(<\text{Insert value.}>\)

48.11. Electrical Characteristics:
   a. Volts: \([115\, 208\, 230\, 460\, <\text{Insert value.}>120\, \text{V.}}\)
   b. Phase: \([\text{Single}\, \text{Three}]\).
   c. Hertz: \([50\, 60]\).
   d. Full-Load Amperes: \(<\text{Insert value.}>\)
   e. Minimum Circuit Ampacity: \(<\text{Insert value.}>\)
   f. Maximum Overcurrent Protection: \(<\text{Insert amperage.}>15\, \text{Amperes}\)

2.4 MANUFACTURED UNITS

A. Description: Factory-fabricated, assembled, and tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.

C. Combustion Chamber: Stainless steel, sealed.

D. Burner: \([\text{Natural}\, \text{Propane}]\) gas, forced draft drawing from gas premixing valve.

E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.

1. Motors: Comply with requirements specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.

G. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.

H. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.

I. Casing:
   1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.


4. Insulation: Minimum 1-inch (25-mm) [2-inch (50-mm)] thick, mineral-fiber insulation surrounding the heat exchanger.


6. Mounting base to secure boiler.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment” when mounting base is anchored to building structure.

J. Characteristics and Capacities:


2. Design Water Pressure Rating: $160 \text{ psig (1100 kPa)}$ <Insert value>.

3. Safety Relief Valve Setting: <Insert psig (kPa)>.

4. Entering-Water Temperature: <Insert deg F (deg C)>.

5. Leaving-Water Temperature: <Insert deg F (deg C)>.

6. Design Water Flow Rate: <Insert gpm (L/s)>.

7. Minimum Water Flow Rate: <Insert gpm (L/s)>.

8. Design Pressure Drop: <Insert psig (kPa)>.


10. Minimum Thermal Efficiency: <Insert value> percent.


12. AGA Input: <Insert MBh (kW)>.

13. Gas Input: <Insert cfh (mL/s)>.

14. AGA Output Capacity: <Insert MBh (kW)>.

15. DOE Output Capacity: <Insert MBh (kW)>.

16. Blower:
   b. RPM: <Insert value>.
17. Electrical Characteristics:
   a. Volts: [115] [208] [230] [460] <Insert value> V.
   b. Phase: [Single] [Three].
   c. Hertz: [50] [60].
   d. Full-Load Amperes: <Insert value>.
   e. Minimum Circuit Ampacity: <Insert value>.
   f. Maximum Overcurrent Protection: <Insert amperage>.

2.5 MANUFACTURED UNITS

A. Description: Factory-fabricated, assembled, and tested, water-jacketed condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket, flue-gas vent, water supply, return, and condensate drain connections; and controls. Water heating service only.

B. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.

C. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.

D. Burner: [Natural] [Propane] gas, forced draft; swing-open front and burner observation port.

E. Blower: Centrifugal fan, forced draft. Include prepurge and postpurge of the combustion chamber.

   1. Motors: Comply with requirements specified in Division 23 Section “Common Motor Requirements for HVAC Equipment.”

      a. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

F. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include 100 percent safety shutoff with electronic flame supervision.

G. Ignition: Electric-spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

H. Casing:

   1. Jacket: Sheet metal, with snap-in or interlocking closures.

   2. Control Compartment Enclosures: NEMA 250, Type 1A.


   4. Insulation: Minimum 4-inch (100-mm-) thick, mineral-fiber insulation surrounding the heat exchanger.

6. Mounting base to secure boiler.
   a. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" when mounting base is anchored to building structure.

I. Characteristics and Capacities:


2. Design Water Pressure Rating: [30 psig (207 kPa)] <Insert value>.

3. Safety Relief Valve Setting: <Insert psig (kPa)>


5. Entering-Water Temperature: <Insert deg F (deg C)>

6. Leaving-Water Temperature: <Insert deg F (deg C)>

7. Design Water Flow Rate: <Insert gpm (L/s)>

8. Design Pressure Drop: <Insert psig (kPa)>


10. Minimum Thermal Efficiency: <Insert value> percent.


12. AGA Input: <Insert MBh (kW)>

13. Gas Input: <Insert cfh (mL/s)>

14. AGA Output Capacity: <Insert MBh (kW)>

15. DOE Output Capacity: <Insert MBh (kW)>

16. Equivalent Direct Radiation: <Insert EDR (W)>

17. Blower:
   a. Motor Horsepower: <Insert value>
   b. RPM: <Insert value>

18. Electrical Characteristics:
   a. Volts: [115] [208] [230] [460] <Insert value> V.
   b. Phase: [Single] [Three]
c. Hertz: [50] [60].

d. Full Load Amperes: <Insert value.>

e. Minimum Circuit Ampacity: <Insert value.>

f. Maximum Overcurrent Protection: <Insert amperage.>

2.62.3 TRIM

A. Include devices sized to comply with [ANSI B31.1, "Power Piping] [ANSI B31.9, "Building Services Piping]."

B.A. Aquastat Controllers: Operating[<firing rate.>] and high limit.

C.B. Safety Relief Valve: ASME rated.

D.C. Pressure and Temperature Gage: Minimum 3-1/2-inch (89-mm-) diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.


G.F. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.7 TRIM

A. Include devices sized to comply with [ANSI B31.1, "Power Piping] [ANSI B31.9, "Building Services Piping]."

B. Pressure Controllers: Operating[<firing rate.>] and high limit.

C. Safety Relief Valve:

1. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.

   a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

D. Pressure Gage: Minimum 3-1/2-inch (89-mm) diameter. Gage shall have normal operating pressure about 50 percent of full range.

E. Water Column: Minimum 12-inch (300-mm) glass gage with shutoff cocks.

F. Drain Valves: Minimum NPS 3/4 (DN 20) or nozzle size with hose-end connection.
G. Blowdown Valves: Factory-installed bottom and surface, slow-acting blowdown valves same size as boiler nozzle. [Slow down valves shall be combination of slow and quick acting as required by ANSI B31.1.]

H. Stop Valves: Boiler inlets and outlets, except safety relief valves or preheater inlet and outlet, shall be equipped with stop valve in an accessible location as near as practical to boiler nozzle and same size or larger than nozzle. Valves larger than NPS 2 (DN 50) shall have rising stem.

I.G. Stop-Check Valves: Factory-installed, stop-check valve and stop valve at boiler outlet with free-blow drain valve factory installed between the two valves and visible when operating stop-check valve.

2.82.4 CONTROLS

A. Refer to Division 23 Section "Instrumentation and Control for HVAC."

B. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.

4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.

5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.

6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At [40 deg F (minus 17 deg C)] < Insert temperature > outside-air temperature, set supply-water temperature at [160 deg F (93 deg C)] < Insert temperature >.

7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.

a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: [Manual] [Automatic] reset stops burner if operating conditions rise above maximum boiler design [temperature] or [pressure].
2. Low-Water Cutoff Switch: [Electronic] [Float and electronic] probe shall prevent burner operation on low water. Cutoff switch shall be [manual] [automatic] -reset type.


4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.

   1. Hardwired Points:

      a. Monitoring: On/off status, [common trouble alarm] [low water level alarm] <Insert monitoring>.

      b. Control: On/off operation, [hot water supply temperature set-point adjustment] [steam pressure adjustment] <Insert control>.

2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.92.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

   1. House in NEMA 250, Type [1] <Insert type 1> enclosure.

   2. Wiring shall be numbered and color-coded to match wiring diagram.

   3. Install factory wiring outside of an enclosure in a [metal] raceway.

   4. Field power interface shall be to [wire lugs] [fused disconnect switch] [nonfused disconnect switch] [circuit breaker].

   5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.

   6. Provide each motor with overcurrent protection.

2.102.6 VENTING KITS

A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

2.4.12.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

   1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Install boilers level on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

B. Vibration Isolation: Elastomeric [isolation pads] [mounts] with a minimum static deflection of [0.25 inch (6.35 mm)] [insert deflection]. Vibration isolation devices and installation requirements are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim.

E. Install electrical devices furnished with boiler but not specified to be factory mounted.

F. Install control wiring to field-mounted electrical devices.
3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to boiler to allow service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Division 23 Section "Common Work Results for HVAC,"

E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

H. Install piping from safety relief valves to nearest floor drain.

I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

J. Boiler Venting:

1. Install flue venting kit and combustion-air intake.

2. Connect full size to boiler connections. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."

K. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

L. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.

2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and [water temperature] [steam pressure]..$$
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within [12 months of date of Substantial Completion] $<\text{Insert time period}>$ provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [two] $<\text{Insert number}>$ visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests:
   1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
   2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
   3. Perform field performance tests to determine capacity and efficiency of boilers.
      a. Test for full capacity.
      b. Test for boiler efficiency at [low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20] $<\text{Insert range}>$ percent of full capacity. Determine efficiency at each test point.
   4. Repeat tests until results comply with requirements indicated.
   5. Provide analysis equipment required to determine performance.
   6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.

3.5 DEMONSTRATION

A. [Engage a factory-authorized service representative to train] $<\text{Train}>$ Owner's maintenance personnel to adjust, operate, and maintain boilers $<\text{Video training sessions}>$. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 52 16
VICTOR VALLEY COLLEGE

CABLING INFRASTRUCTURE STANDARDS

Guidelines for the Design of Telecommunication Infrastructure at VVC Facilities

June 19, 2012 (Rev. 2.0)
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<td>7.2 VVC Product Standards</td>
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<td>7.3 Outside Plant</td>
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<td>7.3.5 General Installation Guidelines for Copper Cables</td>
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<td>7.3.6 Copper Protection</td>
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<td>7.4.1 Fiber Optic Riser Cable</td>
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<td>7.4.2 Innerduct</td>
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<td>7.4.3 Copper Riser Cable</td>
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<td>7.4.4 Coaxial Riser Cable</td>
</tr>
<tr>
<td>7.5 Optical Fiber Terminations</td>
</tr>
<tr>
<td>7.5.1 Fiber Patch Panels</td>
</tr>
<tr>
<td>7.5.2 Optical Fiber Connectors</td>
</tr>
<tr>
<td>7.6 Copper Punch Down Blocks</td>
</tr>
<tr>
<td>7.7 Horizontal Station Cable</td>
</tr>
<tr>
<td>7.8 Voice/Data Jacks</td>
</tr>
<tr>
<td>7.9 Work Area Outlets</td>
</tr>
<tr>
<td>7.10 Outlet Distribution</td>
</tr>
<tr>
<td>7.11 Faceplates</td>
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<td>7.12 Copper Patch Panels</td>
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<td>7.13 Grounding And Bonding</td>
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<tr>
<td>7.14 Rack/Cabinet Layout (Elevation)</td>
</tr>
<tr>
<td>7.15 Floor Mounted Racks</td>
</tr>
<tr>
<td>7.16 Floor Mounted Cabinets</td>
</tr>
<tr>
<td>7.17 Cable Wire Management</td>
</tr>
<tr>
<td>7.18 Cable Runway</td>
</tr>
<tr>
<td>7.19 Cable Pathways</td>
</tr>
<tr>
<td>7.20 Cable Installation Methods</td>
</tr>
</tbody>
</table>
1 Executive Summary

The Information Technology (IT) Department at the Victor Valley College is responsible for the communication and network infrastructure at all sites within the VVC. Any information that is moved from one point on the campus to another by TCP/IP protocols, cabled or wireless networks, uses infrastructure that is operated and controlled by these areas.

This document is intended to provide the Architect, Electrical Engineer, HVAC Consultant, Civil Consultant and Telecommunication Consultant with the basic requirements and standards for network cabling infrastructure in a new or remodeled facility at any VVC building or site. It is the expectation of VVC that the information provided in this Standard shall be incorporated into the Schematic, Design Development and Construction Documents for each project. VVC expects any design process to be an iterative process, where the design team will engage the local Information Technology in review and discussions during the many steps of the design process. All deviations from this standard must be approved by VVC IT.

The objective is to design using standards and materials that will provide the greatest longevity and function for current and future application areas. Standardization of components, installation methods and labeling will ensure that all cabling installation projects have a consistent functionality, and operational appearance. This will allow VVC staff to effectively understand, operate and support the cabling infrastructure and network services traversing that infrastructure.
2 Introduction

2.1 Responsibilities of VVC IT Department

VVC IT department is responsible for provisioning and operating a robust Information Technology Infrastructure. It is expected that the infrastructure will support the connectivity needs of voice, data, video, and multimedia communication, and capacity available for current and future applications such as Intelligent Building System (BMS), Security, Surveillance, Fire Alarm, etc. VVC IT owns the responsibility for the transport of all TCP/IP based traffic on the VVC campuses/sites, both internally and externally.

VVC IT staff or IT designated representative will actively participate in the design process. This includes attending architectural and engineering meetings that in any way will effect the provisioning of any and all information or communication systems during the course of the project.

VVC IT retains the right to review and approve all construction documents pertaining to, or affecting Information Technology Infrastructure. VVC IT also retains the right to be the final reviewer and approval authority for all construction submittals and project acceptance of Information Technology Infrastructure systems. This includes pathways, cabling, the quality of workmanship and acceptance testing of any or all cable plant installed, and any other aspect of the construction/renovation project that could affect the Information Technology Infrastructure. It is the expectation of VVC IT that the information provided in this document shall be used for the basis of the design of the cabling infrastructure and included in the drawings and specifications for the project.

2.2 Architect Responsibilities

When a new building or building renovation is planned, the Architect will ensure that VVC IT or its designated representative is involved in the entire design process, including review of all drawings during the design phases, as allowed by the design/construction process and as follows:

<table>
<thead>
<tr>
<th>Design Phase</th>
<th>Telecommunication Infrastructure Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schematic Design — These are the initial planning documents and design drawings which assist departments in the early stage of the project.</td>
<td>Building Dimensions as related to placement of Telecommunication Rooms, cabling distances and riser pathways. Schematic design submittal.</td>
</tr>
<tr>
<td>Design Development — As the architectural design process progresses, overlays are developed to show the various structures and systems planned for the building.</td>
<td>Outlet placement per room requirements, horizontal cable pathways. 30% and 50% submittal.</td>
</tr>
<tr>
<td>Construction Documents — These documents</td>
<td>Detailed drawings of all outlets, pathways,</td>
</tr>
</tbody>
</table>
### Design Phase

Depict the final design before bid submittal is undertaken.

### Telecommunication Infrastructure Considerations

Telecommunication Room designs, cabling terminations, workmanship & testing. 90% Submittal

**Working Copy**— This is the Bid Copy.

100% Submittal

**“Record Document” Drawings** – These drawings and documents represent the project as it is finally constructed (“as-built”) and are deliverable prior to final inspection of the project.

Actual cabling as constructed, drawings with cable numbers/labels, test results. Close out documents.

### 2.3 Scope of Work Matrix to be Included in VVC Projects

For each project, a Scope of Work Matrix is to be created by the construction manager and updated by VVC IT. It identifies the five areas of telecommunication construction for each project: Telephone, Computer Network, Broadband Television, Security Surveillance, and Security Access systems. It defines specific tasks that must be completed and who is responsible for each task – the VVC or the Contractor. This document is an example, and should be modified based on the project type, scope, and requirements of the specific project.

<table>
<thead>
<tr>
<th>Item / or Material</th>
<th>VVC Purchased</th>
<th>VVC Installed</th>
<th>Contractor Purchased</th>
<th>Contractor Installed</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>**Telephone System (select one: VoIP</td>
<td>Standard)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site conduits and boxes (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>1</td>
</tr>
<tr>
<td>Interior raceways and boxes (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Copper cables (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Termination boxes and terminals (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Modular jacks and plates (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cable testing and reports (If VoIP, coordinate with site)</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Telephones</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telephone cords</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Account setup, voicemails, etc</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog Technology</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final cross connection to Avaya switch if required</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final As-built drawings and documentation</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| <strong>Computer Network Wiring</strong> | | | | | |
| Site conduits and boxes | X | X | | | |
| Interior raceways, cable trays and boxes | X | X | | | |</p>
<table>
<thead>
<tr>
<th>Component</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fiber optic cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDF/IDF racks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper cables</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fiber TDU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiber patch panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat 5-e patch panel</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Jacks and plates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BDF/IDF (racks, backboards, air c., wiring...) Per specs.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cable testing and reports (both copper &amp; fiber)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patch cords</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active electronics including Cisco switches</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Programming, network implementation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Final As-built drawings and documentation</td>
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<td></td>
</tr>
</tbody>
</table>

**Broadband Television System**

<table>
<thead>
<tr>
<th>Component</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site conduits and boxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior raceways, cable trays and boxes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Single mode fiber optic cables</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Coax cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splitters, directional couplers at new building</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Line extender amplifier at new building</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fiber optic transceivers, terminations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection to head-end</td>
<td>X</td>
<td>5</td>
</tr>
<tr>
<td>Testing and reports</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Final As-built drawings and documentation</td>
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</tbody>
</table>

**CCTV Surveillance System**

<table>
<thead>
<tr>
<th>Component</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site conduits and boxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior raceways, cable trays and boxes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fiber optic cables from new building to MDF</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Coax, power and control cables for new building</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Power testing and reports</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cable testing and reports (both copper &amp; fiber)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Camera low voltage power supplies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head-end recorders, switchers, monitors &amp; controls</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cameras</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Camera brackets</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Final As-built drawings and documentation</td>
<td></td>
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</tr>
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</table>

**Security & Access**

<table>
<thead>
<tr>
<th>Component</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Site conduits and boxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior raceways, cable trays and boxes</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fiber optic cables</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>New building interior wiring (Cat 6, AWG) per specs.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Schedule interior building wiring</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Cable testing and reports (both copper &amp; fiber)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Head-end equipment and software at MDF/BDF as needed.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Electric door hardware</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**Notes:**
- X indicates included.
- XX indicates included and verified.
- The numbers 2, 3, 5, and 6 indicate specific requirements or sections.
<table>
<thead>
<tr>
<th>Component</th>
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</thead>
<tbody>
<tr>
<td>Card Reader</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Door switches</td>
<td>X</td>
<td>X</td>
<td>3,4</td>
</tr>
<tr>
<td>BDF/IDF electronic control enclosures/logic boards</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Connection to head-end, programming, implementation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Final As-built drawings and documentation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**TYPICAL NOTES:**

**Note 1:** The location will determine the telephone type for the project (Voice over IP or Standard PBX). The Architects/Engineers are to design the system to meet the specifications/requirements as defined in the VVC Telecommunication Infrastructure Technical Standards for that type. VoIP telephones will use the Computer Network Wiring so will not require separate horizontal telephone cables and outlets.

**Note:** The VVC Campus and Sites is on VoIP (Voice over IP) for its phone system. The Architects/Engineers are to design the system to meet those specifications/requirements as defined in the VVC Telecommunication Infrastructure Technical Standards for that type. VoIP telephones will use the Computer Network Wiring so will not require separate horizontal telephone cables and outlets. All jacks should be red and labeled appropriately. All cables blue and labeled appropriately.

**Note 2:** Initially key operated until head-end connectivity is completed.

**Note 3:** Will not be operational until head-end is connected.

**Note 4:** Hardware type/location and install to be coordinated with campus/security vendor. The contractor installs, but the contractor MUST work with the campus/security vendor PRIOR to installation in order to provide input to make sure that the final product will work as expected.

