SECTION 16000
ELECTRICAL DESIGN STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section provides General Design Standards applicable to Division 16.

1.2 REFERENCES


1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Branch Circuit Requirements:

1. Corridor receptacle circuits shall not be combined with office or laboratory receptacle circuits.

2. Housekeeping receptacle circuits shall not be combined with office or laboratory receptacle circuits.

3. Laboratory and offices shall have individual dedicated circuits as required for specific equipment. A maximum of 6 receptacles per 20A circuit is allowed.

4. Connect Laboratory receptacles in Wiremold to alternating circuits (i.e. A, B, C, A, B, C).

5. Provide countertop receptacles in Laboratories with minimum two (2) foot on center spacing. Each outlet within 6 feet of a sink edge or water source shall be GFCI type. Protection via feed-thru GFI or GFCI breaker is not allowed.

6. Provide general receptacles in corridors no further than 50’ apart

7. Freezers such as -80 degree Celsius or similar equipment shall have a dedicated circuit of 20A rating or higher if required by equipment. Cover and outlets for these freezers must be on emergency circuit and be red and labeled as emergency.

B. Lighting Requirements:

1. General:

a. Provide energy efficient fluorescent luminaries wherever possible.

b. Lamps shall be 4100K unless requested otherwise. Minimum CRI is 82.

c. Luminary installations must comply with requirements set forth in other sections of this Division 16.

d. Provide emergency and exit lighting per NFPA, IBC and NEC requirements and recommendations. Exit lights should be LED type.
e. If emergency generator circuits are not available, provide emergency lighting battery packs in elevator machine rooms, mechanical rooms electrical rooms. Fire, Security rooms and Egress Lighting per Fire Code.

f. Use Alto Low Mercury lamps wherever possible.

g. Provide 2 ballasts in 3 and 4 lamp luminaries for compatibility with dual level switching.

h. Refer to current edition of the IES for lighting levels in areas not included in the following paragraphs.

i. Electronic ballasts to be low inrush current type.

2. Corridors:

a. Provide fluorescent luminaries with energy efficient electronic ballast, less than 10% THD. Provide luminaries with RIF ballasts in sensitive areas. As determined by the UCD.

b. Minimum foot-candle level in corridors shall be 20 foot candles.

c. Minimum foot-candle level in lobbies shall be 15 foot-candles.

d. UCD standard corridor lighting consists of 2-lamp, 2’x4’ recessed luminary with perforated shields on each side, located 12’ O.C. and consistent with current LEED design.

3. Offices:

a. Provide fluorescent luminaries with energy efficient electronic ballast, less than 10% THD. Provide luminaries with RIF ballasts in sensitive areas. As determined by the UCD and design team input and consistency with LEED.

b. Minimum foot-candle level shall be 30 foot-candles. Offices that require detail work at their desk shall be provided with minimum of 50 foot-candles. Rooms with special VDT requirements may be provided with less than 30 foot-candles, either with a dual switching option or Dimming Ballast as determined by the UCD.

c. UCD standard office lighting consists of 3-lamp, 2’x4’ recessed luminary with 3” deep parabolic lenses.

4. Laboratories:

a. Fluorescent luminaries with energy efficient electronic ballast, less than 10% THD. Provide luminaries with RIF ballasts.

b. Minimum foot-candle level shall be 75 or current NIH Standards.

5. Classrooms:
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a. Fluorescent luminaries with energy efficient electronic ballast, less than 10% THD. Provide luminaries with RIF ballasts.

b. Minimum foot-candle level shall be 75.

c. Computer classrooms shall be provided with pendant-mounted indirect luminaries. Luminaries shall be mounted with aircraft cable. Maximum length of steel indirect product shall be 12'-0". Minimum foot-candle level shall be 25.

d. Laboratory classrooms: Minimum foot-candle level shall be 100.

6. **Equipment Rooms:**

   a. Fluorescent luminaries with energy efficient electronic ballast, less than 10% THD. Provide luminaries with RIF ballasts.

   b. Provide a minimum of 3 foot-candles on vertical surfaces and 30 foot-candles at 30” high horizontal surfaces.

7. **Lecture Halls/Auditoriums:**

   a. Lighting in the control booth/room shall be incandescent and on a dimmer switch.

   b. Provide 3 levels of light. One level shall be from a dimmable source. Lighting controls shall be available at the front of the room and in the control booth/room. Provide additional switching capabilities for the primary light at the entry doors.

   c. Consider and plan for how lamps will be changed and make it relatively easy to change lamps.

8. **Exit/Egress Lighting:**

   a. Provide adequate exit/egress lighting per code requirements.

9. **Lighting Controls:**

   a. Provide dual ultrasonic/infrared type motion sensors with programmable time override in the following areas:

      1) Restrooms and Stall area.

      2) Conference Rooms (Provide with override switch on wall.)

      3) Class Rooms (Provide with override switch on wall.)

      4) Other public areas as applicable

   b. Provide 3-lamp dual level or dimming switched luminaries in the following areas:

      1) Offices

      2) Computer Classrooms
3) Laboratory Classrooms

4) Lecture Halls/Auditoriums

c. Create an interface with Campus Building Automation System (currently Siemens) to allow control and management remotely.

10. Outdoor Lighting

a. Outdoor lighting should be zoned to provide flexibility for safety and economy.

C. Fire Alarm layouts:

1. General:

a. Provide a fire alarm system for each building per Section 16720. Actual detection required per building shall be determined by National codes, Local codes and UCD CBO, whichever is more stringent.

b. Provide shunt trip circuit breaker for connection to elevators with sprinkle red shafts.