**Note 5:** The video contractor must work together with VVC IT staff member(s) in establishing any and all connections to the existing campus backbone cable systems. A VVC representative must be present when the contractor makes the connection to the head-end.

**Note 6:** These items must be coordinated with the Security Contractor by the campus.

The Architect is the focal point for coordinating the various engineering consultants during the design process. In order to provide an effective architectural design, the Architect needs to understand what the specific requirements are to support current and future telecommunication connectivity and services. Much can be gained in the design process if the Architect engages
VVC IT in design meetings and coordination sessions beginning at the programming phase. VVC IT department is eager to assist in providing a detailed list of requirements that will aid in programming the required connectivity and communication spaces.

It is the expectation of VVC IT that the Architect will supply background drawings to the various members of the design team. It is very important for the proper design of the Information Technology Infrastructure that the drawings for the Electrical and Telecommunication Consultants contain furniture information. This will be needed by both Electrical and Telecommunication Design team members to correctly locate power and communication outlets.

The Architect will ensure that where other Design Engineers or Consultants need a separate wiring infrastructure to support their systems, that those consultants coordinate their design and infrastructure requirements with the VVC IT staff. This includes, but not limited to design items such as cable type, cable color, use of supplemental or common pathways and support systems. For any Design Engineers or Consultants that need any communication connection of any sort from the building to any other place on or off the Campus, the Architect will ensure that these Engineers/Consultants request and coordinate with VVC IT for this connectivity. No system that is included in the building will be allowed to install any inter-building cable(s) in separate pathway or to use the pathway under VVC IT control without prior approval.

VVC IT expects the Architect to provide coordination with the Design Engineers or Consultants for the support of any required Video and Audio Visual systems. Of particular concern is that the installations of the Video and AV systems do not conflict with installation or potential installation of Information Technology Infrastructure. This document does not include a standard for AV cabling, and only references AV installations as they may interfere with, or affect the voice/data infrastructure.

All video systems shall be designed with the participation of the VVC IT staff or designated representative.

As full participants in the design process, comments and requests submitted by VVC IT must be incorporated into the reviewed documents in full for the next review of documents, or an explanation must be provided to IT, regarding the status of comments and requests. VVC IT will postpone further reviews until all comments and requests have been addressed or incorporated into current documents and drawings.

### 2.4 TELECOMMUNICATION CONSULTANT/DESIGNER ROLE

VVC IT, at its option, may contract with a Telecommunication Consultant, to do its own communication design or may request the Architect to retain the services of a Telecommunication Consultant. Regardless of the approach taken by VVC IT, the Architect is expected to ensure that communication design input from a Telecommunications Consultant that is familiar with and qualified to advise, design, or install to the VVC standards is part of each phase of the design process. The Architect is expected to incorporate comments, communication
drawings and or specifications from VVC IT or the Telecommunication Consultant into the various document packages.

2.5 TELECOMMUNICATION DESIGN APPROACH

In designing a telecommunications system for a building that will not be brought on line for a significant amount of time, the safest approach calls for a forward-looking view into the cabling and pathway requirements. Typically, the telecommunications system design can be divided into the following three parts:

2.5.1 Rooms, Routes & Risers

The planning for Rooms, Routes and Risers are critical to the successful design of any Information Technology system. Appropriately sized equipment rooms and cabling pathways must be provided in the building. Sufficient capacity must be provided not only to house the current IT Systems, but also to allow for additional cabling and equipment to be installed or replaced in the future. Site location of each room is critical to ensure that each room is supported by appropriate environmental systems. Based on experience in telecommunications system design and National Standards, it is possible to estimate equipment room locations and sizes at an early stage in the project. This input will allow the design of the building to progress, while ensuring that it will be capable of supporting the wide range of communications systems and technologies currently required to conduct business of the College.

Adequate cable pathways are critical for ensuring that current and future cabling needs can be supported. Care must be taken to integrate cable pathways (rises, cable trays and conduits) into the building fabric. Based on the EIA/TIA 569B Commercial Building Standard for Telecommunications Pathways and Spaces, these design guidelines ensure basic telecommunication design requirements are provided to the building design team as early as possible for the programming and schematic phases.

2.5.2 Common Cabling Infrastructure

The selection of the communications cabling system and media is specified towards the end of the design phase to ensure the incorporation of the most recent product changes. Based on the EIA/TIA 568B Commercial Building Telecommunications Cabling Standard, VVC has selected a wiring standard based on the most current cabling standards: Systimax - Category 6 unshielded twisted pair copper for voice and data station cabling, and laser-optimized multimode and single mode fiber for backbone interconnection. Support of the distribution of this cabling is made possible by ensuring the cabling pathways are designed to support the required quantity and type of cabling (including additional future expansion). The cabling pathways must also be compatible with the stringent installation requirements, such as those required for optical fiber cables.

2.5.3 Equipment & Systems – Logical Design
The design and procurement of the Information Technology equipment will always be performed outside of the construction phase. This includes network switches and routers, desktop systems, telephones and other equipment. Although costs for this equipment may be funded as part of the overall project budget, the equipment and associated installation costs may be procured separately and NOT be included in any specification or bid package particular to a specific building construction project. This would be determined based on the type of construction project and funding sources. Architect and Engineering teams are required to take into account space, power and cooling requirements particular to the equipment that will be housed in the communications rooms.
3 Architectural

When an architect is designing a building, many technology infrastructure issues must be addressed. The following information is provided to the architect so he/she will understand what is needed and how it should be incorporated in the final design.

3.1 Campus Information Technology Rooms, Functions

Information Technology Rooms are special-purpose rooms that provide an operating environment for telecommunications and/or computer equipment. At one time, these spaces were an after-thought to the design process; this can no longer be the case. Each type of the technology has specific functions and it may have its own individual room within a facility. However, depending on the building size and design, one or more of these functions may be combined into one room.

3.1.1 Main Distribution Frame (MDF)

The Main Distribution Frame (MDF) is the central connection point between the Campus and the Local Exchange Carrier (LEC), Competitive Local Exchange Carriers (CLEC) or Internet Service Provider (ITP). This room or space is considered by the carriers as the Minimum Point of Entry (MPOE) and demarcation point for communication services delivered to the Campus from external service providers. The Main Distribution Frame (MDF) may also be referred to as Network Operations Center (NOC).

The MDF contains network interface devices, protectors and telecommunications data networking and computer equipment. Voice and voicemail systems may also be housed in the Main Telecommunications Room. At some point the MDF may become a stand alone building that may include the data center and is sized according to equipment and number of cable terminations required.

Communication services are extended from the Main Telecommunications Room location to campus facilities by Customer-Owned Outside Plant (CO-OSP) backbone cabling. An outside plant pathway infrastructure system is provided to all campus buildings. Underground (the use of conduits, maintenance holes and or hand holes) provides out-of-sight service to a building. Buried entrances (trenched or plowed) are a means of providing out-of-sight service without conduit. The underground conduit method is the required method to service buildings on the VVC sites. Direct-buried methods are not acceptable. The number of conduits to be installed will depend on the building size, function and telecommunications services to be provided to the building.

A detailed layout for Main Distribution Frame (Room) is required as a part of the overall design/project prints and is to include all systems proposed to be housed within it. Plan and elevation views of the Main Distribution Frame (Room) are required as part of the detailed layout.
3.1.2 Building Telecommunications Room

The Building Telecommunications room is a special-purpose room that provides an operating environment for communications and/or network equipment at the main point of campus backbone connectivity to each building. It is generally considered a building-serving facility. The Building Telecommunications room may also be referred to as a Building Distribution Facility (BDF).

The Building Telecommunications Rooms are laid out and built according to stringent requirements because of the nature, cost, size and complexity of the equipment involved. These rooms typically house:

- Racks or cabinets for equipment and cable ladder system to support cable and connections to various pieces of equipment with supporting grounding infrastructure and electrical outlets.
- LAN equipment, such as routers, switches or fiber optic interface equipment for within-building or campus communications.
- Security systems, if separate security command center is not available or is distance limited
- Wireless paging, and Distributed Antenna Systems as required
- Voice cross-connects.
- Cable TV (CATV), CCTV cabling and equipment.
- UPS system. Access to backup generator power may be needed.
- Independent cooling system.

Given the rapid development of new products in the Information Technology area, the Building Telecommunications Rooms must be designed to accommodate both current requirements and any number of generations of future systems and equipment.

The Building Telecommunications Room houses the conversion of Outside Plant cable to inside rated cable, provides Building Entrance Protectors for all copper cables and bonding point for all metallic cables or cable components. An outside plant pathway infrastructure system (conduit field) shall be provided to the nearest campus connection point (maintenance hole).

The Building Telecommunications Rooms shall house only equipment directly related to the Information Technology systems and its environmental support systems. Typically, other Fire/Life/Safety systems such as access control, security, building management systems, etc., are housed in the same room. A detailed layout for all Building Telecommunication rooms is required as a part of the overall design/project prints and is to include all systems proposed to be housed within each room. Plan and elevation views of each Building Telecommunications room are required as part of the detailed layout.

3.1.3 Telecommunications Rooms (TR)

The Telecommunications Room or Intermediate Distribution Facility (IDF) is located on each floor or building quadrant, and houses telecommunications equipment, cable terminations, and cross-connect wiring. TRs differ from Building Telecommunications (BDF) rooms in that they
are generally considered floor-serving (as opposed to building-serving) facilities that provide a connection point between backbone and horizontal distribution pathways. TRs provide a safe, environmentally-suitable area for installing:

- Cabling.
- Termination fields.
- Premises electronic equipment.
- Related support structures

The number and locations of the TR depends on the:

- Size of the building. Typically one TR is required for every 10,000 square feet of usable floor space.
- Number of floors. One TR is required for each floor.
- The shape of the building and its impact on the length of communication cables. Depending on the dimensions and cabling distances required in a particular building, a floor may house multiple TRs, each serving a quadrant of the building. This is based on a maximum cable length of 90 meters from wall outlet to TR termination point.

A detailed layout for all Telecommunication rooms is required as a part of the overall design/project prints and is to include all systems proposed to be housed within each room. Plan and elevation views of each Telecommunications room are required as part of the detailed layout.

3.1.4 Non-Information Technology Systems

The Architect is reminded to expand the telecom room dimensions for such non-information technology systems such as AV equipment, BMS systems, fire alarm panels, public address systems, and security equipment. Careful consideration is to be taken in the placement of these auxiliary systems so as to NOT impede or hinder access and maintenance to any or all systems and prohibit code violations. ADA compliance should also be a consideration in room layout.

3.2 CAMPUS INFORMATION TECHNOLOGY ROOMS, SITE LOCATION

3.2.1 General

There are a number of factors that need to be considered when placing Information Technology Rooms within a new or renovated facility. Site selection factors for the various rooms are addressed below. Of these factors the two most important are “stacking” of the rooms and providing a way the rooms can be expanded, if required in the future.

- The Information Technology Rooms must not be located in any place that may be subject to water or steam infiltration, humidity from nearby water or steam, heat, and any other corrosive atmospheric or environmental conditions.
The Information Technology Rooms must not be located near electrical power supply transformers, elevator or pump motors, generators, x-ray equipment, radio transmitters, radar transmitters, induction heating devices, and other potential sources of electromagnetic interference (EMI).

The Information Technology Rooms must not share space in electrical closets, boiler rooms, washrooms, janitorial closets, and storage rooms, nor hatches that lead to other spaces.

The Information Technology Rooms must not be situated in a building in such a way that the walls of the Information Technology Room are not on the building structural support systems. Such placement interferes with the installation of the cable riser backbone system.

The Information Technology Rooms must not be located near sources of mechanical vibration that could be conveyed to the room and the sensitive network equipment via the building structure.

The Information Technology Rooms must not be located below water level unless preventive measures against water infiltration are employed. The room shall be free of water or drain pipes not directly required in support of the equipment within the room. A floor drain shall be provided within the room if risks of water ingress exist.

Information Technology Rooms must be vertically aligned in multistory buildings.

Acoustic noise levels in the Information Technology Rooms must be maintained at a minimum level by locating noise-generating equipment outside the Information Technology Rooms. Likewise the walls of the Information Technology Rooms must be of sufficient construction to insulate adjacent offices from noise made by the network equipment.

3.2.2 Building Telecommunications Room

In addition to the general requirements for Information Technology Rooms, the Building Telecommunications Room shall:

- Avoid locations that limit expansion such as structural steel, stairwells, and elevator shafts, outside walls or other fixed building walls.
- Have easy access to distribution cable pathways.
- Be easily accessible for the delivery of large equipment.
- Minimize the size and length of the backbone and horizontal distribution cables.
Access must be directly from hallways, not through offices, classrooms or utility spaces with door openings into the hallways and not the room.

Located so Outside Plant rated building entrance cables will not be exposed for a cable length distance of more than 50 feet from the point of building entrance per the California Electrical Code, Articles 770-50 and 800-50.2. If this is not possible, the entrance cable must be routed to the termination field without breaks using rigid or intermediate rigid conduits within the requirements of a pull box every cumulative 180 degrees of bend and a maximum of 50 feet of cable length from the first pull box; EMT cannot be used inside in lieu of rigid or intermediate conduit. Indoor/Outdoor dual rated cables may be substituted with VVC IT approval.

3.2.3 Telecommunications Rooms (TR)

In addition to the general requirements for Information Technology Rooms, the Telecommunications Rooms shall be:

- Dedicated to the Information Technology function and related support facilities. No other systems can be housed within the TR without the written approval of VVC IT.

- A single function room and not be shared with electrical installations or other equipment or building services other than those required in direct support of Technology equipment or services.

- Located as close as practical to the center of the area served and preferably in the core area. However, the location shall be such that the room can be expanded in the future.

- "Stacked" in multistory a building, that is, constructed so each TR is placed above the TR on the floor below.

- Directly accessible from hallways, not through offices, classroom or mechanical spaces.

- Located such that the average horizontal cable run is 150-feet or less and that no individual cable run exceeds 90 meters.

3.3 INFORMATION TECHNOLOGY ROOM SIZING

3.3.1 General

The sizes of Information Technology Rooms are minimum requirements. However, additional space may be required depending on the requirements, the proposed auxiliary systems sharing the space, and/or the services performed by the occupants.
3.3.2 Building Telecommunications Room

During the early phase of the building design, it will be best to assume the Building Telecommunications Room basic size will be 12 feet long X 10 feet wide X 10 feet high, interior dimension.

The Building Telecommunication Room will house building entrance frames with electrical protectors, service racks or cabinets. For early planning purposes assume at least three racks or cabinets will be required in any size building. Racks/cabinets require a three-foot clearance on all sides. Certain apparatus will be wall-mounted and will project a 12”-24” from the wall.

In larger size buildings, additional rows of equipment racks or cabinets may be required. If the new building is more than five stories, VVC IT will provide specific direction on the size of the Building Telecommunications Room.

3.3.3 Telecommunications Rooms (TR)

There shall be a minimum of one TR per floor. Additional TR, one for each area up to 10,000 sq. ft. should be provided when:

- The floor area to be served exceeds 10,000 sq. ft
- The horizontal distribution distance to the workstation exceeds 90 meters.

For planning purposes, the basic size of each TR shall be a minimum of 8-feet wide by 8-feet long by 10-feet high, interior dimension. In small buildings, the Building Telecommunications Room and the TR functions may be combined into one joint space.

3.4 LIGHTING

It is important that proper work lighting be provide in all Information Technology Rooms. Lighting shall:

- Have a minimum of 50 foot candles measured 3’ above the finished floor in the middle of all aisles between racks or cabinets.
- Be controlled by one or more switches located near the entrance door(s) to the Information Technology Rooms.
- Not be powered from the same electrical distribution panel as the telecommunications or network equipment in the Information Technology Rooms.
- Not be connected to any timing devices. Dimmer switches shall not be used in the Information Technology Rooms.
Emergency lighting and signs should be properly placed in the Information Technology Rooms where absence of light would hamper an emergency exit.

- Be located a minimum of 8'6" above finished floor.

- Be placed so the axis of the fixture is $90^\circ$ to the rack or cabinets layouts. If the Information Technology Room is to have a Main Cross-Connect field mounted on a wall then wall mounted fixtures will be required to provide light while a technician is working at the field so he/she will not be working in a shadow.

3.5 WATER INFILTRATION

As stated earlier, Information Technology Rooms shall not be located below water level. The Information Technology Rooms shall be free of water or drain pipes not directly required in support of the equipment within the Telecommunication Rooms.

3.6 FLOOR

3.6.1 General Floor Design Elements

The floors of all Information Technology Rooms shall be covered with an Asphalt tile, or like type tile. The flooring material shall have anti-static properties.

The only exception shall be if an access raised floor system is installed. If a raised floor system is used then, the space will have to comply with the requirements of Article 645 Information Technology Equipment of the California Electrical Code and NFPA 75 Standard for the Protection of Electronic Computer/Data Processing Equipment.

3.6.2 Loading

Floor loading capacity in the Information Technology Rooms shall be sufficient to bear both the distributed and concentrated load of the installed equipment. The distributed loading shall be at least 250-lbs/sq. ft. and the concentrated loading shall be at least 1,000 lbs over the area of greatest stress. Architects and Engineers must refer to and use the most current BICSI guidelines.

3.7 SPRINKLERS/FIRE SUPPRESSION

3.7.1 Sprinklers

If a fire sprinkler system is required within the Information Technology Rooms, then the following details shall be applied to the design.

- The heads shall be provided with wire cages to prevent accidental damage or operation.
• If possible, the sprinkler system in the Information Technology Rooms should be a pre-action system within the Information Technology Rooms.

3.7.2 Fire Suppression Systems

Halon substitute systems such as FM200 or equal are highly recommended in lieu of sprinkler systems. If a Fire Suppression system is being considered, then abort and reset switches will be placed near each other, near an exit and have protective covers to prevent accidental activation.

Portable fire extinguishers shall be available in the Information Technology Rooms.

If an access raised-floor system is to be installed in any Information Technology Room and a fire detection system is required under the floor, the system shall be a cross-zone detection system. In addition, placement of the detector may affect the way cables are routed under a raised floor. If ionization detectors are installed, there is a potential problem with the accumulation of dust under the floor. It is possible during the performance of cable work under the floor that dust could set off the detectors. Provision shall be made in the fire detection system design to reduce the possibly of false alarms and activation of a fire suppression system, such as but not limited to temporarily disarming the system.

3.8 DOORS

All single doors to any Information Technology Rooms shall be a minimum of 3’ 6” wide and 80” high, without doorsill, and be fitted with a lock. Space permitting, doors will swing completely open towards the corridor to avoid restricting usable space in the room; exceptions shall be noted in the building plans.

If it is anticipated that large equipment will be delivered to the Information Technology Rooms, a double door 72" wide by 90" high, without doorsill and center post is required. The door shall have a gasket to prevent dust from entering the room.

No windows will be allowed or installed in any door accessing a VVC data center or communications room.

3.9 INTERIOR FINISHES

The floor, wall, and ceiling shall be sealed to reduce dust. Finishes shall be light in color to enhance room lighting.