2. Regardless of building occupancy rating, the following areas shall be provided with detection:

a. Laboratories

b. Electrical Rooms

c. Mechanical Rooms

d. Telecommunications Rooms

e. Data Centers

f. Dedicated Storage Rooms

g. Kitchens

3. In general, the following type of detection shall be provided in each type of room:

a. Photoelectric Smoke Detection:

1) Electrical/Telecommunication Rooms

2) Office Corridors (except where sprinkled)

3) Offices (except where sprinkled)

4) Laboratories

5) Mechanical Ducts
6) Elevator Shafts/Machine Rooms
7) Dedicated Storage Rooms
8) Linear Equipment Rooms

b. Thermal Detection:
1) Restrooms
2) Mechanical Rooms
3) Kitchens/Break rooms
4) Environmental Services (Janitor) Rooms
5) Elevator Shafts/Machine Rooms
6) Generator Rooms
7) Autoclaves

c. Flame Detection:
1) Generator Rooms

D. Special Systems:

1. Classrooms:
   a. Each classroom shall be connected to the main TV/Video distribution center via 2 coax cables, 3 audio cables, and 2 fiber-optic cables.
   b. Provide (1) RJ-11/RJ-45 type telephone/data jack with a patchable analog phone line, a network “B” connection, and a patchable t-1 line.
   c. Provide appropriate A/V devices per UCD Project Manager. Provide at proper ratio per UCD Project Manager. Hang televisions from the ceiling and elevated as high as possible to avoid becoming “head-bangers.”
   d. Mount 120V duplex receptacle and TV outlet rough in at +90” A.F.F (or just below the ceiling level).
   e. Switch all TV outlets in a single room from a common switch convenient to the front of the room. Label switch as “TV”.

2. Lecture halls:
   a. Each lecture hall shall be connected to the main TV/Video distribution center via 3 coax cables, 5 audio cables, and 2 fiber-optic cables.
   b. Provide (2) RJ-11/RJ-45 type telephone/data jack with a patchable analog phone line, a network “B” connection, and a patchable t-1 line.
c. Each lecture hall/auditorium shall have a motorized project screen(s) for films, slides or video projection. Bottom of screen(s) shall be 4 feet above the floor when screen(s) is extended.

d. Each lecture hall/auditorium shall have a video projector ceiling mount/lift installed for a video/data projector at the ceiling within the proper projection distance from the screen. There shall be a conduit from the video projector to the control booth/room of sufficient diameter to hold 1 video coax cable, 1 R, G, B, and sync cable, 1 SVHS cable, and 1 2-conductor shielded control cable.

e. Lecture halls/auditoriums shall have a control booth/room, which will allow sound, light, and TV projector control from a podium.

f. Each lecture hall/auditorium shall have a minimum of one podium location in front.

g. Junction boxes and conduit from the podium location at the front of the room shall be provided to the control room/booth to allow control of projectors, lights, and sound systems.

h. Sound amplification systems shall be built into lecture halls/auditoriums. The minimum number of inputs shall be 4 microphones (low level), 1 auxiliary input, and 1600-ohm input. The sound system must include a minimum of 1600-ohm line output.

E. Surge Suppression:

1. Provide integral Transient Voltage Surge Suppressors in the following panel boards:

a. Main Distribution Centers

b. Main Service Unit Substation Distribution Centers after Transformers

c. Computer Laboratory Panel Boards

d. Information Services Panel Boards.

F. Exterior Electrical Equipment:

1. Provide 15’ minimum clearance around generators for maintenance access.

2. Provide ventilation for primary switching and exterior substations. Maintain positive elevation for exterior electrical equipment to protect against wet weather.

3. Provide exterior connections to a portable 500 kW generator for each building not provided with an emergency generator system. Provide kirk-key interlock for operation of generator system.

G. Provide a complete Lightning Protection System for each building.

1.4 DEFINITIONS

1.5 SUBMITTALS
1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE AND HANDLING

1.8 WARRANTY

PART 2 – PRODUCTS

Not Applicable

PART 3 – EXECUTION

Not Applicable

END OF SECTION
SECTON 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The section provides basic electrical requirements specifically applicable to Division 16, in addition to General Requirements of Division 1.

1.2 REFERENCE

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Sections, apply to the work of this section.

B. Section 02780 - Power and Communications.

C. Division 14 – Elevators

D. Division 15 - Mechanical

1.3 SYSTEM PERFORMANCE REQUIREMENTS

1.4 DEFINITIONS

A. Refer to Article 100 of the currently adopted National Electrical Code for definitions as applicable to this project.

B. Other definitions:

1. "Concealed": Embedded in masonry, concrete or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures.

2. "Exposed": Not installed underground or "concealed" as defined above.

3. "Furnish" or "Provide": To supply, install and connect up complete and ready for safe and regular operation of particular work unless specifically otherwise noted.

4. "Install": To erect, mount and connect complete with related accessories.

5. "Indicated", "Shown" or "Noted": As indicated, shown or noted on drawings or specifications.

6. "Related Work" includes, but is not necessarily limited to, mentioned work associated with, or affected by, the work specified.

7. "Reviewed", "Satisfactory", "Accepted", or "Directed": As reviewed, satisfactory, accepted, or directed by or to Engineer.

9. "Supply": To purchase, procure, acquire and deliver complete with related accessories.

10. "Wiring": Raceway, fittings, wire, boxes and related items.

1.5 SUBMITTALS

A. Submittals shall be made in accordance with General Conditions of Contract and the requirements of Section 01300.

B. Shop drawings shall include equipment catalog cuts or manufacturer's printed data identifying: dimensions, weights, recess openings, equipment arrangements, electrical characteristics with bus size, electrical rating, material, wiring diagrams indicating circuit arrangement and NEMA rating for, but not limited to the following:

1. Medium voltage distribution equipment, cable and devices (13..2 kv and above)
2. Transformers
3. Switchboards
4. Panel boards
5. Motor Control Centers
6. Circuit and Motor Disconnects
7. Generator Equipment
8. Automatic Transfer Switches
9. UPS Equipment
10. Contactors
11. Wiring Devices
12. Luminaries
13. Cabinets, Enclosures and Supporting Systems
14. Wall Duct
15. Multi-Outlet Assemblies
16. Generators
17. Modular Wiring Systems
18. Electrical Systems Control
19. Fire Detection/Alarm Systems
20. Special Systems
21. Lightning Protection System
C. Submittals shall also include ¼” scale layouts of all electrical rooms.