3.9.1 Walls

All walls shall have backing to support the plywood Telecommunication Backboard and wall mounted equipment. The walls shall be capable of support up to 200 lbs per linear foot of wall space.
Walls (U.O.N.) will be covered with rigidly fixed with 3/4" void free, fire-rated A-C plywood. The visible side of the plywood shall be painted with two coats of white (or other light-colored) paint. At least one (1) Fire-Rated stamp must be visible per sheet or partial sheet of plywood when painting is completed. Plywood shall be installed from flush to the ceiling line, usually +2-feet to +10-feet AFF, but dependent on the ceiling height.

3.9.2 Ceilings

A drop ceiling shall not be installed.

3.9.3 Clearance

The minimum clearance height in the room shall be 10 feet without obstructions.

Provide the following clearances for equipment and cross-connect fields in the Information Technology Rooms:

- Allow a minimum of 3 feet of clear working space in front of equipment and cross-connect fields.
- Allow for 12-inch depth off wall for wall-mounted equipment.
- Provide aisles at least 36-inches wide.
- In corners, a minimum side clearance of 12-inches is recommended.

In many cases, equipment and connecting hardware may extend beyond racks and backboards. It is important to note that the clearance is measured from the outermost surface of these devices, rather than from the mounting surface of the rack or backboard. As a minimum for relay racks, the clearance shall be measured beginning at the base of the foot flange. For self-standing equipment cabinets, the clearance shall be measured from the outer doors of the cabinets. Note: Equipment cabinets can be 30” to 36” deep, depending on the purpose.

3.9.4 Security

The doors to Information Technology Rooms shall have individual locks and may at the direction of VVC IT be controlled by a “card key” access control system. The locks must be commonly keyed to match other existing Information Technology Rooms on the campuses/sites.

3.10 INFORMATION TECHNOLOGY ROOMS CONSTRUCTION SEQUENCE

Before the installation of any cables or telecommunication equipment all Information Technology Rooms must be completed. In most cases, this means that Information Technology Rooms will have a construction priority and may have to be constructed out of normal building
sequence. At a minimum completed means all electrical, interior finishes, lighting, air conditioning and lockable doors have been provided.

### 3.11 SPECIAL DESIGN CONSIDERATIONS

#### 3.11.1 Building Fire Rated Barriers

Information Technology rooms shall be constructed with fire-rated walls and ceilings. All penetrations shall be fire-stopped to retain the “F” and “T” rating of the room.

#### 3.11.2 Cable Support (General)

The main routing and support systems for communication cables to use are:

- A cable tray system
- J-Hooks
- Conduit home runs

In main corridors and cable paths, the use of a Cable tray system is the preferred method. At least 12” of clearance is needed above the cable tray and the cable tray must have a minimum clearance of 12”-18” on at least one side.

For distribution from the main cable path to discrete outlet locations, J-hook suspension is acceptable. J-Hooks shall be made part of work of the cable installation contractor. The use of tray or J-hooks will require close MEP coordination in the design or installation of the MEP systems.

The use of conduit home runs from the work area outlets to the Telecommunications rooms is the least preferred method of providing cable support.

#### 3.11.3 Slab on Grade

If a slab on grade approach is taken for the first floor of new construction, special attention must be given to potential communication outlets that may be installed in the floor. If possible, the use of communication outlets in the floors shall be avoided. When this is not possible, VVC IT shall be contacted to determine alternatives.

Outlets in the floor must be installed to meet the following minimum requirements:

- At no time shall the conduit run below the membrane barrier or be in the soil.
- Supporting conduits shall run in the slab and shall be PVC schedule 40 or better.
- Supporting conduits shall be sized for 20% fill to allow for additional cabling.
- Conduits feeding floor-boxes will be dedicated runs and not chain through multiple floor-boxes. Conduits will stub up to the closest wall.
- Floor-boxes will be of solid construction to support the anticipated weight and travel.
- Floor-boxes will have lids that can be screwed down to hinder unauthorized access.
• Floor-boxes shall be coordinated with furniture design locations.
• Floor-boxes may support a combination of data and electrical outlets. If so, the design of the floor-box must be such that all data and electrical ports can be connected with cables without causing any obstructions that would limit the use of any jacks/plugs.

3.12 Work Area Telecommunication Outlet

3.12.1 General

Telecommunications Outlets are provisioned with double-gang backbones and faceplates. Each Telecommunications outlet will have a 1 1/4-inch conduit that extends from the back box to the accessible ceiling space.

Telecommunications outlet locations shall be coordinated with the furniture layout. In offices and conference rooms, the typical outlet placement is +18” above the finished floor (AFF) and within three feet of a general-purpose, single-gang electrical outlet. This may be altered based on the proposed furniture designs. Desks that have modesty panels placed against the wall will obstruct access to the electrical and telecommunications outlets. As such, outlets should be located to the right or left of the desk location or at +6” above the desk surface.

In rooms with built-in counters, work surfaces and cupboards, the outlets shall be placed at +6” above counter/surface height, coordinating with the placement of the electrical outlets.

In office spaces with built-in work surfaces, computers can be tower or floor-standing. The telecommunications and electrical outlets may still be located at +18” A.F.F., so as to preserve a clean wall surface. However, this will require the Architect to arrange for the drilling of routing holes in the work surface, installed with grommets, to facilitate the clean routing of patch cords and electrical cables. The grommet will be:

• a minimum of two inches in diameter
• made of plastic or rubber
• oval or circular in shape
• fitted to the hole drilled in the work surface
• with a replaceable cover that can hold the cabling snug after routing

Outlets will not be placed such that they are located inside of cupboards and cabinets unless this specific purpose is desired (such as for a concealed fax machine, printer, TV or computer).

3.12.2 Single-Person Office

A minimum of two telecommunications outlets shall be installed per single-person office and on opposing or adjacent walls. Since outlets should be located to maximize the flexibility of furniture placement, outlet placement should be coordinated with all furniture plans. In fixed configuration offices or if built-in furniture is to be constructed, it is preferred that the electrical and data outlets be located at +6” above the height of the desk surface or +36” A.F.F. If the office is large enough to support a visitor/conference table, an additional telecommunications
outlet shall be installed, normally at +18” A.F.F. Electrical outlets shall be placed consistent with the data outlet height.

3.12.3 Conference Rooms

Conference Rooms will require one communication outlet for every 10-feet of wall space on three sides of the room. The wall that is considered to be the “front” of the room shall have one communication outlet where the “whiteboard” is located. In addition provisions shall be made to have a power and communication outlet flush mounted to the ceiling for possible use of a projector or wireless access point. Electrical outlets shall be placed consistent with the data outlet height.

3.12.4 Instructional Classrooms

Instructional Classrooms that have a specific teaching wall orientation will be provided with a communication outlet every 10 feet on each of the three non-teaching walls. On the teaching wall, a communication outlet shall be located under or in close proximity to the classic or electronic whiteboard. If an instructor’s podium is provided, an outlet will be required. Communication outlets shall be provided flush to the ceiling to support wireless access points and video projectors. AV systems for classrooms shall be installed in a three gang box with a 1.25” conduit. The number and type of network cables included in each outlet will be defined by the instructional technology department for each standard and smart classroom. Electrical outlets shall be placed consistent with the data outlet height.

At the main entrance to the classroom, a communication outlet for a wall mounted telephone will be provided. This outlet shall be positioned such that it does not interfere with light switches or access to the door. The mounting height shall be +42” AFF to ensure compliance with ADA requirements.

3.12.5 Cubicle/Partitioned Offices (Modular furniture)

Cubicle and partitioned Offices will require “feed points”. A feed point is a large (usually a two-inch conduit or 4-gang box) used to route communication cables into the raceway system of modular furniture. The mounting height and exact location of the feed points will depend upon modular furniture system to be installed. The type of furniture system to be used shall be conveyed to both the Electrical and Telecommunication Consultants. Splicing of voice and data cables is not permitted and cabling that routes through modular furniture will be installed as home runs from the faceplate to the serving Telecommunications room. Each modular furniture location will be provisioned with at least one communications outlet consisting of up to two voice and two data (4 Category 6 cables). One additional communication outlet with up to four cables shall be added for every four cubicles (Contact IT for exact location) Consider 1 telecom outlet every 6ft on center, The location will be determine in mod furniture to accommodated compression of furniture to 6’ x 6”. Every 3rd cubicle would then have a 2nd TO, based on and 8’x8’ grid layout consultation with the campus IT Department). Conduits routing to the feed points and the raceway system within the modular furniture must be able to hold sufficient cables for each cubicle in the modular furniture system at a fill ratio of 40%. Typically conduits will be 2” in diameter, and multiple conduits will be installed to provide sufficient space for the required number of cables.
When laying out a modular furniture system it is very important to consider how power and communication cable will be connected to the furniture system. If adjacent to the modular furniture, the use of solid walls and columns to route to the feed point are encouraged. Using walls with windows should be considered as a last resort because of the difficulty of routing cables to outlets underneath windows. In walls with windows, feed points and outlets should be placed on the solid section of the walls.

Furniture pathways may be entered from building walls, columns, ceilings, or floors. The interface between buildings and furniture requires careful planning and may require special products or furniture options. Modular furniture systems with integral raceways for data/voice cables are preferred. Safety, reliability, and aesthetic concerns all favor concealment of the building-pathway to furniture/pathway interface while maintaining future accessibility. These pathway interfaces shall not trap access covers or otherwise block access to building junction boxes or pathways. Pathways used to interconnect the furniture with building horizontal pathways shall be provided with a cross-sectional area at least equal to the horizontal pathways, cross-sectional area for the floor area being served.

3.12.6 Floors

A metallic raceway shall be provided between furniture pathways and horizontal floor pathway terminations (end of conduit, flush junction boxes, and recessed junctions boxes, etc.). Alignment of furniture with building module, duct locations and other cable delivery means will be considered as part of the layout planning. Furniture shall not be arranged such that pathway interfaces are in aisle spaces, where people walk or place their feet, or other places where such obstructions could create a hazard.

3.12.7 Wall Mounted Telephones/Payphones/Text Telephones

In order to comply with the ADA Accessibility Guidelines, the mounting height of the outlet box for Wall Mounted Telephones shall be +42 inches AFF. If a wall mounted telephone is to be installed above a counter top, the clearance for the box shall be 8 inches above the counter top.

The mounting height of the outlet box for wheel chair accessible payphones shall be +42-inches AFF. If a Text Telephone is required, it shall not be mounted to the wheel chair accessible telephone position. The text telephone unit will require a power outlet.

3.12.8 Work Rooms

Faculty or Administrative workrooms will vary in size and function. These workrooms may be equipped with shared departmental resources including:

- Facsimile machines
- Laser Printers
- Desktop computers
- Copiers
A variety of supplemental office devices, such as pencil sharpeners, laminators, electric staplers, etc. may also be located in the work room.

To facilitate the use of these devices, numerous communication and power outlets are needed. Workrooms are typically configured with counters and storage cupboards. Along counter tops where facsimile and printers may be placed communication outlets, with appropriate electrical outlets, will be distributed every six feet. These will be placed at +6” above counter height. For self-standing copier machines, a communication outlet will be provided with appropriate dedicated electrical outlets. At the entrance to the workroom, a wall-mount telephone outlet will be required. This outlet will be situated to avoid space conflict with door-swings, cupboards, fire extinguishers, water coolers, panels and any other fixture or device that could interfere with the accessibility of the telephone.

3.12.9 Computer Labs

Computer labs vary depending on the type of activity conducted in the lab. Since computer labs may be rearranged, it is important that the communication outlets provide as much flexibility as possible. There are many possible computer lab layouts. Computer labs will be custom designed with the participation of VVC IT, and Campus staff. Typical configurations are described below. At the entrance to any lab, a wall-mount telephone outlet will be provided.

3.12.9.1 Instructional Lab – slab floor

In an Instructional Computer Lab, the student computers will to be oriented towards a whiteboard or teaching wall upon which the Instructor’s workstation may project images and perform demonstrations. This lab is typically sized for a class of 30 student computers and an instructor’s computer. The lab may also contain 3-4 printers, scanners and other network devices. The tables are typically arranged to allow the students to all face in one direction and not need to twist around to watch the instruction. Tables are usually positioned against the walls. Printers, scanners and other network devices are distributed around the room as space permits.

The preferred outlet arrangement for this layout is to provide a divided metal raceway around the periphery of the room with power and communication outlets at intervals corresponding to the table spacing. Tables will be situated flush against the walls to prevent the stretching of power or data cables across aisles or walkways. At the front of the classroom, on either side of the whiteboard, power and communication outlets are provisioned.

3.12.9.2 Computer Lab for Student Self-Study

In a computer lab where students come to work on assignments, there is typically no formal instruction. As such, the lab layout is oriented to provide the highest number of student stations, with little space reserved for an instructor’s workstation or whiteboard. The layout of this type of computer lab will vary with room dimensions and shape. In an arrangement of long tables, typically one computer workstation is provided for every 2.5 feet of table top.
Computer Kiosks vary in size, typically 6-8 stations per kiosk. Outlets for these computer labs should follow the general design guidelines:

- All power and communication outlets on walls should be provisioned in metal raceway at a height of +6” above the table top, typically +36” A.F.F. Power and communication outlets will be provisioned intervals corresponding to the table spacing. Power and communication outlet placement must be coordinated with Campus IT DEPARTMENT staff. In some situations, it may be preferred that the outlets are below the table top.

- All rooms which support islands of tables or kiosks will be configured with flush-mount floor boxes. Dual purpose floor boxes (communication and power) are acceptable providing that there is adequate separation maintained so that all power outlets and all communication jacks can be used simultaneously without the cords interfering with each other’s access. The preferred design is a flush mount brass floor box with brass covers that can be accessed when a power and communication outlet is used. All floor power and communication outlets will be provisioned in the floor slab. No cabling will extend across the floor. Floor mounted raceway (pancake raceway) is not acceptable.

- Sufficient floor boxes will be provided to support the required number of computers, plus supplemental printers, scanners and other networkable devices.

3.12.9.3 Computer Lab – raised floor

In new buildings with rooms that are designed for permanent computer labs, the computer lab design shall include a raised floor environment. For ground floor implementations, a depressed slab is preferred to allow for the raised floor environment without losing rooms space due to ramps or stairs. The raised floor environment will provide:

- The raised floor will provide a depth of 12 inches, with removable floor tiles to grant unhindered access to the floor space.
- Within the raised floor there will be a matrix of power and communication outlets that provides sufficient density to computer tables. Typically, this will be communication outlets each equipped with four data jacks, spaced every four feet, and equivalent power plugs and circuits to power computers and network devices plugged in to every network jack and powered on concurrently. The number and location of communication and power outlets will vary with room size and orientation. Each matrix will be custom designed with VVC IT according to room requirements.
- Cables routing to the data outlets will be fully enclosed in a metallic raceway system that provides sufficient space so that the enclosed cabling does not exceed a 40% fill. The raceway system shall consolidate to suitable junction boxes that route conduits back to the serving Telecommunications room.
- Raceway system will be suspended from the floor and mounted so that the communication and power outlets face at a 90 angle to the floor. This will minimize the possibility of dust, particulate matter, and liquid falling into the network jacks.
The removable floor tiles will be provided with notched access so that patch and power cords can be routed through the raised floor to the computer tables. Floor tiles will be reloadable so that as room configurations change, cable notches can be re-positioned underneath tables and avoiding circulation paths.

3.12.10 Specialty Locations

The campus will have specialty locations that will require custom configuration at the time of building design. These locations include but are not limited to:

- Theatres
- Lecture Halls (seating capacity > 200)
- Auditoriums
- Athletic Broadcasting Control Rooms
- Scoreboards, Electronic Advertising Boards, etc.

At the time of design, the requirements for each of these locations will be individually determined in consultation with VVC IT and campus staff as needed.

3.12.11 Maintenance Spaces

A Maintenance space is defined as any room that contains materials, supplies, equipment or tools used for the performance of maintaining systems on campus. These can include but may not be limited to:

- Electrical Rooms
- Security Rooms
- Mechanical Rooms
- Control Rooms
- Boiler Rooms
- Garages

In these spaces, the minimum communications outlet shall be an outlet for a wall-mount telephone. The estimated size of the wall-mount telephone is 10”H x 12”W, centered on the outlet. This outlet will be located on the same wall as the doorway to the space, with sufficient clearance so that the outlet is not obstructed by light switches, equipment or storage shelves. If the door swings into the room, the outlet will be located on the wall beside the door lock, i.e. NOT beside the door hinges, so that the door can swing open and damage the telephone.

If the Maintenance Space will also be used as an office for maintenance personnel, the space will be equipped with additional communication outlet(s), located on the wall within three feet of a general purpose electrical outlet. One communications outlet will be provided for each desk area assigned to the Maintenance Space.

If the Maintenance Space contains panels, control systems or other devices that need to remotely communicate status and operation via modem or network connection, each of these devices will be separately equipped with a dedicated data station cable. The definition of which
devices/panels need cabling will be done in conjunction with engineering specialists for each
device type. These can include: HVAC monitors, elevators, EMS panels, etc. Communications
outlets shall be located as close to these panels as possible, generally located +18” above the
finished floor (AFF).

3.12.12 Building Rooftops

Control equipment that is located on building rooftops frequently requires special provisioning of
communications connectivity. This equipment can include HVAC monitors, cellular/wireless
antennas, broadcasting equipment, telescopes, communication relays, etc. Some of these
systems may be added after the building is built. It is more important to provide a clear pathway
through which connections can be added later. Any control systems that require network
connectivity need to be located within 90 meters of an Information Technology Room.

3.12.13 Storage Areas

All storage areas that will be accessed by VVC staff on a daily basis will be provided with an
outlet for a wall-mount telephone. If the storage area will be provisioned with general purpose
electrical outlets, at least one communications outlet will be provisioned on each wall where
there is an electrical outlet. Frequently, storage areas are redefined in purpose and may change
into small meeting rooms, offices or other work areas requiring connectivity.

3.12.14 Wireless and Projector Support

For support of wireless access points, a ceiling communications outlet shall be installed adjacent
to a power outlet in the ceiling. For rooms with hard ceilings, this may take the form of a flush-
mount outlet. For dropped ceiling spaces, the outlets may be concealed in the ceiling space with
equipment mounted in a pocket door, or above the dropped tiles. The actual design will be
determined on a room-by-room basis by VVC IT and campus IT DEPARTMENT.

For video connectivity to an instructor’s desk/podium, an AV outlet and pathway shall be
provided for a video projector location to the classroom through the AV cabinet. The actual
design will be determined on a room-by-room basis by VVC IT and campus IT DEPARTMENT.

3.12.15 Security Devices

As determined by the site security plan, there will be a distribution of telephones that provide
ring-down connectivity to campus police. These phones may be implemented along
corridors/hallways, in foyers, at bus stops or parking lots. The precise location and functionality
of these telephones is yet to be determined.

Additional TCP/IP-enabled security devices, such as cameras, will be connected to the network.
These devices may be located on building exteriors, light poles or other internal and external
structures. Cabling to these devices may require copper or fiber cable, possibly with outside
plant sheaths. Pathway and routing to these security devices will be designed on an individual
basis.
3.12.16 Fire/Life/Safety Devices

It is the responsibility of the Telecommunications Design Architect and campus IT staff to clearly identify and make provisions for traditional phone lines/connections for Fire/Life/Safety devices. These connections are necessary for helping to meet the requirements of industry regulations such as PCI DSS. Therefore, a careful review of campus systems must be completed to determine other needs for these traditional phone circuits. These devices include but are not limited to elevator phones, emergency phones, off campus security monitoring systems and services, etc. Provisions for these lines and services will need to be coordinated end-to-end to the campus MPOE across the campus copper cable network.