D. Submit composite coordination drawings to include location and routing of the electrical system components in relation to the mechanical ducts, piping and structural beams.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: All electrical work at the UCD shall be performed by a State of Colorado licensed contractor under the supervision of a licensed electrician. Contractors shall verify that electricians are currently licensed by the State of Colorado and shall supply Project Manager with names and license numbers. Contractor shall have a minimum of 3 years of satisfactory performance in conducting the type of work specified.

3. NECA - Standard of Installation.
5. IEEE – The Institute of Electrical and Electronics Engineers.
7. UCD/Anschutz Medical Campus Project Guidelines and Standards.
9. ASTM - American Society of Testing Materials
10. IPCEA - Insulated Power Cable Engineers Association
11. Underwriter's Laboratories (UL)
12. American National Standards Institute (ANSI)
13. Other requirements as listed elsewhere in these specifications.

B. The drawings and specifications take precedence when they are more stringent than codes, statutes, or ordinances in effect. Applicable codes, ordinances, standards and statutes take precedence when they are more stringent than, or conflict with the drawings and specifications.

C. Record Documents:

1. Maintain a separate set of contract electrical drawings at the site in accordance with Section 01720 to show the following:

   a. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
b. All branch circuits, feeders, communications conduits embedded in concrete, dimensioned from prominent building lines.

c. Equipment locations (exposed and concealed) dimensioned from prominent building lines.

d. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

D. Operations and Maintenance Data:

A. O and M Data shall be provided in accordance with Section 01730 including the following information:

1. Description of function, normal operating characteristics and limitations, fuse curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

5. Complete list of parts and wiring diagrams.

6. Names, addresses and telephone numbers of the Contractor, Subcontractors and local company responsible for maintenance of each system or piece of equipment.

7. All information shall be permanently bound in a 3-ring binder. The job name and address, and Contractor's name and address shall be placed on the cover and spine of each binder in a permanent manner. Dymo-tape is not acceptable.

8. Copies of all test reports shall be included in the manuals.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle products in accordance with manufacturer's instructions, and the requirements of Section 01105.

1.8 WARRANTY

A. All electrical equipment, materials and workmanship warranties shall be provided in accordance with the requirements of Section 01740 and the following:

1. The Contractor warranties the electrical system, material and workmanship, for a period of one year from the date of the UCD final acceptance of the installation unless as otherwise noted in Commissioning.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 MATERIALS, GENERAL

A. All equipment and materials installed shall be new, unless otherwise specified. Defective or damaged materials shall be replaced or repaired, prior to final acceptance, in a manner acceptable to the Engineer or UCD and at no additional cost to the UCD.

B. All electrical materials shall be acceptable for installation only if labeled or listed UL and, if accepted, by the authority having jurisdiction.

C. All major equipment components shall have the manufacturer's name, address, model number, and serial number permanently attached in a conspicuous location.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Construct Work in sequence under provisions of Division 1 where applicable.

B. Electrical Contractor shall coordinate Division 16 work with the installer of Division 15 and other work to ensure that code required clearances relating to space required for access to electrical equipment is properly maintained.

C. Install Work using procedures defined in NECA Standard of Installation.

D. Workmanship shall conform to highest industry standards for each trade involved in erection of the Work.

E. Upon completion of work, all equipment and materials shall be installed complete, thoroughly checked, correctly adjusted, and left ready for intended use or operation. All work shall be thoroughly cleaned and all residues shall be removed from surfaces.

F. Exterior surfaces of all material and equipment shall be delivered in a perfect, unblemished condition.

G. Carefully lay out all work in advance so as to eliminate where possible, cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings and roofs. Any damage to the building, structure, piping, ducts, equipment or any defaced finish shall be repaired by skilled mechanics of the trades involved at no additional cost to the UCD.

H. All openings made in fire-rated walls, floors, or ceilings shall be patched and made tight in a manner to conform to the fire rating for the surface penetrated. Paint to match surface when visible.

I. All penetrations required through completed concrete construction shall be core drilled at minimum size required. Precautions shall be taken when drilling to prevent damage to structural concrete. The Contractor shall obtain permission from the Architect before proceeding with drilling.

J. Sleeve Seals: Provide sleeve seals for penetrations located in foundation walls below grade, or in exterior walls, of one of the following:
1. Caulk between sleeve and raceway with approved Caulk material.

2. Mechanical Sleeve Seals: Modular mechanical type, as manufactured by Thunder line Corp., consisting of interlocking synthetic rubber links shaped to continuously fill annular space between raceway and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal.

K. Install equipment and materials to provide required Code clearances and access for servicing and maintenance. Coordinate the final location with piping, ducts, and equipment of other trades to insure proper access for all trades. Coordinate locations of concealed equipment, disconnects, and boxes with access panels and doors. Allow ample space for removal of parts, fuses, lamps, etc., that require replacement or servicing according to the National Electric code and the AHJ.

L. Extend all conduits so that junction and pull boxes are in accessible locations.

M. Install access panel or doors where equipment or boxes are concealed behind finished surfaces in areas such as restrooms. These access doors shall be a minimum of twenty by twenty inches there by allowing fixtures such as high hats with compact florescent lamps to be worked from above.

N. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

O. Electrical system layouts indicated on drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from engineering drawings.

P. Consult all other drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Engineer before submitting bid.

Q. All home runs to panel boards are indicated as starting from outlet nearest panel and continuing in general direction of that panel. Continue such circuits to panel as though routes were completely indicated.

R. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc. required for equipment specified under this Division.

S. Remove all unused or abandoned conduit, junction boxes, panels, and other electrical components.

T. All "above counter" receptacles located within 6’ of any sink or basin shall be GFCI type.

U. Receptacles located with 6’ of any eyewash station shall be GFCI type.

V. Clean all luminaries, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

W. Provide all power feeds and final connections to motors and other electric equipment furnished under Division 15.

1. Install and wire through all control devices which directly handle full load motor or electric heating equipment current, such as magnetic starters, line voltage.
thermostats, P.E. switches, etc. which are furnished by Electrical Contractor. Located where shown on the electrical drawings.

2. Provide disconnects for all mechanical equipment as indicated on project drawings.

3. Provide all power and control wiring which directly handles full load current of motors or electric heating equipment.