3.13 Outside Plant (General)

Provisions must be made in the site work package to provide underground pathway to connect the building to the campus connection point. At least one, possibly more, common utility box/vault (size and location TBD) will be required so Communication services can enter the building.

From this new utility box/vault at least three (4) four inch Schedule 40 conduits will be run into the building. At least one of the spare conduits shall be pre-facilitated with a minimum of 4 ea-1” innerducts for future fiber optic cable installations.

Early on in the project, a coordination meeting is required between VVC IT, and VVC Maintenance and Operations, the Civil Contractor and the Electrical Design to resolve design aspects and requirements.

3.13.1 Campus Environments

New construction on the existing campus will require an assessment of the Outside Plant Infrastructure. This assessment is of particular importance if demolition of any structures is required as part of the overall project.

3.13.2 Renovation Projects

As part of the construction process for renovation, projects plans must include the removal of any abandoned cable(s) that may be in the space. The current California Electrical Code requires removal of accessible abandoned cable. All cabling reserved for future use, must be identified as such and tagged.

3.14 Construction Documents

The Telecommunications designer will use these standards to produce a comprehensive set of drawings that address all the specific design requirements of each construction project. This includes:

- Drawings will be provided as a discrete Telecommunications Set or “T” set.
T set drawings will be stamped by the RCDD.

T set drawings will be coordinated with electrical engineering staff for suitable placement of power outlets.

T set drawings will include the following:

- Outlet locations in all buildings using an Industry standard symbol set.
- Drawings of standard outlet details.
- Backbone riser diagrams for each subsystem: voice, data, and video (coax & fiber).
- Detailed drawings of Information Technology Rooms including: cable runway design, wall space allocation/usage, rack/cabinet equipment layout.
- Detailed drawings of seismic bracing for racks and cabinets.
- Where not provided by others, detailed drawings of fire-stopping around cabling bundles, J-hook/conduit/raceway suspension, etc.

Every construction project will be supplied with a unique set of specifications that address the specific design needs of the project. These specifications will be written as and must be in a separate Division Section or within the electrical section. Communications systems shall be covered in a separate Division 27 Communications section. Division subsections will include:

1. Telecommunication Floor Plans
2. Telecommunications Equipment Rooms and Spaces
3. Backbone Cabling
4. Horizontal Station Cabling

Documents will be updated in accordance with changes to product, standards and codes.

The Architect shall ensure that VVC IT has the opportunity to review and comment on all drawings and/or specifications that can in the remotest definitions be construed to have any impact on the Telecommunication Infrastructure.

4 Electrical

The following information is the basic guidelines for the Electrical Design Consultant. These design guidelines are to be considered to be minimum requirements. The Electrical Design
Consultant shall contact VVC IT in the Schematic Design phase to determine if there are any other or special requirements. It is the expectation of VVC IT that the information from this Guideline shall be included in drawings and specifications. The Construction Specifications Institute (CSI) Master-Format shall be used, with separate sections written to specify:

- Conduits for Telecommunication Use
- Outlet boxes for Telecommunication Use
- Telecommunication Cable Tray
- Telecommunication Grounding System

These sections and drawings are to be made available to VVC IT. Unless otherwise noted, it is VVC IT’s expectation that the work listed in this section will be installed by an electrical contactor.

4.1 **GENERAL POWER REQUIREMENTS**

All outlets shall be installed as double-gang quad-plug outlets. This is to facilitate the use of electrical adapters fashioned with large transformers at the plug end. These transformers frequently obscure more than one electrical plug, thereby limiting the usefulness of the outlet.

The plentiful distribution of electrical circuits is critical to ensuring that equipment does not experience power surges or lulls as everyone “powers on”. A dedicated circuit will be installed for every three computer devices (computer/laptop/printer/scanner) and other circuits will be installed for shared use between offices for supplemental office devices. It is recommended that the outlet designed for computer usage shall be a surge protected power outlet or allow for the placement of a surge protected power strip. These outlets shall be defined for computer usage.

Unless otherwise noted on the Architectural drawings, power outlets shall be mounted within 3 feet of communication outlets and at the same mounting height. For additional information about outlet placement refer to section 3.12.

4.2 **TELECOMMUNICATION ROOM POWER REQUIREMENTS**

4.2.1 General

To ensure that the Information Technology Rooms have clean power, the electrical panel(s) in Information Technology Rooms shall be connected to an isolation transformer. Each Information Technology Room shall have its own electrical panel. The electrical service shall be at least 100 Amps. The estimated electrical load for Information Technology Rooms shall not exceed 80% of the panel.

As a design alternative, one electrical panel may serve multiple Information Technology Rooms. This applies to buildings where multiple small Telecommunication Rooms are located. If this
design is selected, the Electrical Engineer will coordinate with VVC IT to estimate the power consumption to provide ample dedicated circuits.

Convenience outlets shall be mounted at +18-inches AFF (just below the plywood backboard). See comments in previous sections about backboard mounting. Horizontal spacing between convenience outlets shall not exceed six feet around the edge of the space. Convenience wall outlets shall be split circuited, i.e. outlets on the same wall will be wired to different circuits. No more than four (4) outlets shall be on the same circuit. Each outlet will be clearly marked with the circuit number. All convenience outlets shall be 120v 20 Amp, quad-plug outlets.

If the room has a raised floor, all under-floor outlets will be side mounted on a flex whip not to exceed 30 inches in length. All circuits for under floor outlets shall be of a ground-fault interrupter type.

To provide power to equipment racks/cabinets, electrical outlets will be provisioned along cable runway and between racks/cabinets. Each rack/cabinet will be provisioned with a dedicated circuit in a quad-plug outlet. Specialty outlets may be required to support rack-mount UPS systems. This need will be coordinated with VVC IT during the design phase. Whether installed nearby, or on racks, the conduits required for power outlets must not interfere with the ability to place equipment in the racks.

HVAC system shall not use the same electrical panel as that used to support Information Technology Rooms.

### 4.3 Electromagnetic Interference

Electromagnetic interference shall not exceed 3.0 V/m throughout the frequency spectrum. Special attention shall be given to electrical power supply transformers, motors and generators, X-ray equipment, radio and radar-transmitters, microwaves and induction sealing devices.

### 4.4 Generator/UPS

A generator may be required to support ongoing power to critical locations when extended power outages occur. The sizing of the generator will depend upon the nature and function of the equipment at the location to be powered. It is possible that more than one generator may be required. For example: a generator to maintain the PBX equipment may have to have a longer power life than the local PBX equipment if the facility is acting as a center for other Campus locations.

An Uninterrupted Power Supply (UPS) system may be required to support AC-powered equipment such as routers, switches, etc. at various locations on campus. Each Building Telecom room will be provisioned with a UPS. Specialty electrical outlets for the support of rack-mount UPS systems will be identified as needed and provisioned by racks/cabinets.
4.5 GROUNDING

Besides the normal electrical ground system, a Telecommunications Ground System will be designed per J-STD- 607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications. This Telecommunications Ground System shall be installed to support the Information Technology Rooms and Infrastructure.

A Telecommunications Main Grounding Busbar (TMGB) shall be located in the Building Telecommunications Room. The TMGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing. The TMGB shall be electro tin-plated for reduced contact resistance. The TMGB shall be a minimum size of 5 mm thick, 100 mm wide and 300 mm in length. The TMGB shall be insulated from its support by a two (2) inch separation.

The TMGB will be bonded to the electrical panel ground bus bar and to building steel or ground rod by conventional welds, exothermic welds clamp-and-braze method, or UL approved compression type connectors where practical. Exothermic welds are the preferred method. Because of the high temperatures involved, copper materials may be bonded to iron or steel. The mold size must match the cable or conductor cross section. The size of the weld metal charge must match the size of the mold being used. The connection between the TMGB and the bonding point is to be 3/0 insulated copper ground wire.

In each Telecommunications room, a Telecommunications Grounding Busbar (TGB) shall be installed. The TGB shall be a minimum size of 5 mm thick and 50 mm wide and 150 mm long. The TGBs shall be bonded to the electrical panel serving the rooms were the TGB is installed, bonded to building steel, and bonded in series to the main TMGB.

4.6 RAISED FLOOR BONDING AND GROUNDING

If a raised floor is present, the raised floor bonding shall consist of a #6 AWG, bare stranded copper ring around the floor perimeter. #6 AWG supplemental cables shall run within the perimeter in both directions to form a grid. All crossovers shall be bonded. The supplemental cables shall bond to each fourth (4th) pedestal and both ends will anchor on the perimeter #6 AWG ring.

- A bus bar shall be provided under the floor with a dedicated connection to the Telecommunications Main Grounding Busbar (TMGB). This bus bar shall be labeled "Raised Floor Bus".
- Two diametrically opposed connections shall be made between the raised floor grounding bus bar and the perimeter #6 AWG ring.

4.7 TERMINAL BOARD

The terminal board shall consist of rigidly fixed ¾-inch void free fire-rated A-C plywood. The visible side of the plywood shall be painted with two coats of white (or other light-colored) paint. At least one (1) Fire-Rated stamp must be visible per sheet or partial sheet of plywood when painting is completed. Plywood shall be installed from +2-feet to +10-feet AFF.
4.8 COMMUNICATION PATHWAYS.

The main types of horizontal pathways are:

- Ceiling distribution.
- Cable Tray
- In-floor ducts (one-level or two-level).
- Cellular floors.
- Conduit.
- Access (raised) floors.
- Surface raceway (refer to section 3.12.9.2)

Many buildings require a combination of the above systems. VVC IT prefers an overhead distribution method base on the use of cable tray/J-hooks for routing and conduit stub-ups from outlet boxes.

Trays and conduits located within the ceiling shall protrude into the Telecommunications room a distance of 1 to 2 in without a bend and above 8 ft. high. All conduits and cable tray shall have approved cable radius drop outs.

4.9 FIRE STOP PENETRATIONS

Each Telecommunications room will require either a cable tray entrance with fire-stop system or a minimum of three (3) 4-inch sleeves through the wall suitably fire-stopped around and inside the sleeves with intumescent materials that will preserve the fire rating of the wall.

Typically each Telecommunications room will require a minimum of three (3) 4-inch sleeves to be used for risers through the floor. The exact requirements will be coordinated with VVC IT for final quantities. The current California Building Code requires “…The system shall have an F rating and a T rating of not less than one hour but not less than the required rating of the floor penetrated”.

The electrical drawings shall show the location and type of Fire Stop Penetration systems to be used. All systems are to be sealed at the completion of the cabling installation. If the cable contractor returns to run additional cable, the seal will be broken, cable installed and then the systems will be re-sealed by the cable contractor.

4.10 COMMUNICATION OUTLETS

4.10.1 Communication Outlets

During the early part of the design process the Architectural drawings shall be annotated with the placement of communication outlets. Coordination with both the Architect and
Telecommunication Consultant may reveal the need for additional communication outlets as the design details develop.

4.10.2 Outlet location considerations

Telecommunications outlet locations must be coordinated with the furniture layout, particularly in the case of cubicles and built-in furniture. Power outlets shall be installed within 3 feet of each telecommunications outlet box. Telecommunications outlet locations are typically at the same height as the power outlet.

4.10.3 Outlet Boxes

Unless advised by VVC IT to the contrary, the typical communication outlet shall consist of a 4-11/16 inch square by 2-1/8 inch deep back box with one (1) 1-1/4” inch trade size conduit that will stub out to the closest accessible ceiling space, communications J-Hook or within 6” of a cable tray run. The outlet box shall have a single gang mud ring. Typical mounting height shall be +6 inches above counter/desk surface in offices and workrooms and +18 inches AFF for outlets in classrooms, conference rooms, etc.

Wall mounted Telephones outlet boxes shall be 4-inch by 2-½ inch by 2-1/8-inch deep back box with single gang mud ring and one (1) 1 inch trade size conduit that will stub up and out to the accessible ceiling space to the closest communication J-Hook or within 6” of a cable tray run. The back box shall be mounted at +42 inches AFF.

4.11 Floor Boxes

Floor boxes will be used in limited locations where connectivity is needed for islands of computers/desks, in order to alleviate the incidence of power and data cables straddling across floors. If outlets must be installed in the floor, they shall meet the following minimum requirements:

- At no time shall conduit feeding the floor box run below the membrane barrier or be in the soil.
- Supporting conduits shall run in the slab and shall be PVC schedule 40 or better.
- Supporting conduits shall be sized for 20% fill to allow for additional cabling.
- Conduits feeding floorboxes will be dedicated runs and not chain through multiple floorboxes. Conduits will stub up to the closest wall.
- Floorboxes will be of metal construction to support the anticipated weight and travel. Typically this is a brass floorbox with brass lids. Lids must be flush to finish floor when the outlet is in use.
- Floorboxes will have lids that can be screwed down to hinder unauthorized access.
- Floorboxes may support a combination of data and electrical outlets. If so, the design of the floorbox must be such that all data and electrical ports can be fully connected with cables without causing any obstructions that would limit the use of any jacks/plugs.
For each occurrence, a review of the connectivity density and need will determine the type of box to be used. The selection of floor box will be coordinated with VVC IT.

### 4.12 Wireless Access Points (WAP) and Projector Support

For support in conference rooms, classrooms and other specified areas, ceilings will be installed with communications cabling support wireless access points. A single Cat 6 (CommScope xx71 series cable) shall be run from a Communications room to a single gang surface mount TO in the ceiling. An additional 20ft coil of cable shall be included to allow for movement of the access Point to adjust for signal gaps after installation A power outlet, if WAP is not PoE enabled, shall be installed in on a flexible power whip configuration with the ability to maintain a 4ft or less distance from WAP. Support hardware for WAP shall be part of the installation and independent of the ceiling support system.

At ceiling-mounted projector location, AV, communications and power outlets will be required. These outlet boxes will consist of 4-1/16 inch square by 2-1/8 inch deep back box with one (1) 1 inch trade size conduit that will stub out to the closest communications J-Hook or within 6” of a cable tray run. The outlet box shall have a single gang mud ring. The support for the box shall be such that the box is independent of the ceiling. From the box, a data cable will route back to the closest TR. One 2-inch trade size conduit will route to the AV control cabinet to support AV cabling. Three additional 2-inch conduits will route to each of the Instructor’s desk and lecture podium from the AV control cabinet. This provides discrete point-to-point connectivity for AV specialty cables. AV connectivity and placement of the AV control cabinet and Instructor’s desk and lecture podium will be custom-designed for each room.

A power outlet, adjacent to the communications outlet is required. In rooms where both ceiling mounted projectors and wireless access points are required, these outlets can be consolidated.

### 4.13 Communication/Power Raceways

If communication/power divided raceways are being installed, the communication channel shall be above the power. The sizing of the communication channel shall be based upon the following:

- If the raceway system is to support “standard” outlet in office locations, the outlet faceplate shall be sized for 4 cables. Conduit stub-up from the raceway must be sized to support the maximum number of cables in that segment of the raceway plus 40%.
- If the raceway system is to support a computer lab facility then each communication faceplate shall be sized for 4 or more cables. Unless specified otherwise, the communication outlets shall be spaced every 4 feet. Conduit stub-up from the raceway must be sized to support the maximum number of cables in that segment of the raceway plus 40%.
- In outlet locations, the jacks may protrude into the raceway cavity and pinch the cable connections. Raceways shall not be filled greater than 40% and the fill may be reduced to avoid cable pinching at outlet locations.
• Only metallic raceway is acceptable.
• The mounting height of the raceway should be +6” above the table top, typically +36”AFF. Quad-plug power outlets should be provided with each communication outlet.
• Raceways will be provided with custom fittings to data jacks.

4.14 FLOOR POKE-THROUGHS

VVC prefers that the use of floor poke-throughs be minimized and considered only on an exception basis.

4.15 BUILDING ROOFTOPS

Each roof shall have at least one location for potential rooftop systems. The location must be such that the distance from the location to the nearest Telecommunications room does not exceed 90 meters of conduit. This location shall consist of an electrical weatherproof box sized to support one electrical 4-plug outlet and two (2) 2” conduits. The power outlet shall be fed from the nearest electrical room. The two conduits shall run to the same electrical room. The conduits shall be sealed to prevent moisture or insect ingress.

In addition to the electrical connectivity, one (1) one-inch conduit will be provisioned from the roof top to the nearest telecommunications room, terminating on the roof within 90 meters of the Telecommunications room. This communications outlet shall be in a weatherproof enclosure, separate from the electrical weatherproof box. This outlet will support the incidental use of a telephone or data connection. If a permanently installed telephone is required, the termination will be located in a weatherproof box, sized appropriately to house the telephone set.

4.16 INSIDE CONDUITS (GENERAL)

The Electrical Engineer will design conduits conforming to EIA/TIA 569 B Commercial Building Standard for Telecommunications Pathways and Spaces and the following:

• Run in the most direct route possible (parallel to building lines), with no more than two 90 degree bends in any dimensional plane between pull points or pull boxes (PBs).

• An accessible pull box must be added to a conduit run if it contains more than the equivalent of two 90 degree turns in any dimensional plane.

• Contain no straight through or 90 degree conduits (also known as LBs).

• Contain no flex-conduit material.

• Contain no continuous sections longer than 100 ft. For runs that total more than 100 ft in length, insert pull points or PBs so that no segment between points/boxes exceeds the 100 ft limit. It is recommended that total conduit runs be kept to 150 ft or less (including the sections through pull boxes).
- All conduits shall have a minimum bend radius 10-times the diameter of the conduit.

- All conduit stub-ups, up to trade size 1¼” shall have a bend radius 6-times times the diameter of the conduit. Conduit stub-ups that are trade size 2-inch or less shall only have a 45 degree bend above the wall.

- Equip all conduits with a plastic or nylon line (also called a fishtape or pull cord) with a minimum test rating of 200 lb.

- Minimum trade size for communication EMT conduits is 1 ¼” inch (UON) for use with all communication back boxes or J-boxes.

- All communication conduits from communication outlet or J-boxes shall stub up and out to within 6-inches of J-Hooks or cable tray run.

- Conduits will stub up to an accessible ceiling area. No communication conduit is to stub out in a hard ceiling area.

- The conduits shall be reamed at both ends and have a bushing on the stub up end.

- Conduits which feed modular furniture are considered “feed points”. These conduits are sized according to the number of cables and outlets served, typically as 2-inches in diameter. These conduits may terminate on backboxes for use as a pull point during cabling installation. The use of flex conduits to enter the modular furniture cabling channel shall be minimized.

4.17 COMMUNICATIONS CABLE TRAY

The preferred method to support telecommunication cables is the use of wire basket cable tray. This approach allows for change in direction or elevation without having to install pre-manufactured assemblies. Design of the size and location of the communication wire basket tray will be coordinated with VVC IT. In general the design of the cable tray will follow the guidelines described below.

Cable tray routes will follow normal corridor routes. The tray shall be placed in the hallway ceiling space in such a manner such that at least 12-inches of space exists above the sides of the cable tray and there is at least 12-inches to 18-inches of clearance on at least one side of the tray. There shall be working space of at least 2-feet on one side of the tray to facilitate the installation of cable. Cable tray support shall be a trapeze support system independent of the ceiling support system. Steps shall be taken to ensure the support and trays are seismically braced.

All metallic cable trays must be grounded, but shall not be used as grounding conductors for equipment. Clearly mark all cable trays and grounding conductors in accordance with ANSI/TIA/EIA- 606 and J-STD- 607-A.
4.18 **COMMUNICATIONS J-HOOKS**

Typically, information on the general placements of J-hook will not be included on drawings. The Cabling Contractor is in a better position to install J-hooks due to the adjustments that need to be made to J-hook runs to support the cable runs as the cables are being installed. Unless instructed otherwise by VVC IT, the installation of J-hooks shall be covered in the Scope of work assigned to the Cabling Contractor.

For additional J-hook installation information, refer to the Telecommunications Consultant section and sample specifications.

4.19 **PULL BOXES**

If an inside pull box is required the size of pull box shall conform to the following chart.

<table>
<thead>
<tr>
<th>Maximum Trade Size of Conduit</th>
<th>Size of Box</th>
<th>For Each Additional Conduit Increase Width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Width x Length x Depth</td>
<td></td>
</tr>
<tr>
<td>¾</td>
<td>4 in x 12 in x 3 in</td>
<td>2 in</td>
</tr>
<tr>
<td>1</td>
<td>4 in x 16 in x 3 in</td>
<td>2 in</td>
</tr>
<tr>
<td>1-1/4</td>
<td>6 in x 20 in x 3 in</td>
<td>3 in</td>
</tr>
<tr>
<td>1-1/2</td>
<td>8 in x 27 in x 4 in</td>
<td>4 in</td>
</tr>
<tr>
<td>2</td>
<td>8 in x 36 in x 4 in</td>
<td>5 in</td>
</tr>
<tr>
<td>2-1/2</td>
<td>10 in x 42 in x 5 in</td>
<td>6 in</td>
</tr>
<tr>
<td>3</td>
<td>12 in x 48 in x 5 in</td>
<td>6 in</td>
</tr>
<tr>
<td>3-1/2</td>
<td>12 in x 54 in x 6 in</td>
<td>6 in</td>
</tr>
<tr>
<td>4</td>
<td>15 in x 60 in x 8 in</td>
<td>8 in</td>
</tr>
</tbody>
</table>

Any pull box installed shall be located in such a manner that the pull box can be accessed during normal working hours. This includes providing wall or ceiling access-panels that can be easily removed to gain entry to the pull box.

4.20 **UNDERGROUND CONDUITS**

It is the expectation of VVC IT that the following information will be placed on the Electrical Site Plan.

- Conduits are to be 4” in diameter, schedule 40 PVC or equivalent. At least one conduit will contain innerducts.
- Changes in direction for conduits will occur outside of the maintenance or handhole at a minimum of 20 feet from the maintenance or handhole. The conduit runs will contain no more than cumulatively, 180 degrees of bend between pull boxes, vaults/manholes or the Building Telecommunications Room. This includes the turn from horizontal to vertical when entering the Building Telecommunications Room from below.
- Conduit bends shall be sweeps. All conduits shall have a minimum bend radius 10-times the diameter of the conduit.
- If the conduits penetrate from below, the conduits will stub up at least 4-inches.
- If the walls of the Telecommunications room are penetrated, the conduits shall stub out 1 to 2-inches and conduits shall pass through the wall at an upward angle so water will not drain into the room.
- The conduits will have plastic bushings at the building side end.
- A pull rope with a minimum of 200 pounds of pulling tension will be installed in all conduits.
- All conduits, sub-channel systems shall be sealed at the building end to prevent rodents, water, or gases from entering the building.

4.21 **EQUIPMENT SPECIFICATIONS**

All network, computer, Voice/Voicemail, AV or other active equipment shall be procured in a discrete bid and acquisition process that is independent of the building construction. As such, specifications and bid documents shall NOT include descriptions of active components or equipment.
5 Mechanical (HVAC)

The following information is the basic guidelines for the Mechanical Design Consultant. These design guidelines are to be considered to be minimum requirements. The HVAC Consultant shall contact VVC IT to determine if there are any other or special requirements. In addition to the requirements of the Telecommunication Rooms, VVC IT has a vested interest in how thermal dissipation of desktop devices and special equipment is handled.

5.1 GENERAL

- Mechanical Drawings shall carry a sheet note to the effect that installation of all duct work must be coordinated with the installation of the Communication Cable Tray and the final installation shall be such that the Communication Cable Tray has sufficient clearance to allow access to install and maintain the Information Technology cabling.

- All Building and Main Telecommunications Rooms require HVAC 24 hours per day and 365 days per year, separately controlled from adjacent rooms. If the building's HVAC system cannot meet this requirement, then a stand-alone HVAC system with independent controls for the various Information Technology Rooms shall be installed. If a separate unit is to be installed, chilled water; at 45°F is preferred. Otherwise, a non-interrupted water source is acceptable. Note: if water is not available, a way must be found to exhaust hot air from the air conditioning unit's evaporator.

- The HVAC unit will not be powered off the same electrical panel as the Information Technology Rooms.

- Final BTU load estimates can be provided after the equipment has been selected. For planning purpose assume at least 6,000 BTUs per equipment rack/cabinet to be installed.

- In larger or critical installations, the air conditioning system (or that part of a larger system) will be connected to a backup generator system. Provisions must be made so the telecommunications or network equipment will not be exposed to excessive operating temperatures due to a loss of power to the air conditioning system. This shall be coordinated with VVC IT.

- A positive pressure differential with respect to the surrounding areas shall be provided.

- The ambient temperature and humidity shall be measured at the distance of 5' above the floor level. After the equipment is in operation and the room temperature has reached steady state, the measurement can be taken at any point along an equipment aisle centerline. The normal temperature range is 64°F to 74°F with a humidity range of 35% to 55% relative.

- If the Information Technology Rooms are fire-rated, fire/smoke dampers will be required for supply and exhaust air.
5.2 **THERMAL DISSIPATION**

Computer devices will add heat to the room, in proportion to the power drawn by the device(s). Planning for air flow systems that service these environments should be equipped to dissipate the heat accumulation, particularly in high density areas like computer labs, workrooms, etc. Typical ratings per device are:

- Desktop computer w/ LCD monitor 1600 BTU/hr
- Color Inkjet printer 250 BTU/hr
- Color LaserJet printer 1900 BTU/hr
- Scanner 50 BTU/hr
- Facsimile (or all-in-one printer) 250 BTU/hr
- Ceiling projector 900 BTU/hr
- Servers 4750 BTU/hr

The Mechanical Design Consultant will coordinate with VVC IT for the specific equipment installation in each Building Information Technology Room. This will allow for the accurate calculation of thermal dissipation requirements. Typical values are:

- Network Switch (48 port) 250 BTU/hr
- Network Switch (fiber concentrator) 4000 BTU/hr
- Network router 600 BTU/hr

5.3 **COORDINATION WITH MAINTENANCE AND OPERATIONS**

While VVC IT will act as a focal point for all issues associated with Information Technology rooms, computers and network equipment, the Mechanical Design Consultant must coordinate with the VVC and Campus Maintenance and Operations departments to address more global HVAC issues for each renovated space. Additionally, coordination with Campus Maintenance & Operations for all site work regarding the Plumbing, Electrical, and Fire Alarm trades must be maintained at all times.
6 Civil (Outside Cable Plant)

The following information is the basic guideline for the Civil Design Consultant. These design standards are to be considered as minimum requirements. The Civil Consultant shall contact VVC IT to determine if there are any other or special requirements. The Outside Plant Conduit System must be designed and installed to the NESC and ANSI/EIA/TIA-758 and 758-1 Specifications for Outside Plant Construction.

6.1 General

The Outside Plant Conduit System provides inter-building pathway for communication cable(s) and services. The conduit system is typically a combination of a number communication vaults, maintenance holes (MH), hand-holes (HH) and conduit runs.

Maintenance Holes are typically used in main and branch conduit systems that require four or more trade size 4 conduits. If placed in a traffic area, the “box” and cover will be rated for the intended traffic loads. Unless directed to the contrary by VVC IT, the typical Maintenance Hole shall have center conduit window and be a Type A configuration as defined in ANSI/TIA/EIA-758. The Maintenance Hole shall be a pre-cast unit and shall contain all necessary hardware such as, but not limited to, cable racking, pulling iron, and provisions for bonding and grounding.

Hand-holes differ from Maintenance Holes in that they provide full access to the entire space inside the hole, i.e. you can stand in a Hand-hole with your head above finished grade. Hand-holes are usually pre-cast and also require the same hardware as a Maintenance Hole.

6.2 Underground Conduits

The following information is supplied as information only. It is the expectation of VVC IT that this information will be placed on the Electrical Site Plan.

- Each building shall have, at a minimum, three trade 4-size conduits for routing communication cables into the building. The number of conduits may be increased for multi-storey buildings where larger backbone cables must be routed.
- Conduits are to be schedule 40 PVC or equivalent.
- At least one conduit shall contain four innerducts.
- The conduit runs will contain no more than two 90 degree turns or cumulatively 180 degrees of bend between vaults maintenance holes (MH) or hand-holes (HH) and the termination point in the Building Telecommunications Room. This includes kicks, offsets and the turn from horizontal to vertical when entering the Telecommunications Room from below.
- If the conduits penetrate from below, the conduits will stub up at least 4-inches.
• If the walls of the Telecommunications room are penetrated, the conduits shall stub out 1 to 2 inches and conduits shall pass through the wall at an upward angle so water will not drain into the room.

• The conduits will have plastic bushings at the building side end.

• A 3/8” nylon pull rope with a minimum of 200 lbs. of pulling tension will be in all conduits.

• Measurement (true tape) in one conduit in a multi-conduit run.

• All conduits, sub-channel systems shall be sealed at the building end to prevent insects, rodents, water, or gases from entering the building.

6.3 CONDUITS/DUCT BANKS

Underground routes must be designed from engineering drawings. These drawings must include the following information:

• Details of typical trench cross sections showing duct locations in the trench, clearances from final grade, backfill materials and depths, pavement cutting information, and compacting requirements for both paved and unpaved areas.

• Construction notes applicable to the work being performed.

• A scale drawing showing location ties to existing structures, cable, conduit, utility boxes, and any conflicting substructures and profile drawings of congested areas where vertical and horizontal separation from other utilities is critical during cutting and placing operations and any other areas as requested by the VVC IT.

• A legend explaining symbols of all relevant structures and work operations.

• Conduit types, dimensions, and wall-to-wall measurements when used with MH, HH, PB, Pedestals, electrical rooms and Telecommunications Rooms.

• Warning tape containing metallic tracings must be placed a minimum of 12 inches above the underground conduit/duct structure to minimize any chance of an accidental dig-up. The American Public Works Association has adopted the color orange for the telecommunications cables. Both ends of the metallic warning tape will be assessable from both ends after installation. VVC IT must approve this assess ability prior to complete of conduit/duct and cable placement.

• The minimum depth of a trench must allow 24 inches of cover from the top of the conduit/cable to final grade for conduits that traverse areas with no vehicular traffic. Depth must be increased with the increasing incidence of vehicular traffic to a maximum of 6 feet for constant traveled roadways. Conduits that route underneath pedestrian
pathways that also support vehicular traffic must be buried with appropriate depths, so that maintenance vehicles or Fire trucks driving over the pathways will not inadvertently crush the underground conduits.

- Conduits shall be designed so that changes in cable routing direction occur outside of the manhole. Bends must occur at least 20 feet away from the box. No bends greater than 90 degrees are permitted. Reversals of conduit path are not allowed.

- Local underground utilities must be contacted (48 hours prior to excavation or in accordance with statutes regulation utilities); an Underground Service Alert (USA) call number receipt (ticket) must be present and on site during any construction, and utilities must be located before digging to locate all subsurface facilities such as power, gas, water and outdoor lighting.

- Conduit penetration of a building must be located so that the outside plant cable termination area is within 50 feet of the point of penetration. If the cable must extend inside the building for greater than 50 feet, it must be encased in Rigid or Intermediate conduit that does not expose the cable for more than 50 feet. EMT is not acceptable for use. The Rigid or Intermediate conduit must conform to the same requirements of requiring a pull box after two 90 degree or cumulatively 180 degrees of bend. From the point of the first pull box, the outside plant cable can only run 50 feet until its termination point. The cable length includes routing and service loop lengths.

- All conduits in a duct bank that enter a Maintenance Hole or Building shall be sealed at the time of installation with Universal Blank duct plugs to prevent the intrusion of liquid or gases into the MH or Building. Seal after pull rope is installed. During cabling, the seals will be opened and resealed with a Simplex duct plug after cable installation, testing and acceptance is completed.

- Per ANSI/TIA/EIA-758 a drain slope of 0.125 inches per foot toward the HN/HH shall be provided.

- The following table shows the vertical or horizontal separations that must be maintained between telecommunications facilities and other facilities sharing a common trench.

<table>
<thead>
<tr>
<th>Adjacent Structure</th>
<th>Minimum Separation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power or other foreign conduit</td>
<td>3 inches of concrete, or 4 inches of masonry, or 12 inches of well-tamped earth</td>
</tr>
<tr>
<td>Pipes (gas, oil, water, etc.)</td>
<td>6 inches when crossing perpendicular 12 inches when parallel</td>
</tr>
</tbody>
</table>

6.4 COMMUNICATION MAINTENANCE HOLES/ HAND-HOLES SIZES

The size of a Maintenance Hole or hand-hole will depend upon the number of conduits it will have to support. The typical maintenance hole is 12-feet long, 6-feet wide with an interior height
of 6-feet. Hand-holes will vary in size from 4-feet long by 4-feet wide by 4-feet high to as small as 17-inches wide by 30-inches long by 36-inches deep.

All maintenance and hand-holes must be sized for the current conduit need with a minimum of 30% spare capacity. Conduits will be added to maintenance and hand-holes when additional buildings are constructed on campus and as such, maintenance and hand-holes must not be sized so that they are at their maximum during the initial installation. At the time of construction of a new maintenance or hand-hole, the conduits for immediate use and any stub-outs that may be prepared for future buildings will be installed.

6.5 **COMMUNICATION MAINTENANCE HOLES/ HAND-HOLES LOCATIONS.**

Vaults and Maintenance Holes shall be located such that it:

- Provides a safe work area.
- Allows for proper traffic control during operations at the vault or MH.
- Provides proper space for cable reel dollies, winch trucks, etc.
- Not overly restricts the flow of vehicular or pedestrian traffic.
- Be located out of the road way whenever possible.
- The distance between vaults or MH shall not exceed 300 feet.

Hand-holes shall be located such that it should:

- Expedite cable placement.
- Provided for drainage provisions (e.g., drain holes, sump hole).
- Aid cable pulling when the bends in the conduit run exceeds either two 90 degree bends or a total of 180 degrees (in any dimensional plane), or when the conduit section is so long it must be pulled in two segments.

Vaults, maintenance holes and hand-holes that are located in pedestrian pathways that are designated as emergency Fire Routes or routes for maintenance vehicles must be constructed with traffic-rated boxes.

Maintenance and hand-holes must be located so that they are accessible for future conduit additions. In particular, Maintenance and hand-holes are best located in lawns, beddings or soft ground that can be more easily accessed for the addition of conduits. Installation of maintenance or hand-holes in pavement, sidewalks, roadways, specialized stonework surfaces, or other concrete or permanent material must be avoided so that future conduit additions will not mar the surface or cause undue expense to recreate after the conduit addition. Stub-outs that extend 5-10 feet from the maintenance and hand-holes should be included in all new installations to facilitate future conduit additions.
7 Telecommunication

7.1 Telecommunication Consultant

The primary role of the Telecommunication Consultant is to act on the behalf and at the direction of VVC IT to provide a Telecommunication Cabling Design for VVC building and infrastructure projects. The Telecommunication Consultant may be retained by the Architect or directly by VVC. The Consultant shall:

- Ensure all information in this Standard is followed by the Architect and other consultants. If the discrepancies are not corrected by the Architect or other consultants, the discrepancy is to be brought to the attention of VVC IT.
- Develop a Telecommunication Cabling Design based upon the current, published EIA/TIA Standards, the latest BICSI Manuals and other Standards produced by VVC IT. Communication system information shall be contained in a separate section, Division 27- Communications, of the construction documents. The Design Documents shall include, but may not be limited to:
  - Drawings consisting of:
    - Legend
    - Site Plan showing OSP conduits and boxes, etc. (can be part of the electrical site plan)
    - Floor plans showing the type and number of communication cable(s) to be installed at each outlet.
    - Cable Infrastructure (cable pathway, outlet boxes locations, conduit, cable tray or J-Hook routing (can be part of the electrical drawings)
    - Telecommunication Room detailed drawings, including plan and elevation views of each room.
    - Single Line Drawing for backbones
    - Single line drawing of grounding system
    - Other construction details
  - Project Manual Specifications or Scope of Work (SOW) documentation.
- Provide the point of coordination between the Architect and Engineering team and VVC IT.

The Telecommunications Consultant is responsible for advising the Architect and other consultants when multiple Information Technology Rooms are needed in a specific building. Most frequently this will occur when the building is multiple floors. The Information Technology Rooms shall be situated so that the wiring length will not exceed 100 meters. Every building will be examined on an individual basis.

Before actual design work commences, the Telecommunication Consultant will meet with VVC IT to determine what active equipment such as network equipment (voice/data/video), servers, PBX equipment etc., will be installed in each Information Technology Room in each building. This will include a discussion of computer lab and server rooms in the building. If there are to be multiple lab and server rooms in the facility, each lab/server room will be treated as an Information Technology Room. Although the equipment will never be specified as part of a
construction projects, it is important that a clear understanding of the electrical and HVAC loading, space and connectivity requirements be understood as part of the design process for the Information Technology Rooms.

7.2 **VVC Product Standards**

The basis for the design specifications defined within this document is primarily the CommScope Systimax family of products. The approved model numbers, along with any approved equivalent are listed elsewhere. Any deviation or substitutions offered as part of this specification must be pre-approved by VVC IT. Any submittals in response to any part of this specification that do not meet the product requirements as defined, may be rejected without further consideration, or may cause monetary charges to be incurred by the submitter.

Other manufacturers have been approved for certain products required for a complete system. Those manufacturers are listed in their appropriate sections. Strict adherence to these approved manufacturers is required.

The cabling materials standards specifying data cabling components shall be branded as CommScope Systimax. This includes copper station cables, patch panels, termination blocks and jacks. The fiber backbone cable shall also be branded CommScope Systimax. As VVC moves forward, the voice and data infrastructure shall be constructed in a homogeneous, standardized fashion. This includes the specification of one manufacturer’s product line (CommScope) as the standard so across all buildings, the faceplates, patch panels and cabling will have a identical design, implementation, appearance, functionality and labeling. This will ensure a consistent functionality across all buildings.

7.2.1 OPTICAL FIBERS

Multimode Optical Fiber Cables shall:

- Be graded-index laser optimized optical fiber with nominal 50/125µm-core/cladding diameter.
- Meet the performance specifications below. Testing of the optical fiber shall be in accordance with TIA/EIA 526-14A, using power meter testing Type B. The measurements shall be performed at 23 degrees C +/- 5 degrees.