3.3 TESTING, CLEANING AND CERTIFICATION

A. Operating and Acceptance Tests: Provide all labor, instruments, and equipment for the performance of tests as specified below and elsewhere in these specifications.

1. Perform a careful inspection of the main switchboard bus structure and cable connections to verify that all connections are mechanically and electrically tight.

2. For a one-day period after the remodeled area has been placed into normal service, record the full load current in each phase or each line at the panel bus and submit to the Engineer.

B. Test Reports:

1. Test Reports: Submit three (3) copies of test results.

2. The final UCD inspection of the project will not be made until a satisfactory report is received and approved by the UCD Project Manager.

3. Results shall include:

   a. Insulation resistance readings for each segment of high voltage (over 600V) cable, each phase.

   b. Insulation resistance readings for transformers for each phase of primary and secondary to ground and for primary to secondary.

   c. Insulation resistance readings on all feeders entering main distribution switchboard, each phase.

   d. Resistance to ground readings for main distribution switchboard service ground.

   e. Insulation resistance readings for all motors and motor feeders 5 horsepower or greater.

   f. Full load current reading for main service entrance and main distribution panel board, each phase.

4. Testing shall be done by an independent testing agency.

C. Clean-Up: Remove all materials, scrap, etc., relative to the electrical installation, and leave the premises and all equipment, lamps, fixtures, etc. in a clean, orderly condition. Any costs to the UCD for clean up of the site will be charged against the Contractor.

3.4 COMMISSIONING (DEMONSTRATION)
A. Acceptance Demonstration: Upon completion of the work, at a time to be designated, the Contractor shall demonstrate for the UCD the operation of the entire installation, including all systems provided under this contract.

B. The Contractor shall furnish the services of a qualified representative of the supplier of each item or system who shall instruct specific personnel, as designated by the UCD, in the operation and maintenance of that item or system.

1. Instruction shall be given when the particular system is complete, and shall be of the number of hours indicated. A representative of the Contractor shall be present for all demonstrations.

3.5 SCHEDULES

END OF SECTION
SECTION 16110

RACEWAYS

PART 1 – GENERAL

1.1 SUMMARY

A. This section provide standards for raceways including the following:
   1. Electrical metallic tubing (EMT)
   2. Flexible metal conduit
   3. Liquid-tight flexible metal conduit
   4. Rigid metal conduit (RGC)
   5. Rigid Aluminum Conduit
   6. Fittings and Conduit Bodies
   7. Metal-clad cable.

1.2 REFERENCES

A. Section 02780 - Power and Communications
B. Section 16010 - Basic Electrical Requirements
C. Section 16120 - Wire and Cable
D. Section 16130 - Boxes
E. Section 16190 - Supporting Devices
F. Section 16195 - Electrical Identification
G. Section 16740 - Telecommunication Voice and Data Systems

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide complete raceway system required to meet project requirements in sizes as required by NEC.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submit catalog cut sheets for conduit and conduit fittings in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE

A. Raceway systems shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Raceway systems shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY

A. Raceway systems warranties shall be provided in accordance with the requirements of Section 16010.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Rigid Metal Conduit:
   a. Allied
   b. Republic
   c. Triangle

2. EMT:
   a. Allied
   b. Republic
   c. Triangle

3. Steel Fittings:
   a. O/Z Gedney
   b. Raco
   c. Appleton

4. Die-cast Fittings:
   a. Regal
   b. Bridgeport
   c. Raco

5. Conduit Bodies:
   a. O/Z Gedney
   b. Regal
   c. Appleton

6. Conduit Seals:
   a. Chase-Foam CTC PR-855, or approved equal

7. Surface metal raceways:
   a. 3000 series Wire mold (preferred) receptacle circuits to rotate phases (A, B, C, A, B, C).

8. Wire ways:
a. Hinged cover or screw cover complete with all necessary fittings which shall be of one manufacturer.

b. General Electric (Type HS)

c. ITE KEL Duct

d. Approved equal

9. Liquid-tight flexible metal conduit:

a. American Brass with Appleton “ST” Connectors, or approved equal.

2.2 MATERIALS, GENERAL

A. Metal Conduit and Tubing:

1. Rigid Galvanized Steel Conduit (RGC):


b. Fittings: Threaded galvanized steel, bushings shall have nylon-insulated throat.

2. Electrical Metallic Tubing (EMT):

a. Conduit: Galvanized steel tubing. EMT shall be galvanized on the outside and coated on the inside with a hard smooth lacquer finish. EMT shall comply with UL 797 and ANSI C80-3.

b. Fittings: Steel compression fittings for rain-tight and concrete-tight applications. Steel set-screw for all other connections. Set-screw quick fit type for 2-1/2 inch and larger may be used. Bushings shall be threaded and have nylon insulated throat or nylon bushing.

3. Intermediate steel conduit


b. Fittings: Threaded galvanized steel, bushings shall have nylon-insulated throat.

4. Rigid Aluminum Conduit:

a. Not allowed unless otherwise noted.

5. Flexible Metal Conduit:

a. Conduit: Continuous spiral wound, interlocked, zinc-coated steel, NEMA/UL approved for grounding.
b. Fittings: Cadmium plated, malleable iron. Straight connector shall be one-piece body, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. Angle connectors shall be two-piece body with removable upper section, female end with clamp and deep slotted machine screw for securing conduit, and threaded male end provided with a locknut. All fittings 1 inch and larger shall be terminated with threaded bushings having nylon insulated throats.

c. Maximum length of 6 feet.

d. Minimum size of 1/2 inch.

6. Liquid-Tight Flexible Metal Conduit:

a. Conduit: Continuous spiral wound, interlocked zinc-coated steel with polyvinyl chloride (PVC) jacket, NEMA/UL approved for grounding.

b. Fittings: Cadmium plated malleable iron. Straight and angle connectors shall be the same as used with flexible metal conduit but shall be provided with a compression type steel ferrule and neoprene gasket sealing rings.

B. Conduit Bodies:

1. General: Types, shapes and sizes, as required to suit individual applications and National Electric Code (NEC) requirements. Provide matching gasket covers secured with corrosion-resistant screws.