**Transmission Characteristics for multimode cabled fiber:**

<table>
<thead>
<tr>
<th>Maximum Attenuation</th>
<th>Minimum OFL Bandwidth</th>
<th>Minimum EMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5 dB/km @ 850 nm</td>
<td>1500 MHz.km @ 850 nm</td>
<td>2000 MHz.km @ 850 nm</td>
</tr>
<tr>
<td>1.5 dB/km @ 1300 nm</td>
<td>500 MHz.km @ 1300 nm</td>
<td>Not Required</td>
</tr>
</tbody>
</table>
The performance characteristics of the fiber shall also comply with those specified in TIA/EIA-568-C.3.

Single Mode Fiber Cables shall:

- Be Full Spectrum Dispersion-Unshifted Matched-Clad single mode optical fibers complying with ANSI/EIA/TIA-492CAAB (OS2) and ITU-T G.652.D.
- Have a zero dispersion wavelength between 1300 nm and 1324 nm. The ANSI/EIA/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.093 ps/km-nm². Dispersion measurements shall be made in accordance with ANSI/EIA/TIA-455-169 or ANSI/EIA/TIA-455-175.
- Provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.
- Shall support new and emerging applications that utilize extended E band, 1360 to 1460 nanometers.
- Also support existing and legacy singlemode applications that traditionally operate in 1310 and 1550 nanometer regions.
- Deliver a cost-effective upgrade path by expanding available wavelengths by 50 percent supporting 16 channels of coarse wave division multiplexing (CWDM) on a single optical fiber and up to 400 channels of dense wave division multiplexing (DWDM) on a single cable.
- Meet the performance specifications below. Testing of the optical fiber shall be in accordance with TIA/EIA 526-7, using testing Type A.1. The measurements shall be performed at 23 degrees C +/- 5 degrees.

### Transmission Characteristics for single mode cabled fiber:

<table>
<thead>
<tr>
<th>Maximum Cabled Attenuation</th>
<th>Cable Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 dB/km @ 1310/1550 nm</td>
<td>Riser (inside) Plant</td>
</tr>
<tr>
<td>0.50 dB/km @ 1310/1550 nm</td>
<td>Outside Plant</td>
</tr>
</tbody>
</table>

Applications Support

The multimode optical fiber shall couple sufficient power from light emitting diode (LED) sources to support legacy applications such as Ethernet, token ring, FDDI, Fast Ethernet, and ATM. In addition, 50 micrometer core size multimode fiber and single mode fiber shall be directly compatible with laser-based applications, as follows:

- Ethernet from 10 megabits per second to 10 gigabits per second
• Fiber channel from 1 to 10 gigabits per second

ATM/synchronous optical networking (SONET)/synchronous digital hierarchy (SDH) from OC-1 to OC-192

7.3 **OUTSIDE PLANT**

The outside plant consists of the Outside Plant (OSP) cables and structures needed to interconnect a new or renovated building to the campus. The supporting structure includes underground (in conduit) cables, conduits, maintenance holes (MH), hand holes (HH), pull boxes (PB), pedestals and outside terminals. The outside plant must be designed and installed to the NESC and ANSI/EIA/TIA-758 and 758-1 Specifications for Outside Plant Construction. All communications cables shall be located below ground in conduit or innerduct. Direct buried cables and aerial cable runs are **not acceptable**.

7.3.1 **OSP Design Activities:**

The Telecommunications Consultant will work with VVC IT and other consultants and engineers in:

- Identifying cable routes from building to building.
- Determining the underground cable requirements.
- Identifying the types of cable used in the campus segment.
- Determining conduit, maintenance hole, hand hole, and pull box requirements.
- Determining electrical protection and bonding/grounding requirements.

7.3.2 **Outside Plant Fiber Optic Cables**

VVC has specified that each building will be provisioned with multimode and single mode fiber backbones installed as a home run to the MDF on campus. OSP Fiber Optic Cables shall:

- Utilize a dielectric design with MDPE sheath jacket and no metallic elements
- Contain industry standard buffer tubes S-Z stranded around a central strength member for protection against thermal expansion and contraction at operational temperature extremes
- Be compatible with standard mounting and termination hardware, cable routing, and fan-out kits
- Contain optical fibers that are industry-standard color coded in accordance with ANSI/TIA-598-C and separated into 12-fiber color-coded binder groups surrounded by plastic core tubes
- Utilize water blocking technologies suitable for underground conduit applications.
- be suitable for temperatures of -40° to +75° C.
Outside plant optical fiber cables shall comply with the testing and test methods requirements in TIA 472D000-B/ICEA S-87-640 for its cable design.

- Outdoor cable shall have a minimum pull strength of 2670 N (600 lbf).
- Outdoor optical fiber cables shall support a bend radius of 10 times the cable outside diameter when not subject to tensile load, and 20 times the cable outside diameter when subject to tensile loading up to the cable’s rated limit.

7.3.3 OSP Fiber Optic Cable Sizing

VVC sites may be provided with new permanent buildings and temporary, semi-permanent buildings. Permanent Buildings are defined as single or multi-story buildings or clusters of portable structures that will remain for the foreseeable lifetime of the campus. Depending on the purpose, dimension or square footage of these buildings, there may be one or more telecommunication rooms identified in these structures. Semi-permanent or temporary buildings structures consist of trailers, modular buildings or other structures defined to have a limited life span and usage less than three years. Semi-permanent buildings may be used as “swing space” during renovations, temporary offices for contractors and consultants or special purpose buildings for campus activities. As such, they are provided with a limited complement of fiber backbone cabling, compared to that for permanent buildings.

Where new conduit infrastructure is installed with unused conduits, all shall be equipped with a 3/8” nylon pull rope, to facilitate future cabling installations.

**Design Guidelines for Permanent Buildings:**

Permanent buildings will be equipped with outside plant backbone cables to the Main Telecommunications Room. For each building, outside plant backbone fiber will consist of, as a minimum, a 24-strand, 50/125-micron multimode and 12-strand single mode fiber bundle. This can be provided as two separate cables or one composite cable where both fiber types are contained under a single cable jacket. The composite cable is preferred for pathways that are limited in space. The backbone cables will be run as home runs with no splices, back to the MDF for the campus or site.

Where diverse pathways exist, a redundant set of backbone fiber cables is required for building connectivity. Redundant backbone cabling will be of the same type and composition as the primary fiber backbone cabling. The route and termination point of redundant fiber backbone cabling will be designed in conjunction with VVC IT.

**Design Guidelines for Semi-Permanent or Temporary Buildings:**

Semi-Permanent buildings typically house smaller numbers of staff/students and require less connectivity than permanent buildings. Outside plant fiber backbones feeding semi-permanent buildings will consist at a minimum, of a 12-strand, 50/125-micron multimode fiber bundle. Fiber backbones for semi-permanent buildings may route to the Building Telecommunication Room of the nearest permanent building, or may route back to the Main Telecommunications Room. The design of the backbone routing will be determined in conjunction with VVC IT staff.
7.3.4 General Installation Guidelines for Optical Fiber Cables

All fiber optic cable shall be installed as follows:

- For OSP cables, use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate the cable or conduit.
- All cable/cabling shall be kept 30 inches away from any heat source; i.e., steam valves, etc.
- Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
- Cables shall not be pulled across sharp edges. All conduits and sleeve with rough edges will be provided with bushings on both ends. Cables shall not be forced or jammed between metal parts, assemblies, etc.
- Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
- Cable splicing will not be permitted at any point within a cable run.
- Conduits will not be filled to greater than a 40% fill.
- Outside Plant Conduits must have appropriately size pull-boxes every 300 to 500 feet. When the conduit routes through up to a total of two 90 degree bends (180 degrees total) in any dimension plane, additional pull-boxes are also required. Cabling will not be installed in conduits that do not meet these specifications.
- Cable mountings and service loops on backboards inside Information Technology Rooms will be installed efficiently to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be tie-wrapped every 4 to 6 feet.
- All outside plant cables will be terminated within 50 feet of the entrance point. This is a maximum cable measurement and includes lengths for service loops, routing, back-board, and patch panel mounting inside the building.
- Polarization for entire system shall be maintained as described in ANSI/EIA/TIA-568-B section 12.7.1.
- All optical fiber cables shall be terminated on rack-mounted optical fiber patch panels. No fiber will be left un-terminated.
- All vacant innerducts shall be capped.

7.3.5 Copper Outside Plant Cables

VVC is in the process of converting to voice-over-IP connectivity on a campus to campus basis which may have significant implications for UTP cabling. In those cases, a minimum of 25 pairs is required. This needs to be carefully evaluated during the design process. All pair counts for backbone UTP cabling will be verified with VVC IT during the design phase.

Physical Characteristics:
• Backbone UTP copper cables shall consist of a core of 24 AWG solid annealed copper conductors, color-coded in accordance with telephone industry standards.
• As a minimum, UTP copper backbone cables will be UL Verified Category 3 and will meet or exceed the Category 3 requirements in ITO/IEC 11801, CENELEC EN50173 and EIA/TIA 568B.
• Conductors shall be twisted to form pairs. Cable having more that 25 pairs shall be assembled in units, each individually identified by color-coded unit binders.
• The mutual capacitance of any pair shall not exceed 5.6 nF per 100 m at 1 kHz.
• The core shall be covered with a plastic tape.
• The cable will be designed for use in the outdoor environment, with a gel-filled design to be used in wet locations. This includes an aluminum steel with polyethylene (ASP) sheath and a core of solid-copper conductors, dual insulated with foam skin and plastic, and surrounded by a gel filling compound.
• Outside Plant Cable installations will meet all ITO/IEC 11801 requirements for a horizontal link. No more than 4 connections are allowed, including the protection devices at each end.
• All multipair outside plant cables and riser or plenum multipair cables must be accepted by CommScope to be part of their end to end warranty.

**Design Guidelines for Permanent Buildings:**

The current PBX voice/voicemail systems are based on analog and digital connections requiring one twisted pair per telephone set. OSP pair counts will be estimated based on the following active pair utilization. VoIP implementations may use data cabling to support phones except as noted in 3.12.16:

- Classroom: one telephone
- Computer lab: one telephone
- Large lecture hall: two telephones
- Theatre: two telephones
- Single-person Office: one telephone,
- Partitioned office: one per cubicle, plus three additional per ten cubicles
- Conference room: one telephone, one speaker phone
- Maintenance room*: one telephone
- Security/Monitoring: one telephone per 1000 square feet
- Payphones: one per building

* Maintenance room is defined as: Information Technology room, electrical room, HVAC/EMS control room, other control space.
This does not include estimates for phones external to buildings such as parking lot call boxes, pedestal payphones, etc. Additional pair counts will be included when the analysis of the building location is performed. The Telecommunications Consultant will allow for a growth factor of 20% and estimate the pair count upward to the next size cable.

Consideration for installing a redundant copper cabling for building connectivity will be determined on a building-by-building basis. Redundant backbone cabling is defined as the use of a two copper connections between equipment rooms, ideally routed in separate paths to ensure no single point of failure.

**Design Guidelines for Semi-Permanent or temporary Buildings:**

Backbone UTP copper cabling for these structures are to follow the same usage estimates as shown above for Permanent buildings, except to add a growth factor of 10%.

7.3.6 General Installation Guidelines for Copper Cables:

- Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable or conduit. Adhere to all manufacturers’ requirements regarding pulling tension and allowable lubricants.
- All cable/cabling shall be kept 30 inches away from any heat source; i.e., steam valves, etc.
- Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.
- Cables shall not be pulled across sharp edges. All conduits and sleeve with rough edges will be provided with bushings on both ends. Cables shall not be forced or jammed between metal parts, assemblies, etc.
- Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.
- Cable splicing will not be permitted at any point within a cable run.
- All outside plant backbone cables will be installed in conduit. Aerial runs are not permitted.
- Conduits will not be filled to greater than a 40% fill.
- Conduits must have appropriately size pull-boxes every 300 feet. When the conduit routes through up to a total of two 90 degree bends (180 degrees total) in any dimensional plane, pull-boxes are also required. Cabling will not be installed in conduits that do not meet these specifications.
- Backbone cables will be installed with a 30 foot service loop. At each building, the service loops will be coiled neatly in the pull box or nearest hand hole on the building’s exterior wall. Cable mountings and service loops on backboards will be installed efficiently to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be tie-wrapped every 4 to 6 feet.
- Cable shall be continuous and without splices (Splices imply same pair count cable splices: i.e.: 200-pair to 200-pair).
- Verify all actual cable distances. Shall not exceed 100 meters.
7.3.8 Copper Protection

All copper backbone cables that extend between buildings will be terminated at both ends on protector blocks.

- All pairs at both ends of the copper backbone cable shall be protected.
- The protector blocks will be housed within a covered case. Protectors will be sized for the termination of all pairs in the copper backbone cable.
- The protector blocks shall be fully populated with solid-state or gas-tube protection fuses.
- The protector blocks will contain an integrated 110 block for extension to the building cross connect fields or patch panels.
- The protection block shall have an integrated 26 AWG stub.
- The protection blocks shall be grounded with a #6 AWG copper bonding conductor between the protector ground lug and Telecommunications Grounding Busbar.
- Copper extension cables shall be installed from the protector blocks to the copper patch panels, extending one pair per jack.

In the event that copper backbone cabling is added to building areas where existing cabling is not protected, the Contractor shall retrofit the existing cabling with protector blocks according this standard.

7.4 RISER SEGMENT

VVC campuses have a limited number of multi-storey buildings. However the layout of the buildings may require several distributed closets to allow station cabling to stay within the 295 foot length limitation, or to accommodate difficult or limited cabling pathways. As such, the installation of “riser” cabling includes vertically stacked Telecommunication Rooms, or horizontally dispersed Telecommunication Rooms.

7.4.1 Fiber Optic Riser Cable.

Buildings that contain multiple Information Technology Rooms will require fiber backbone cabling installed between the rooms. If the Information Technology Rooms are on the same floor then, plenum rated (OFNP) cables shall be used. If the Information Technology Rooms are on different floors then riser rated (OFNR) or plenum rated (OFNP) cables shall be used. In all cases the local authority having jurisdiction (AHJ) makes the determination if a cable link must
be riser or plenum. All riser fiber backbones will consist, at a minimum, of a 24-strand, 50/125-
micron multimode and 12-strand single mode fiber bundle. This can be provided as two separate
cables or one composite cable where both fiber types are contained under a single cable jacket.
The composite cable is preferred for pathways that are limited in space.

- Inside plant optical fiber cables shall comply with the testing and test methods
  requirements in TIA 472C000-B/ICEA S-83-596 for its cable design.

- Inside plant cables shall support a bend radius of 10 times the cable outside diameter
  when not subject to tensile load, and 20 times the cable outside diameter when subject to
  tensile loading up to the cable’s rated limit.

7.4.2 Innerduct

For identification purposes, all inside plant fiber shall be installed protected in proper UL listed,
1-½ inch innerduct. All innerduct installed through riser systems and in ceiling spaces shall be
plenum-rated, whether the ceiling space is plenum or not. Use of split duct innerduct is only
acceptable in retrofit applications where existing exposed fiber exists but is not already
protected.

All new installations of innerduct must be orange in color. In existing spaces, installation of
additional innerduct should match manufacturer and color of existing duct, if any exists. All
innerduct shall be placed in conduit or in cable tray, adhering to all manufacturer installation
guidelines. Exposed innerduct must be supported every 48 inches.

Alternatively, interlocking armored cables may be used in place of fiber cable in innerduct.
Interlocking armored cable consists of an aluminum tape formed around a regular premises
distribution cable, with an overall sheath jacket to provide additional protection and security.
Available in Riser or Plenum-rated, the sheath is color-coded to optical fiber type and printed
with relevant cable information.

7.4.3 Copper Riser Cable

The riser pair count shall be equal to the number of voice stations served by the
Telecommunications Room with a 20% growth factor. Cable sizes will be rounded to the next
multiple of 25, 50 or 100 pairs.

The cable shall be Category 3 UL listed CMP rated. All pair counts for backbone UTP cabling
will be verified with VVC IT during the design phase.

7.4.4 Coaxial Riser Cable

The coaxial riser cable shall be .500 plenum (rigid or quantum reach) cable run between and
interconnecting each serving BDF/IDF. From each BDF/IDF, the cable will also be used to
distribute signal on to each floor to ensure a balanced distribution of CATV signals throughout
each floor and building. Refer to section 16740 of the “Sample Specifications” document set for a complete description of specifications.

7.5 **OPTICAL FIBER TERMINATIONS**

7.5.1 Fiber Patch Panels

Optical fiber patch panels shall meet or exceed the following specifications:

- Must be rack mounted.
- Must be configured in duplex LC style termination configurations.
- Must be completely covered.
- Must be available as a 4U high-density (up to 288 fibers) shelf for Main and Building Telecommunication Room installations or 24-connector 1U trays for smaller Telecommunication room backbone terminations.
  
  - **CommScope Systimax 360 iPatch ready panels will be substituted for planned iPatch installation areas as designated by VVC IT.**

7.5.2 Optical Fiber Connectors

Field termination is required for all fiber strands in the telecommunications rooms. No fiber is to be left unterminated.

- All connectors are to be anaerobic field-installable LC duplex connectors.
- LC connectors shall meet ANSI/EIA/TIA-604-10 standards.
- Must contain an insertion release mechanism similar to RJ45 type plug
- Must be pull-proof to prevent momentary disconnect from axial loads.
- Temperature stability (–40°C to +75°C) insertion loss change: 0.3 decibels maximum
- Cable retention: 0.91 kilograms (2 pounds) minimum for buffered fiber and 4.5 kilograms (10 pounds) for 1.6 mm jacketed cordage.
- Multimode duplex connectors shall be aqua.
- Single mode duplex connectors shall be blue.
- Single mode connectors for broadband analog video (CATV) applications shall utilize an angled polish and shall be green.
- The average insertion loss shall be 0.10 decibels for multimode; 0.10 decibels for singlemode (Standard deviation of 0.1 dB).
- Maximum Loss per connector pair must conform to manufacturer’s guidelines.
• Multimode connectors shall have a return loss greater than or equal to 20 dB.
• Single mode connectors shall have a return loss greater than or equal to 26 dB.
• Single mode connectors for broadband analog video (CATV) applications shall have a return loss greater than or equal to 55 dB
• Mating durability for 500 re-connects insertion loss change: 0.2 decibels maximum.

7.6 COPPER PUNCH DOWN BLOCKS

All new copper backbone cables will be terminated on rack-mounted patch panels, one pair per RJ-45 jack. This will facilitate moves and changes via patch cords from the station jack instead of cross-connect wire.