2. Metallic Conduit and Tubing: Use metal conduit bodies. Use bodies with threaded hubs for threaded raceways and in hazardous locations. Telephone EL's are not acceptable.

C. Conduit Sizes:

1. Conduit sizes shall be as shown on the drawings. If the conduit size is not given on the drawings, the conduit shall be sized in accordance with NEC Table 3A based on the number of conductors enclosed plus parity sized equipment ground conductor and be subject to the following minimum sizes:

   a. Rigid and EMT Conduit: All home runs shall be 3/4” minimum, all unbroken runs 40 feet or longer shall be 3/4” minimum except lighting switch legs, and some temperature control may be 1/2 inch.

   b. Flexible and Liquid-tight Flexible Conduit: 1/2 inch for all runs. Maximum 6-foot length.

   c. Conduits used for home runs shall contain only the conductors for the circuits indicated on the drawings. Combining unrelated multiple home runs into a single conduit would not be permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL
A. Type of Conduit Used

1. Rigid conduit or intermediate metallic steel conduit shall be installed in the following areas.
   a. Where exposed to mechanical injury.
   b. Where specifically required by the National Electrical Code.

2. Electrical Metallic Tubing (EMT):
   a. Shall be installed per NEC.

3. Sealtite metal conduit shall be provided for: Makeup of motor, transformer or equipment, and/or raceway connections where isolation of sound and vibration transmission is required. For connections in locations exposed to weather, or in interior locations subject to moisture, watertight flexible conduit shall be used.

B. General: Install electrical raceway in accordance with manufacturer’s written installation instructions, applicable requirements of NEC, and as follows:

1. Conceal all conduits unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes.

2. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping, keep close to structure.

3. Complete installation of electrical raceways before starting installation of conductors within raceways.

4. Provide supports for raceways as specified elsewhere in Division 16.

5. Prevent foreign matter from entering raceways by using temporary closure protection.

6. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel. Bends in conduit larger than 2 inch shall be factory-made elbows unless otherwise specifically approved. All bends shall be made in an approved bending machine or factory-made. Hickey bends will not be permitted in conduits larger than 3/4 inch. Refer to Section 16740 for special bending requirements for Telecommunications Systems.

7. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. Install expansion fittings across all structural construction joints and expansion/deflection couplings across all structural expansion joints and in every 200 feet of linear conduit run. A flexible bonding jumper at least three times the nominal width of the joint shall be installed.

8. Run concealed raceways parallel and perpendicular to building elements at right angles.

9. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
10. Run exposed and parallel raceways together. Make bends in parallel runs from the same centerline so that the bends are parallel. Factory elbows may be used only where they can be installed parallel. In other cases, provide field bends for parallel raceways.

11. Make raceway joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Joints in non-metallic conduits shall be made with solvent cement in strict accordance with manufacturer’s recommendations.

12. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. RGC shall be secured with double locknuts and an insulated metallic bushing. EMT shall be secured with one locknut and shall have nylon-insulated throats or threaded nylon bushings from 1/2 inch to 1 inch. 1-1/4 inch and above shall be metal with nylon insulated throats. Use grounding type bushings for feeder conduits at switchboards, panel boards, pull boxes, transformers, motor control centers, VFDs, etc.

13. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

14. Install pull wires in empty raceways. Use #14 AWG zinc-coated steel or monofilament plastic line having not less than 200-pound tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

15. Telecommunications and Signal Systems Raceways: Install raceways with maximum lengths at 100 feet and with a maximum of two, 90-degree radius bends or equivalent. Install 2’ x 2’ pull boxes where necessary to comply with these requirements.

16. Install raceway-sealing fittings in accordance with the manufacturer’s written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL Listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway-sealing fittings at the following points and elsewhere as indicated:

a. Where conduits enter or leave hazardous locations.

b. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.

c. Where required by the NEC.

17. Flexible Connections: Use short length (maximum of 6 feet) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet locations. Install separate ground conductor in all flexible connections.
18. Conduit Seals: Conduit passing through concrete walls shall be sealed.

19. Where conduits are to be installed through structural framing members, the contractor shall provide sleeves. Cut all openings in concrete with rotary type drill, or other method as approved by the UCD Project Manager. Holes cut with pneumatic hammer will not be accepted. For areas where sleeves have not been provided, the Engineer’s written approval must be obtained prior to cutting, notching or drilling of structural framing members.

20. Ream the ends of all cut and/or threaded conduit. Ends shall be cut square.

21. Use of running threads for rigid metallic conduit are not permitted. When threaded couplings cannot be used, provide 3-piece union or solid coupling.

22. Conduits shall not cross pipe shafts or ventilation duct openings “access panel”.

23. Conduit shall not obstruct full and direct access to equipment requiring maintenance. This includes but is not limited to valves, actuators and terminal box controllers.

23. Install an insulated ground conductor in all conduits.

24. Where individual conduits penetrate fire-rated walls and floors, provide pipe sleeve one size larger than conduit; pack void around conduit with fire rated insulation and seal opening around conduit with UL Listed foam silicone elastomer compound. Conduits on trapeze type support system shall require fire taping only.

25. Where conduit sleeves penetrate fire rated floors or walls for installation of system cables, AC or MC cables, or modular wiring cables, pack void around cables or empty sleeve with fire rated insulation and fill ends with fire-resistant compound. Seal opening around sleeve with UL Listed foam silicone elastomer compound.

26. Provide separate raceway systems for each of the following:
   a. Lighting
   b. Power Distribution
   c. Emergency (Essential)
      1) Lighting
      2) Power distribution
   d. Low voltage systems, including telephone and communications, EQ alarm, security, fire alarm.

27. Provide for waterproofing of all raceways, fittings, etc., which penetrate the roof to preserve the weatherproof integrity of the building. Installation of materials shall conform to the following:
   a. General:
1) Install all raceways concealed except at surface cabinets, for motor and equipment connections and in mechanical equipment rooms. Install a minimum of 6 inch from flues, steam pipes or other heated pockets for water-flashing and counter-flashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc., which penetrate roof. Route exposed raceways parallel or perpendicular to building lines with right angle turns and symmetrical bends. Concealed raceways shall be run in a direct line, and where possible, with long sweep bends and offsets.