Punch down blocks will be used for cross-connect of existing copper backbone. Blocks shall meet or exceed the following specifications:

• 110 style termination blocks.
• 100- or 300-pair blocks as appropriate for the density of the terminations.
• Labeled per ANSI/TIA/EIA-606-A
• Supplies with connecting clip, designation strip, plastic covers and retaining clip necessary to terminate cables, including but not limited to:
  • 4-pair connecting clip for horizontal copper cabling (When terminating 4-pair cables).
  • 5-pair connecting clip for backbone copper cabling (When terminating high pair count copper cables).
• Installed on plywood backboard so that the top of the highest block is no higher than 5 feet 6 inches above the finished floor.
7.7 **HORIZONTAL STATION CABLE**

All cabling projects at the VVC sites shall be installed with the most current ratified standard available at the time of the cabling project. At the time of publication of this document, the current cabling standard is Category 6A. To support a complete Category 6A channel, all cabling components will be certified for Category 6A transmission. This includes patch panels, cross-connect blocks, patch cords and outlet jacks.

The conduits will need to be sized to maintain 40% fill based on the selected and approved cable (OD .285) (CommScope 2071) cable.

This document requires the specification of plenum cabling rated as “CMP” for all new installations of cabling at Campus sites. Although functionally identical, station cabling for different transmissions systems shall be cabled with different colors cable sheaths for ready identification. The cable sheaths will be blue for data and white for voice. Other low-voltage subsystems must specify cabling with different color sheaths, so as to avoid confusion with voice/data cabling. The Telecommunications Consultant will coordinate with consultants and designers of other cabling systems to ensure that cable sheath colors are kept discrete. Cable colors for different low voltage systems will be coordinated by VVC Information Technology.

7.8 **VOICE/DATA JACKS**

Although the cabling infrastructure for voice and data jacks is functionally identical, at the work area outlet, the modular jacks shall be color coded to designate the preferred purpose of the jack. The jack colors are white for voice and red for data.

Voice/Data jacks shall be 8-position modular jacks and shall be Category 6 performance as defined by the references in this document including ANSI/TIA/EIA -- C.2 performance requirements. All pair combinations must be considered, with the worst-case measurement being the basis for compliance.

Modular jack performance shall be third-party verified by a nationally recognized independent testing laboratory.

- The jack shall be CommScope MGS400 Series GigaSPEED XL series. Color as required by VVC IT.
- The punch down scheme shall be T-568B.
- The jack shall be Cat 6 rated, with a Cat 6 NEXT performance and have a minimum of 6.0 dB of headroom above TIA 568b Cat 6 specification
- The eight-position jack shall accommodate six-position modular plug modular cords without damage to either the cord or the module.
- The jack shall have all of its housing components made of fire-retardant UL 94V-0 plastic.
- The jack shall have a protective cap that snaps in the back of the module to provide strain relief for the conductors after termination.
• The jack shall have a minimum Insulation Resistance of 200 mega ohms.
• The jack shall be FCC Part 68, Subpart F compliant.
• The jack shall be IEC-603-7 compliant.
• The jack durability shall be greater than 750 mating cycles (cable insertion/removals).
• The jack maximum Current Rating shall be 1.5 amperes.

7.9 **WORK AREA OUTLETS**

The standard work area outlet configurations used on the Campus are as follows:

**For non VoIP installations**

- **Type A:** Voice/Data outlet is defined as one (1) voice and one (1) data cable, terminated in a six-port faceplate, usually at a height of +18” A.F.F. Typical installation: conference room.
- **Type B:** Data outlet is defined as two (2) data cables usually at a height of +18” A.F.F. Typical Installation: classroom.
- **Type C:** Voice/Data outlet is defined as two (2) voice and two (2) data cables, terminated in a six-port faceplate. Typical installation: administrative office.
- **Type D:** Data outlet is defined as four (4+) data cables, terminated in an eight-port faceplate. Height varies with installation. Typical installation: computer lab.
- **Type E:** Voice outlet is defined as one (1) voice cable, terminated in a one-port metal faceplate, for wall-mount telephones at a height of +48” A.F.F. Typical installation: classroom, corridor.

**For VoIP installations**

The Telecommunications Design Architect and Campus IT representatives must meet to define the requirements for this type of installation. Project prints and Bid Documents need to be clear as to the type and style of cable and jacks to install including provision for adequate services for Fire/Life/Safety devices as defined in Section 3.12.16.

- **Type A.V:** Voice/Data outlet is defined as two (2) data cables, terminated in a six-port faceplate, usually at a height of +18” A.F.F. Typical installation: conference room.
- **Type B.V:** Data outlet is defined as two (2) data cables usually at a height of +18” A.F.F. Typical Installation: classroom.
- **Type C.V:** Data outlet is defined as two (2) data cables, terminated in a six-port faceplate. Typical installation: administrative office.
- **Type D.V:** Data outlet is defined as four (4+) data cables, terminated in an eight-port faceplate. Height varies with installation. Typical installation: computer lab.
- **Type E.V:** VoIP outlet is defined as one (1) data cable, terminated in a one-port metal faceplate, for wall-mount telephones at a height of +48” A.F.F. Typical installation: classroom, corridor.

Refer to Section 9 for typical faceplate drawings.

7.10 **OUTLET DISTRIBUTION**
The typical outlet styles described in the preceding section will be installed according to room function. In addition to the general outlet information detailed in Section 3.11, the following specific outlets types are required for each room:

<table>
<thead>
<tr>
<th>Room Type</th>
<th>Outlet Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Person Office*</td>
<td>Two (2) Type C/(C.V) outlets to maximize flexibility in placing desks and furniture. One (1) Type C outlet at conference table.</td>
</tr>
<tr>
<td>Cubicle/Partitioned Office</td>
<td>One (1) Type C/(C.V) outlet per cubicle in modular furniture communications raceway/trough as available. Outlet provisioned with fittings to hold jacks securely. One (1) additional Type C/(C.V) outlet for each four cubicles for support of fax/shared printers, etc.</td>
</tr>
<tr>
<td>Conference room</td>
<td>One Type A outlet on front wall by “whiteboard” or presentation screen One (1) Type A/A.V outlet every ten feet of wall within three feet of electrical outlets, minimum one outlet per wall. One (1) Type B/B.V outlet centered in ceiling by location for ceiling projector.</td>
</tr>
<tr>
<td>Instructional Classroom</td>
<td>One (1) Type C/C.V outlet at instructor’s podium. One (1) Type B/B.V outlet every ten feet of wall within three feet of electrical outlets, minimum one outlet per wall. One (1) Type B/B.V outlet centered in ceiling by location for ceiling projector. One (1) Type E/E.V outlet at main entrance to classroom, for wall-mount telephone. Where classrooms contain network-attached electronic whiteboards, add one data cable routed in wall as needed to whiteboard location.</td>
</tr>
<tr>
<td>Work/Prep room</td>
<td>One (1) Type E/E.V outlet at room entrance. Multiple Type A/A.V outlets distributed every six feet above counter top. One (1) Type C/C.V outlet at photocopier location.</td>
</tr>
<tr>
<td>Storage Rooms‡</td>
<td>One (1) Type E/E.V outlet at room entrance.</td>
</tr>
<tr>
<td>Maintenance Rooms‡</td>
<td>One (1) Type E/E.V outlet at room entrance. Multiple voice/data cables to system controllers that have modem or Ethernet connection requirements. If an office/desk for maintenance personnel are included in the maintenance room, add: One (1) Type A/A.V outlet for every desk location.</td>
</tr>
<tr>
<td>Rooftops</td>
<td>One (1) Type A/A.V outlet in weatherproof box. Multiple voice/data cables to rooftop HVAC or other controllers that have modem or Ethernet connection requirements routed in conduit with weatherproofing.</td>
</tr>
</tbody>
</table>

* Single Person offices may often be reconfigured to be shared by multiple part-time staff, with several desks, phones and computers.
‡ Storage rooms are often converted to offices after the fact.
Payphone

One (1) Type E outlet at each location designated for payphone or TTY phone.

Emergency Phones (corridors, Elevators, foyers, parking lots, bus stops)

One (1) Type E outlet or cable with custom termination located at every location as required by security plan. OSP cable required for all below grade or routing to building exterior.

Change Rooms

One (1) Type E outlet at room entrance.

The following are general guidelines for computer labs. Each computer lab must be custom designed, incorporating the size, purpose, furniture layout, and floor type into the detailed design.

### Room Type | Outlet Types
--- | ---
Instructional Computer Lab | Two (2) Type B/B.V outlets on front wall, one on each site of the “whiteboard” or teaching wall. One (1) Type B/B.V outlet centered in ceiling by location for ceiling projector. One (1) Type E/E.V outlet at main entrance to classroom, for wall-mount telephone. Multiple Type D/D.V outlets distributed around room periphery, usually in metallic raceway mounted at +6” above tabletop. Number and exact location of outlets varies with room size and placement of computer tables in room.

Self-Study Computer Lab | One (1) Type B/B.V outlet centered in ceiling by location for ceiling projector. One (1) Type E/E.V outlet at main entrance to classroom, for wall-mount telephone. Multiple Type D/D.V outlets distributed in walls, wall-mount raceways and flush-mount floorboxes. Pathways will not obstruct pedestrian traffic or viewing. In particular pancake raceway, or power poles are to be avoided.

Specialty locations such as theatres, auditoriums, press boxes, large lecture halls, pools, playing fields and for scoreboards and advertisement boards require custom design according to the proposed functionality. It should be assumed that each specialty device will require a data or voice connection for current or future connectivity. As a minimum, two Category 6 cables shall be provisioned for each location. Where cabling runs below grade or is exposed to the building exterior, outside plant cable shall be required. Cables will be provisioned within the 90 meter length requirement for data connectivity.

### 7.11 Faceplates
The standard faceplate configuration is single-gang faceplate providing for four ports of connectivity. Configurations of any additional number of ports are subject to the approval of VVC IT.

- The faceplate housing the jacks shall provide a symmetrically centered appearance for the modules.
- Snap-in inserts shall be provided to cover any unused openings in the faceplate. Inserts are removable for future installation of additional jacks.
- It shall be possible to install the jacks in wall-mounted single- and dual-gang electrical boxes, utility poles and modular furniture (cubicle) access points using manufacturer-supplied faceplates and/or adapters.
- The faceplate housing the jacks shall have a labeling capability using built-in labeling windows, to facilitate outlet identification and ease network management.
- The faceplate housing the jacks shall accommodate up to a maximum of six modules in a single-gang form and up to a maximum of twelve modules in a dual-gang form.
- The faceplate housing the jacks shall provide flexibility in configuring multimedia workstation outlets that respond to present or future network needs such as audio, video, coaxial and optical fiber applications.
- The color of the faceplate shall be coordinated with the color of the surrounding electrical outlets, usually as Electric Ivory or Electric White. No metal faceplates will be allowed, except as required for extra durability at wall-mount telephone locations.

7.12 **COPPER PATCH PANELS**

Category 6 patch panels will be used for termination of all voice and data station cabling. Category 6 patch panels shall meet or exceed the following specifications:

- TIA 568B.2-1 Category 6 standard.
- Rack mounted with front-facing RJ-45 patch panels and rear-facing 110 blocks.
- Will be T568-B wired.
- Have a paired punch down sequence to allow pair-twist within ½-inch of the termination.
- RJ-45 jacks will be modular to allow discrete removal and replacement of jacks without removal of the entire patch panel, as maintenance issues arise.
- UL listed.
- Made of rolled edge black anodized aluminum construction.
- Must have 48 ports with integrated cable management ring and rear cable suspension racks.
- CommScope 1100GS3 GigaSPEED XL series panels 24 or 48 port as required by VVC IT by applications. Angled panels are approved as alternate as required by VVC IT
- **CommScope Systimax 360 iPatch ready panels will be substituted for planned iPatch installation areas as designated by VVC IT.**

Rear patch panel cable management should include the 2-inch or 5-inch cable support bars. Category 6 requirements require the cable to enter perpendicular to the termination and the cable
bar facilitates this requirement. All cable bundles on cable support bars will be managed with Velcro straps. Tie-wraps are not acceptable.

7.13 **GROUNDING AND BONDING**

The Telecommunication Consultant will work with the Electrical Designer to insure a Telecommunication ground system is installed per J-STD-607-A Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications. This Telecommunications Ground System shall be installed to support the Information Technology Rooms and Infrastructure. The design of the grounding infrastructure is described below.

A Telecommunications Main Grounding Busbar (TMGB) shall be located in the Building Telecommunications Room. The TMGB shall be a predrilled copper busbar provided with standard NEMA bolt hole sizing and spacing. The TMGB shall be electrotin-plated for reduced contract resistance. The TMGB shall be a minimum size of 5 mm thick, 100 mm wide and 300 mm in length. The TMGB shall be insulated from its support by a 50 mm separation.

The TMGB will be bonded to the electrical panel ground bus bar and to building steel or ground rod by conventional welds, exothermic welds clamp-and-braze method, or UL approved compression type connectors where practical. Exothermic welds are the preferred method. Because of the high temperatures involved, copper materials may be bonded to iron or steel. The mold size must match the cable or conductor cross section. The size of the weld metal charge must match the size of the mold being used. The connection between the TMGB and the bonding point is to be 3/0 insulated copper ground wire.

In each Telecommunications room, a Telecommunications Grounding Busbar (TGB) shall be installed. The TGB shall be a minimum size of 5 mm thick and 50 mm wide and 150 mm long. The TGBs shall be bonded to the electrical panel serving the rooms were the TGB is installed, bonded to building steel, and bonded in series to the main TMGB.

All metallic structures (racks, cabinets, cable runway, etc.) shall be attached to the TGB using grounding straps. Use minimum of #6 AWG, green jacket, stranded grounding wire between all equipment racks and the existing telecommunications grounding busbars. Metallic straps shall be used to join individual segments of cable runway, relay racks, equipment and other metallic structures. All metallic structures will be stripped of the paint coating at the point of grounding connection to ensure that the metallic straps and ground wires mate to the metal structure with sufficient contact.

The electrical contactor shall install and bond the main components of the system (busbar, ground rod, ground wire to grounding source, etc.) The cabling contractor shall install the connectivity to the metal components of the cabling system, including voice protectors, racks, cable runway, cabinets, patch panels, etc. The Telecommunication Consultant shall ensure that the communication specification/RFP calls for the bonding of all components within the Information Technology Rooms.
7.14 **RACK/CABINET LAYOUT (ELEVATION)**

All equipment in racks must follow the general guidelines provided below in regards to placement within the rack or cabinet.

**Fiber Patch Panels:** All fiber patch panels shall be placed at the highest point possible in the rack or cabinet. Single mode fiber patch panels will be mounted above the multimode fiber patch panels. Fiber patch panels will have integrated cable management in the front and cable guides in the rear.

**Copper Patch Panels:** All copper patch panels will be installed below the fiber patch panels. Wire management will be integrated in the copper patch panels.

**Wire Management:** The horizontal wire managers will be supplied to route patch cords to the network equipment. One horizontal wire manager is required for each 48-port patch panel or 48-port network switch.

**Network Equipment:** All network equipment will be installed such that wire management is located directly above and below each network switch, alternating down the rack. For easy access, network equipment will be mounted between waist and neck height on the rack (3’ to 5’ A.F.F). **NOTE:** Network equipment will not be included as part of any construction bid, but are important considerations in the design of appropriate racking/cabinet layouts.

**Power management:** Where rack-mount Uninterruptible Power Supplies (UPS) are provided, UPS units shall be installed at the base of the rack. Surge-protected power strips shall be installed midway in the rack/cabinet, above the network equipment, to allow for easy access to equipment power cords. Care must be exercised to ensure that power conduits do not block access to mountable rack space.

7.15 **FLOOR MOUNTED RACKS**

All racks will be floor-mounted, open, two or four post (coordinate with campus IT before selecting rack model), self-standing relay racks. Racks shall meet the following physical specifications:

- 19-inch wide rack mounting space.
- 84 inches high.
- Lightweight aluminum construction.
- Black polyurethane finish.
- Equipped with at least four (4) ⅜-inch bolt-down holes.
- Each rack shall have double-sided tapped holes with standard EIA hole pattern.
- CommScope RK3-45A

Each rack will have an integral vertical cable channel with a minimum of 6.5” of channel space to facilitate the vertical cable management of the cables entering the rack from the under floor and above ceiling cable tray. Each rack will be supplied with a bag of bolts matching rack color.
and threading for mounting equipment in the rack. All racks will be installed with a minimum of 3’ of clearance from the mounted equipment on front and rear sides. All racks shall be properly anchored to the slab floor using all four (4) holes. Per DSA approved design, the anchoring will use Hilti ½” anchor bolts which pass a 45 lb torque test. If racks are located over raised floors, the racks shall be installed with Raised Floor Rack support units that include threaded rod, z-braces and anchors that securely attach the rack to the building structure (slab).

Each rack shall be equipped with a rack-mounted horizontal power strip. All power strips shall meet or exceed the following specifications:

- Shall be 20 amp, 115V.
- Shall be rack mounted.
- Shall be non-switched.
- Shall be fusible and provide surge suppression.
- Shall have a visible AMP meter.
- Shall have a minimum of 6 outlets – transformer spaced.
- Power switch will be lockable to prevent accidental power-down.
- Power cord shall be a minimum of 10 feet in length.
- Shall meet UL 1363 and 1449 requirements.

7.16 **Floor Mounted Cabinets**

When Information Technology rooms must coexist with infrastructure for other electrical or low voltage systems, the Information Technology infrastructure will be completely concealed in lockable telecommunication cabinets. Floor-mounted cabinets are preferred. These cabinets will be

- Self-standing structures.
- Sized as a 32”W x 32”D x up to 84”H.
- 19-inch wide rack mounting space.
- Lockable, with common key set for all cabinets from one manufacturer.
- Black in color, with fully vented front and rear doors, removable front and back doors and vented side panels.
- Equipped with manufacturer provided seismic kit, rated for Zone 4.
- Contain internal adjustable rails upon which patch panels, wire managers and network equipment shall be installed.
- Contain knockouts for and cable routing. Any knockouts used for cable routing will be wrapped with bushings to prevent the rough edges of the knockout from damaging the cabling.
- Server Cabinets must be rated for a minimum of 2000lb
- Network Cabinets must be rated for a minimum or 1100Lbs
- All cabinets must have a minimum of 3 separate rails settings available concurrently

All cabinets shall be mounted with a minimum of 3 feet clear access in front, back and sides of cabinets. All cabinets shall be properly anchored to the slab floor using manufacturer-provided
seismic bracing kit. Per DSA approved design, the anchoring will use Hilti ½” anchor bolts which pass a 45 lb torque test.

Per grounding described above, cabinets will be grounded to the TGB with a minimum #6 AWG copper wire.

7.17 **CABLE WIRE MANAGEMENT**

Where integrated cable management systems are not available, vertical and horizontal cable management systems will be provided. There shall be horizontal and vertical cable management associated with all racks. Cabinets will be provided with horizontal cable management. Use of finger duct style management with hinged covers is preferred. All horizontal and vertical cable managers should utilized rounded edges and avoid sharp bends in the installed cables.

Vertical cable managers with covers are required on all racks and in between racks to facilitate cable management and routing between the racks. The vertical cable managers will be the finger-duct style with integrated cable guides. For single racks, a minimum size of a 4”Wx 8”D channel is required on each side of the rack. For multiple racks, a minimum 6”Wx 16”D channel is required between the racks. If two or more racks are installed side-by-side, install cable managers in between and on the end of racks. Vertical cable managers will be double-sided with lockable hinged covers that can be opened in either direction or removed completely. Pass-through slots will provide access from the front to rear cable channels. Vertical cable managers will be sized to extend the complete length of the relay rack. The covers will be one piece for the entire height of the rack.