2) Provide raceway expansion joints with necessary bonding conductor at building expansion joints and where required to compensate for raceway or building thermal expansion and contraction. Terminate raceways 1-1/4 inch and larger with insulated bushing or rain tight connections with insulated throats.

28. Special areas methods for raceway installation (with appropriate seal-offs, explosion-proof fittings, etc.), in all special occupancy areas, as defined and classified in Article 500 of the National Electric Code (NEC), shall be in accordance with that Article.

29. If type MC or AC cable is used for branch circuits, the home run conduit will be EMT and must run from the panel to within 10 feet horizontally of the first device served.

C. Raceway Installation:

1. Surface raceways, where indicated on drawings, shall be metal and of a size approved for number and size of wires to be installed, shall be installed in a neat, workmanlike manner, with runs parallel or perpendicular to walls and partitions. Raceways, elbows, fittings, outlets and devices shall be of same manufacturer, and designed for use together.

2. Wire ways, where indicated, complete with elbows, tees, connectors, adaptors, etc., with all parts factory-fabricated and of same manufacture.

3.3 TESTING, CLEANING AND CERTIFICATION

A. Refer to Standard Section 16010 for testing, cleaning, and certification requirements.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16111
CABLE TRAYS

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for aluminum low voltage cable trays and accessories.

1.2 REFERENCES
A. Section 16010 - Basic Electrical Requirements
B. Section 16170 - Grounding and Bonding
C. Section 16190 – Electrical Supports and Firestopping
D. Section 16740 - Telecommunications Voice and Data Systems

1.3 SYSTEMS PERFORMANCE REQUIREMENTS
A. Provide cable tray for converged low voltage systems such as telephone, data networking, security access control, closed circuit TV, community antenna TV, building automation systems, overhead-paging systems, and similar systems. Systems outside this scope require separate cable trays.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submit a combination ductwork, piping, and cable tray plan for coordination, providing section views of areas as required, in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE
A. Cable tray shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Cable tray shall be delivered, stored, and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Cable tray warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufactures: subject to requirements, provide products by the following:
   1. Chalfant Manufacturing Company
2. B-Line Systems, Inc
3. Square-D Company
4. TJ Cope, Inc.

2.2 MATERIALS, GENERAL

A. Ladder Type Cable Tray:

2. Description: NEMA VE 1, Class 20C ladder type tray, ventilated with solid sides.

2. Material: Aluminum that complies with the Aluminum Association’s alloy 6063-T6 for rails, rungs, and cable trays and alloy 5052-H32 or alloy 6061-T6 for fabricated parts.

3. Protect steel hardware against corrosion by galvanization according to ASTM B 633 or cadmium plating according to ASTM B 766.

4. Finish: fabricate cable tray products with rounded edges and smooth surfaces

5. Width: typically 24-inch in main corridors, with 18-inch feeders. Minimum width is 12-inches (Refer to Section 16740 for additional width requirements.).


7. Load: 200 pounds/foot minimum.

8. Straight Section Rung Spacing: 9-inch rung spacing.

9. Length: 14-foot sections maximum, 12-foot sections preferred.

10. Provide manufacturer's standard components such as clamps, 90-degree bends, tees, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.

B. Warning Signs:

1. Engraved Nameplates: 1/2-inch high black letters on yellow laminated plastic nameplate, engraved with the following wording:

   a. Warning! Do not use cable tray as walkway, ladder, or support. Use only as mechanical support for cables and tubing.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

B. Install metallic cable tray in accordance with NEMA VE 1.

C. Install cable tray in accordance with NEMA FG 1.
D. Support trays in accordance with Section 16190. Provide supports at each connection point, at the end of each run, and at other points to maintain the proper loading rate. All-thread supporting cable tray shall be covered 12-inches from the base of support to prevent cable damage during installation.

E. Use expansion connectors when the cable tray run exceeds 90-feet or where required.

F. Remove burrs and sharp edges from cable tray.

G. Make cable tray connections and changes in direction and elevation using standard fittings.

H. Install cable tray to facilitate cable placement; access to the cable tray should not be restricted.
   1. A minimum of 12-inches access headroom shall be provided and maintained above the cable tray.
   2. A minimum of 3-inches of clearance shall be maintained below the cable tray.
   3. Clear working space adjacent to the cable tray shall be 30-inches.
   4. Desired cable tray clearance from fluorescent light fixtures is 24-inches when parallel and 12-inches when crossing.
   5. Cable tray installation height shall not exceed 11-feet.
   6. Coordinate resolution of obstructions with UCD Information Technology (IT) Services.

I. Seal cable tray penetrations through fire and smoke barriers according to Section 16190.

J. Ground and bond cable tray at each section connection as per the provisions of Section 16170.
   1. Provide continuity between cable tray components.
   2. Use anti-oxidant compound to prepare aluminum contact surfaces before assembly.
   3. Provide a 6 AWG bare copper equipment grounding conductor through entire length of cable tray; bond to each component.
   4. Bonding connections to cable tray may be made using mechanical or exothermic connectors.
   5. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. Use those specified in UL 486A if manufacturer’s torque values are not indicated.

K. Install warning signs on 50-foot centers along cable tray, located to be visible.

3.3 TESTING, CLEANING AND CERTIFICATION

A. Test the installed cable tray by performing the following.
1. Visually inspect joints and connections for mechanical continuity.

2. Measure ground resistance of each cable tray system from the most remote element to the point where connection is made to service disconnect enclosure grounding terminal. Record results in ohms.

3. Certify and report results of inspection and electrical connectivity tests in writing to UCD Program Manager and IT Services department.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16120
WIRES AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides standards for wires, cables, and connectors for power, lighting, signal, control, and related systems rated 600 volts and less.

1.2 REFERENCES

A. Section 02780 - Power and Communications
B. Section 16010 - Basic Electrical Requirements
C. Section 16110 - Raceways
D. Section 16130 - Boxes
E. Section 16195 - Electrical Identification

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide complete wire and cable system to meet the requirements of the project. All wire sizes shall be chosen in accordance with NEC.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Product data shall be submitted in accordance with the requirements of Section 16010 each of the following:

1. Wires
2. Cables
3. Connectors

1.6 QUALITY ASSURANCE

A. Wire and cable shall be provided and installed in accordance with the requirements of Section 16010.

B. Installer Qualifications and Certifications: Firms with at least 3 years of successful installation experience with projects utilizing electrical wiring cabling work similar to that required for this project.

C. Regulatory Requirements: Conform to applicable code relations regarding toxicity of combustion products of insulating materials.
E. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Wire and cable shall be delivered, stored and handled in accordance with the requirements of Section 16010.

B. Deliver wire and cable properly packaged in factory-fabricated type containers, or wound on NEMA-specified type wire and cable reels.

C. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

D. Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

1.8 WARRANTY

A. Wire and cable warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following (for each type of wire, cable, and connector):

1. Wire and cable:
   a. Triangle - PWC
   b. American Wire and Cable Co.
   c. Anaconda-Ericsson Inc; Wire and Cable Div.
   d. Belden Div; Cooper Industries
   e. General Cable Corporation
   f. General Electric
   g. Okonite

2. Connectors:
   a. O-Z/Gedney Co.
   b. AMP, Inc.
   c. Burndy Corporation
   d. Ideal Industries, Inc.
2.2 MATERIALS, GENERAL

A. Wires and Cables:

1. Provide new wire and cable suitable for the temperature, conditions, and location where installed. All cable shall be new and shall conform to or exceed IPCEA requirements. Building wire shall be insulated with THHN/THWN/THW or XHHW insulation, rated 600 volt.

2. Conductors: Provide solid conductors for power and lighting circuits 12 AWG and smaller. Provide stranded conductors for 10 AWG THHN/THWN and larger. In sizes 250 MCM and larger use type THW or THWN. In sizes #1 AWG and smaller all conductors shall have heat/moisture resistant thermoplastic insulation type THW or THWN (75 degree C), except as follows:
   a. Where conduit temperature will exceed 100 degree F, use type THHN (90 degree C). Type XHHW (90 degree C) permissible in dry locations.
   b. In 120-volt incandescent fixtures, type AF (150 degree C).
   c. In wire ways of fluorescent lighting fixtures types THW-MTW (90 degree C).

3. Conductor Material: Provide copper for all wires and cables.

4. Metal Clad cable is acceptable.

5. Use colors of wires as specified in paragraph 3.5 of this section.

6. For general applications, other than special use, use THHN insulated wire.

7. Type NM, NMC, NMS cable are acceptable for any application.

8. Use copper wire only.

9. No wire splices shall be allowed in the conduit or conduit fittings. All splices shall be done in a approved box.

10. Grounding conductors shall be copper type THHN with green integrally-colored insulation, sized to meet NEC.

11. Plenum rated cable only when required by Plenum conditions.

B. Connectors:

1. Provide UL type factory-fabricated, solder less metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperatures equal to or greater than those of the wires upon which used.
C. Wiring to Light Fixtures:
   1. Type THHN to fluorescent light fixtures, 12-gauge minimum.
   2. Type THHN to incandescent fixtures, 12-gauge minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mechanical work likely to damage cable has been completed.

3.2 INSTALLATION, GENERAL

A. Install electrical cables, wires and connectors in compliance with applicable requirements of NEC, NEMA, UL, and NECA’s “Standard of Installation”, and in accordance with recognized industry practices.

B. Coordinate wire/cable installation work, including electrical raceway and equipment connection work, with other work. Pull no wire into any portion of conduit system until all construction work, which might damage the wire, has been completed.

C. BAS Conductor installation: (see section 15900, 2.4, D, 7,8 & 9)

D. Wires and Cables:

1. On systems greater than 600V thoroughly swab raceway before installing wire. Pull conductors simultaneously where more than one is being installed in same raceway. Use pulling compound or lubricant on all cable installations. Compound used shall not deteriorate conductor or insulation.

2. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed manufacturer’s tension requirements.

3. Keep conductor splices to minimum. Install all wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in hand holes, pull boxes, or junction boxes and shall be in strict accordance with cable manufacturer’s recommendations utilizing solder less connectors NEMA/UL approved for the use. Splice only in accessible junction boxes. Use splices and tap connectors which are compatible with conductor material.

4. Install splices and tapes, which possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

5. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer’s published torque tightening values. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 486 for copper.

6. Support cables above accessible ceilings, do not rest on ceiling tiles. Use spring clips and hanger rods, bridle rings or ‘J’ hooks, independent from the ceiling suspension system to support cables from structure.
7. Provide adequate length of conductors within electrical enclosures and form the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than 10 AWG cables to individual circuits. Make terminations so there is no bare conductor at the terminal.

8. Make up splices in outlet boxes with 8-inch minimum of correctly color-coded tails left in box. Splices in wires size #8 AWG and smaller shall be made with insulated spring type wire connectors, "Scotchlok" or equivalent. Splices in larger wire and cables shall be made with indent connectors NEMA/UL approved for the purpose.

9. Use split bolt connectors for copper wire splices and taps, 6 AWG through 1 AWG. Tape un-insulated conductors and connectors with electrical tape to 150% of the insulation value of conductor. Rubber, friction and 3M-33 or 88 or better. Two (2) layers minimum each.

10. Use copper compression connectors for copper wire splices and taps, 1/O AWG and larger. Tape un-insulated conductors and connectors with electrical tape to 150% of the insulation value of the conductor. Rubber, friction and 3M-33 or 88.

11. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

12. Thoroughly tape the ends of spare conductors in boxes and cabinets.

13. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural member, and follow surface contours, where possible.

14. Make all ground, neutral and line connections to receptacle and wiring device terminals as recommended by manufacturer. Provide ground jumper from outlet box to individual ground terminal of devices.

15. Parallel conductors shall be cut to the same length and be the same type of wire.

16. All splices in control panels, terminal junction boxes, low voltage control circuits and fire alarm conductors shall be on numbered terminal strip.

17. When routed in a wall, install all thermostat wire, fire alarm, computer cable, low voltage cable, and other communication cable in conduit.

18. All junction boxes shall be fully accessible.

19. All wiring shall be routed through an acceptable raceway regardless of voltage application, unless specified otherwise under other sections of these standards.