Horizontal cable managers will be provided for every 48-port patch panel that is installed. The horizontal wire managers will be used to manage patch cord connections to the network switch equipment since the patch panels will have integrated cable management. The horizontal cable managers will be double-sided and 3.5” H. The covers will be hinged and can be opened up or down, or be completely removable as needed.

All cable bundles inside of cable managers will be managed with Velcro straps. Tie-wraps are not acceptable.

7.18 **CABLE RUNWAY**

All cabling run exposed horizontally in an Information Technology Room must be routed using cable runway (ladder rack).

- Cable runway shall be appropriately secured to walls and top of equipment rack/cabinet per manufacturer recommended guidelines.
- Cable runway shall be grounded to the telecom grounding bus-bar using a minimum #6AWG ground wire. Metallic straps shall be used to join individual segments of cable runway. All metallic structures will be stripped of the paint coating at the point of
grounding connection to ensure that the metallic straps and ground wires mate to the metal structure with sufficient contact.

- In new construction, all cable runways will be black in color. In existing spaces, installation of additional ladder rack should match manufacturer and color of existing ladder, if any exists.

7.19 CABLE PATHWAYS

In accessible main corridors, the use of a wire basket tray system is the preferred method for the main cable path. At least 12” of clearance is needed above the cable tray and the cable tray must have a minimum clearance of 12”-18” on one or both sides. Cable tray shall be appropriately secured to ceiling deck and grounded per manufacturer recommended guidelines.

For distribution from the main cable path to discrete outlet locations, J-hook suspension is acceptable. Cables shall be supported by J-hooks every 4 to 6 feet. A J-hook shall be installed above every outlet location, on which a 12” service loop of station cabling will be attached. J-hooks shall be independently supported and not attached to existing conduit, ceiling/lighting structures or other suspension apparatus. J-hooks shall be installed according to the manufacturer’s instructions.

J-hooks will not be overfilled beyond their specified capacity. Where dense cable runs create large bundles of cables and cable runway is not available, the cable bundles will be split and supported on multiple J-hook routes. Cable bundles will not exceed 50 cables. Bundles of cable will be tie-wrapped to the J-hook to prevent cables from spilling out in the event of an earthquake or other disturbance. J-Hook installation shall be made part of work of the cable installation contractor.

7.20 CABLE INSTALLATION METHODS

The Contractor shall adhere to cable installations methods that will ensure that the cabling transmission is not adversely effected in any possible manner. This includes strictly adhering to the manufacturer’s installation methods and workmanship described as follows:

1. When placing cable, the contractor shall maintain the following clearances from sources of electro-mechanical interference (EMI):
   - Main Power panel: 6 feet
   - Power cable - 12 inches
   - Fluorescent Lights - 12 inches
   - Heat source: 30 inches
   - Transformers – 6 feet
2. All power feeds crossing the path of the UTP cables at right angles must be a minimum of 12 inches in distance from the UTP cables.
3. The cables shall be placed at a minimum of 18 inches above the ceiling.
4. The cables are to be as accessible as possible.
5. Pull conductors together where more than one is being installed in a raceway. Cable bundles in suspension systems or on wallboards must be velcro-wrapped every 4 feet.
Strapping to any other wires (e.g. lighting ceiling grid, etc.) will not be permitted. Station wire cannot be attached to electrical conduit, gas or sprinkler piping, or other code-restricted items.

6. Use pulling compound when necessary; pulling compound must be a water-base pulling lubricant that will not deteriorate cable sheath or conduit.

7. No cabling is allowed to rest on any ceiling tile or suspension system.

8. Cables shall be pulled free of sharp bends, kinks, twists, or impact damage to the sheath.

9. Cables shall not be pulled across sharp edges. Bushings will be installed on rough sleeve or conduit edges before cable installation takes place. Cables shall not be forced or jammed between metal parts, assemblies, etc.

10. Cables shall not be pulled across access doors and pull box covers. Access to all equipment and systems must be maintained.

11. Insulation shall be removed to expose shielding and conductors to the exact length required by manufacturer for proper termination of plugs and pins and as specified in EIA/TIA 568B/569.

12. Pins and plugs, upon termination, shall not be damaged in any way.

13. Cable guides and suspensions (J-hooks, cable runway, waterfalls, etc.) shall be provided to ensure that the cable path is securely suspended and adheres to the manufacturer’s bend radius.

14. Cable splicing will not be permitted at any point within a cable run.

15. Cable mountings on backboards will be installed efficiently (no divers), to minimize the backboard space consumed. All cables will be routed at right angles, in accordance with the bend radius specifications for the type of cable being routed. Cables will be Velcro-wrapped every 4 to 6 feet and routed through D-rings for a neat appearance and manageability.

16. Fiber optic OSP cable additional considerations: Consult cable manufacturer for maximum tensile load and minimum bend radius for each size of cable used. Note that installation bend minimum bend radii are larger than “at rest” bend radii. Sheaves used to help guide the cable into innerducts also must meet installation minimum bend radii. Continuously monitor pulling tension and use a breakaway swivel to minimize cable twist.

7.21 **Fiber Optic Cable Testing and Test Results**

**General Test Requirements**

Provide complete end to end testing for all fiber optic systems/channels based on latest applicable standards. Document all testing and submit with final as-built submittal package.

Optical fiber cabling shall be tested and certified after installation as described below and as required for cable manufacturer’s warranty. Fiber testing shall be performed on all fibers in completed end to end system. Testing shall consist of a bi-directional end to end test in accordance with EIA/TIA-455-53A. The system loss measurements shall be provided at 850 and 1300 nanometers for multimode type glass and 1310 and 1550 nanometers for single-mode type glass. These tests shall also include continuity checking of each fiber. Each tested span must test
to a value less than or equal to value determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be less than or equal to 2.0 decibels. The insertion loss for each mated optical fiber connector pair shall not exceed 0.40 decibels.

**Pre-installation testing:** Test all optical fiber cable for all fibers prior to installation of cable (fiber cable on-the-reel acceptance testing).

**Performance testing:** Where links are combined to complete a circuit between devices, Contractor shall test each link from end to end to ensure performance of system. Only a basic link test is required. Contractor can optionally install patch cords to complete circuit and then test entire channel. The test method shall be same used for test described above. The values for calculating loss shall be those defined in applicable TIA/EIA standards.

**Attenuation testing:** Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach test equipment to cable plant. The light source shall be left in place after calibration and power meter moved to far end to take measurements.

**Loss budget:** Fiber links shall be calculated for Loss Budget using the Commscope Link Loss Calculator. All links must be within Commscope guidelines.

**Link loss:** A mated connector to connector interface shall be considered a single connector. Loss numbers for installed link shall be calculated by using Commscope’s Link Loss Calculator. Any other method is not acceptable. All links not meeting requirements of standard shall be brought into compliance by the Contractor, at no additional cost to VCC IT.

All fiber optic cables will be tested and results will be submitted for all fibers in an electronic format on CD-ROM and provide one (1) soft copy of the test results showing graphically, the entire length of the fiber. Test results shall be printed directly from test unit or from a download file using an application from test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test result achieved. Provide test equipment information by name, manufacturer, model number and last calibration date. Unless manufacturer specifies more frequent calibration cycle, annual calibration cycle shall be required on all test equipment used for the installation. Test document shall detail test method used and specific settings of equipment during test. Hand written test results (attenuation results and continuity results) shall be documented on a suitable test form. When repairs and re-tests are performed, note problem found and corrective action taken, and provide with both failed and passed test data. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files.

### 7.22 Backbone Copper Cable Testing and Test Results

The Specifications or RFP shall required the Contractor to perform tests on the copper backbone cable (OSP and riser). The tests shall be performed from each termination block on each pair on 100% of the copper cable pairs. The end-to-end test shall include the following:

- DC Continuity
- Reversals
• Shorts
• Opens
• Overall loop resistance/cable length
• Attenuation
• Spits
• Transpositions
• Grounds
• Presence of AC voltage.

The technician will examine open and shorted pairs to determine if the error is a termination issue. If not correctable, the technician shall tag bad pairs at both ends, and make note on the as-built documentation. If copper backbone cable contains more than one percent (1%) bad pairs, the Contractor shall remove and replace the cable at the Contractor’s expense.

The cable test results shall be submitted in electronic format on CD-ROM, with the resulting file formatted with one test result per 8.5-inch x 11-inch page. Files exported and saved as *.txt files will NOT be acceptable, but must be provided in the native format of the tester. The Contractor shall submit (1) copy of software capable of viewing the electronic test result files.

7.23 UTP HORIZONTAL CABLE TESTING AND TEST RESULTS

General Test Requirements

All horizontal UTP cabling will be tested and certified to meet Systimax standards when all pairs are terminated on a patch panel port and at an outlet port.

- Testing shall conform to ANSI/TIA/EIA-568-B.
- Testing shall be accomplished using a UL certified Level III tester.
- All final Cat 6 tests must meet or exceed the CommScope GigaSPEED XL guaranteed minimum headroom specs above TIA568b.2-1 standards
- Any cable failing the prescribed certification testing shall be removed and replaced at the Contractor’s expense.

The Contractor shall provide Category 6, channel test results on all pairs of cable, including but not limited to cable length, wire map, NEXT, Power Sum NEXT, ACR, Power Sum ACR, ELFEXT, Power Sum ELFEXT, Return Loss, Propagation Delay and Delay Skew.

All cables will be tested and the results and submitted in electronic format on CD-ROM, with the resulting file formatted with one test result per 8.5-inch x 11-inch page. Files exported and saved as *.txt files will NOT be acceptable, but must be provided in the native format of the tester. If the test results are not pdf viewable, the Contractor shall submit (1) copy of software capable of viewing the electronic test result files.

7.24 CABLE TESTING VALIDATION

After installation is completed and the Telecommunication Contractor has completed testing, the VVC IT reserves the right to separately test the installed cables, up to 100% using the
Telecommunication Contractor testing equipment or with VVC-provided computer/network equipment. Cables that have been tested and fail to meet performance requirements as stated in the specifications shall be removed and replaced with all new material and re-tested at no cost to the College. The Telecommunication Consultant will verify that these requirements are reflected in the RFP or specification details.

7.25 **IDENTIFICATION AND LABELING**

VVC IT will work with the Telecommunications Consultant to implement a consistent and unique labeling scheme across all buildings. All labels shall:

- Horizontal cables shall be marked at each end, on the sheath indicating the Telecommunications Room and jack number to which the cable is wired.
- Backbone cables shall be marked at each endpoint and at all intermediate pull/access points or junction boxes. Label shall indicate origination and destination Telecommunication Rooms, sheath ID and strand or pair range.
- Meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- Be pre-printed or laser printed type.
- Where used for cable marking, a label with a vinyl substrate and white printing area and a clear “tail” that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than that of the cable to which it is attached.
- Where insert type labels are used, provide clear plastic covers to go over label.
- The Contractor shall confirm specific labeling requirements with the Owner or Owner’s Representative prior to cable installation or termination.
- Labeling will include site notations as follows: M for Main campus, W for West campus and E for the East campus.

**Information Technology Room Naming**

Each Information Technology Room will be named and numbered with an individual numeric identifier. Current room naming conventions at the Colleges use a unique room number that also correlates to the floor and building number. For example, in Building 300 at Main College, the second floor TC is in room 307, indicating that it is in Building 300.

**Fiber Backbone Cable Labels**

All backbone fiber cables (riser cables) will be labeled at each end of the cable bundle at the furthest point where the sheath is intact (before breakout). If the riser cables pass through multiple pull-boxes, Information Technology rooms and riser openings, they will be labeled at each opening.

All outside plant backbone fiber cables will be labeled at each end and in each hand-hole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at point of access.
All cables will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:

- The origination point
- The destination point
- The type of cable (SMF, 50MMF)
- The fiber strand count

Example: The-48 strand single mode backbone cable that runs between the building 600 and building 300 at Main College shall be labeled M600-300-SMF-48.

Optical Fiber Patch Panel Labels

Fiber patch panels shall be marked using adhesive labels indicating the range of fibers installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the strand count. Each fiber strand shall be labeled with a unique strand ID.

All fiber patch panels will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:

- Name of source Telecommunication space
- Name of destination Telecommunication space
- Fiber pair number

Riser/Backbone Copper Cable Labels

All riser copper cables will be labeled at each end of the cable bundle at the furthest point where the sheath is intact (before breakout). If the riser cables pass through multiple pull points, Information Technology rooms and riser openings, the cables will be labeled at each opening.

All outside plant backbone copper cables will be labeled at each end and in each hand-hole/maintenance hole that they pass through. Labels will be heat and water-proof so they do not decay when exposed to the elements. All labels must be visible at every point of access.

All cables will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:

- The origination point
- The destination point
- The type of cable
- The pair count

Example: The 25-pair, Category 3 backbone cable that runs between Building 300 and Building 500 at Main College shall be labeled M300-F500-CAT3-25.

Copper Protector Labels
Copper protectors shall be marked using adhesive labels indicating the range of copper backbone pairs installed in it. Each panel shall be labeled with the origination and destination Telecommunication Spaces and the pair count.

All protectors will be labeled according to the guidelines as set forth in the EIA/TIA 606-A standard. This shall include:

- The origination point
- The destination point
- The type of cable
- The pair count

Example: At Main campus, the 50-pair copper backbone cable starting in the Building 400 and running to the Building 500 shall be labeled M400-500-50.

Where protectors terminate multiple backbone pairs, each backbone will be clearly and discretely labeled.

Faceplate/Outlet Labels

All faceplates/outlets for station cable terminations will be labeled. This includes wall outlets, wall phones, faceplates in floor boxes and all other termination points. For faceplates equipped with a label trough and plastic cover, the Contractor shall include the jack designation in the label trough. If upper and lower troughs are available, the Contractor shall divide the jack labeling horizontally, labeling the top two jacks in the upper trough and the bottom two jacks in the lower trough.

All faceplates/outlets will be labeled according to the following guidelines:

- Name of Telecommunication Space the cable routes to.
- Unique faceplate/outlet number, incrementing numerically.

Station Cable Labels

All station cables will be labeled at each end of the cable within 6 inches of the termination. At the patch panel end, all labels must be visible and not be placed inside wire management. Station cables will also be labeled on the faceplate. All cables will be labeled according to the guidelines as follows:

- Name of the Telecommunications Space where the cables terminate.
- Faceplate/outlet number
- Jack label – numeric (1, 2, 3, 4) labeled left to right, top to bottom (coordinate with VVC IT for and changes to this requirement).
If in overhead cable trays or J-hooks, large bundles of Category 5e cables (up to 50 max) must each be independently labeled every 50 feet. Bundle labels must state the type of cable and the Information Technology Space where that cable bundle will terminate.

Copper Patch Panel Labels

All ports on the station patch panels shall be labeled with the station cable labels described above. Cables will be terminated in ascending outlet and jack order, and be so labeled.

Patch panels which provide cabling connection to voice riser and backbone pairs shall be labeled using a similar convention as the backbone/riser cable labeling. The patch panel will be labeled with the cable name including:

- The origination point
- The destination point
- The type of cable

Each jack will be labeled for each pair in the riser/backbone cable.

7.26 ROLE OF VVC IT

As described at the beginning of section 2.0, VVC IT will take an active role in all aspects of the design, construction and acceptance of the network infrastructure.

Inspection

VVC IT shall participate in the inspection and acceptance of all cabling installations. During the construction process, inspections will be coordinated with the Inspector of Record and Engineering teams. As a minimum, periodic inspections will occur at the following phases of construction:

1. Submittals Review and Approval
2. RFI clarifications
3. Fiber Reel testing (prior to installation)
4. Cable tray/J-hook installation
5. Information Technology Space construction (rack/cable runway installation)
6. Cable installation
7. Cable termination
8. Labeling
9. Testing and review of test results
10. Final construction inspection
11. Manufacturer’s inspection and warranty approval

VVC IT will participate in the acceptance of all construction projects to verify that the installation is compliant to these standards and the design documents.
8 References

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA--526-7 1998
Industry Association (TIA), Measurement of Optical Power Loss Of
Installed Single-Mode Fiber Cable Plant.

Industry Association (TIA), Measurement of Optical Power Loss Of
Installed Multimode Fiber Cable Plant

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA-568-C.0, 82008
Industry Association (TIA, GENERIC TELECOMMUNICATIONS
CABLING FOR CUSTOMER PREMISES

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA-568-C.2 2011
Industry Association (TIA), Balanced Twisted-Pair Telecommunications
Cabling and Components Standard

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA-568-C1C.1 82008
Industry Association (TIA), COMMERCIAL BUILDING
TELECOMMUNICATIONS CABLING STANDARDS - PART 1
GENERAL REQUIREMENTS

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA-568-C.3 82008
Industry Association (TIA), OPTICAL FIBER CABLING
COMPONENTS STANDARD

American National Standards Institute (ANSI)/Telecommunications ANSITIA-569 B 2004
Industry Association (TIA, Commercial Building Standard for
Telecommunications Pathways and Spaces

Residential Infrastructure Standard. 570-B 2009
Optical Fiber Cable Color Coding -598-C 2005
Administration Infrastructure -606-A1 2008

American National Standards Institute (ANSI)/Telecommunications ANSI/TIA/EIA 607 1994
Industry Association (TIA)/ Electronic Industries Alliance (EIA),
Commercial Building Grounding and Bonding Requirements for
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Standard Outlet Details

8.1 **Typical Faceplates**

**Type A Outlet**
- Jack faceplate
- One voice jack (white)
- Two data jacks (red)
- Faceplate label in upper and lower labeling window
- Jacks labeled individually.
- Blanks (dust covers) in unused jack locations.

\[ \text{Symbol for Type A Outlet}\]

**Type B Outlet**
- Jack faceplate
- One to six data jacks (red)
- Faceplate label in upper and lower labeling window
- Jacks labeled individually.

\[ \text{Symbol for Type B Outlet}\]
### TYPE C OUTLET
- Jack Faceplate
- One Voice Jack (White)
- One Data Jack (Red)
- One 2MM Fiber Optic
- Faceplate Label in Upper and Lower Labeling Window
- Jacks Labeled Individually.

![Diagram of Type C Outlet](image1)

### TYPE D OUTLET
- Single Jack Faceplate
- One Voice Jack (White)

![Diagram of Type D Outlet](image2)
9 Sample Specifications

The following specifications are supplied as templates for incorporating into the project manual of construction projects. These specifications provide the basis of content and must be reviewed and updated for each construction project.

Specification format must be reviewed and approved by VVC for each project.
ADDENDUM #2

MUSIC BUILDING MODERNIZATION & ADDITION

VICTOR VALLEY COLLEGE

TITLE:

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DATE:

APPL. NO:

FILE NO:

DATE:

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VICTOR VALLEY COLLEGE

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ADDENDUM #2

MUSIC BUILDING MODERNIZATION & ADDITION
VICTOR VALLEY COLLEGE

NTD ARCHITECTURE
955 Overland Court, Suite 100, San Dimas, California 91773
San Diego ● Los Angeles ● Auburn ● Visalia ● Salinas ● Phoenix ● Tucson

DATE: 06/12/13
AMA JOB NO: 7V01-01-001
DRAWING: ESK-2