3.3 TESTING, CLEANING AND CERTIFICATION

A. Refer to Section 16010 for testing, cleaning, and certification requirements.

B. Prior to energizing circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled. Test shall be made on all feeders regardless of size and on all branch circuits with No. 4 AWG and larger conductors.

C. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.
D. Subsequent to wire and cable hook-up, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

A. Color code secondary service, feeder, and branch circuit conductors as follows:

<table>
<thead>
<tr>
<th>120/208 Volts</th>
<th>Phase</th>
<th>277/480 Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>Red</td>
<td>B</td>
<td>Orange</td>
</tr>
<tr>
<td>Blue</td>
<td>C</td>
<td>Yellow</td>
</tr>
<tr>
<td>White</td>
<td>Neutral</td>
<td>Gray</td>
</tr>
<tr>
<td>Green</td>
<td>Ground</td>
<td>Green</td>
</tr>
<tr>
<td>Switch leg - Pink</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 &amp; 4 way travelers - Purple</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Conductors shall be solid color for entire length.

**EXCEPTION**

Conductors 8 AWG and larger may be black and shall be with color-coded at each termination and in each box or enclosure. For a distance of 6 inches use half-lapped 3/4 inch plastic tape in the specified color. Do not cover cable identification markings. Adjust tape locations to prevent covering of markings.

END OF SECTION
SECTION 16130

BOXES

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for device boxes, outlet boxes, wiring, and pull boxes.

1.2 REFERENCES
A. Section 16010 - General Electrical Requirements
B. Section 16110 - Raceways

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. Boxes shall be utilized as part of the electrical raceway system. Size boxes in accordance with NEC requirements and this standard.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submittals shall be made in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE
A. Boxes shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Boxes shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Boxes warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 MATERIALS, GENERAL
A. Sheet Steel: Flat rolled, code-gage, galvanized steel.
B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
C. Fasteners for damp or wet locations: Stainless steel screws and hardware.
D. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.

E. Metal outlet, device, and small wiring boxes:
   1. General: Conform to UL 514A, “Metallic Outlet Boxes, Electrical,” and UL 514B, “Fittings for Conduit and Outlet Boxes.” Boxes shall be of type, shape, size, and depth to suit each location and application.
   2. Steel Boxes: Conform to NEMA OS 1, “Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.” Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

F. Outlet Boxes, Pull and Junction Boxes (J-Boxes):
   1. General: Comply with UL 50, “Electrical Cabinets and Boxes”, for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted-on covers of material same as box and shall be of size and shape to suit application.
   2. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.
   3. Hot dipped galvanized steel boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.
   4. Outlet Boxes: Hot-dipped galvanized of required size, 4 inch square minimum or octagonal and of depth required for flush mounted devices and lighting fixtures. Cast-type with gasketed covers for surface-mounted devices. All outlets for exterior application shall be cast, weatherproof type with gasket and cast cover plate.
   5. Junction and Pull Boxes: Use outlet boxes as J-boxes wherever possible. Larger J-boxes pull boxes shall be accessible and shall be fabricated from sheet steel, sized according to code, with screw-on copy.

G. Non metallic boxes shall not be permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Boxes:
   1. Every J-box shall be secured, independent of conduit entries into the box. Boxes shall be secured to the building structure. Ceiling wire shall not be used to support (secure) J-boxes.
   2. Box fill shall be governed by code requirements. Only the allowable amount of conduit entries shall be allowed into the box.
3. Box covers shall be marked so as to indicate the voltage, panel number, and circuit number of the enclosed conductors.

4. Each J-box shall have only one voltage installed.

5. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

6. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

7. Remove sharp edges where they may come in contact with wiring or personnel.

8. All conduits connected to a flush panel shall be concealed.

B. Outlet Boxes:

1. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc. with the UCD Project Manager.

2. Switch Outlet and Panel board height dimensions to meet ADA requirements.

3. Over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscoting, outlets shall be at a height (6 inches above) to prevent interferences to service equipment, or as noted on drawings.

4. Fire rated poke-through shall be installed in areas to miss beams and ductwork in ceiling below. Floors shall be X-rayed before core drilling in questionable areas and if Contractor encounters resistance during drilling.

5. Outlets at windows and doors: Locate close to window trim in an accessible location. For outlets indicated above doors center outlets above the door opening except as otherwise indicated.

6. Column and pilaster locations: Locate outlet boxes for switches and receptacles on columns or pilasters so the centers of the columns are clear for future installation of partitions. Locate in an accessible location.

7. Locations in special finish materials: For outlet boxes for receptacles and switches mounted in desks or furniture cabinets or in glazed tile, concrete block marble, brick, stone or wood walls, use rectangular shaped boxes with square corners and straight sides. Install such boxes without plaster rings. Saw cut all recesses for outlet boxes in exposed masonry walls.

8. Mounting: Mount outlet boxes for switches with the long axis vertical or as indicated. Mount boxes for receptacles horizontally. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so the will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim. Provide far side box supports for electrical boxes installed on metal studs.

9. Ceiling outlets: For fixtures, where wiring is concealed, use outlet boxes 4-inches square by 1-1/2 inches deep, minimum.
10. Protect outlet boxes to prevent entrance of plaster, and/or debris. Thoroughly clean foreign material from boxes before conductors are installed.

11. Concrete boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6-inch depth.

12. Existing outlet boxes: Where extension rings are required to be installed, drill new mounting holes on the existing boxes where existing holes are not aligned.

13. Back to back outlet boxes are not permitted. Separate boxes a minimum of 6 inches in standard walls and 24 inches in acoustical walls.

C. Installation of Pull and J-Boxes:

1. Box selection: For boxes in main feeder conduit runs, use sizes not smaller than 8-inches square by 4-inches deep. Do not exceed 6 entering and 6 leaving raceways in a single box.

2. Cable supports: Install clamps, grids, or devices to which cables may be secured. Arrange cables so they may be readily identified. Support cable at least every 30 inches inside boxes.

3. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling.

4. Size: Provide pull and J-boxes for telecommunications, signal, and other systems at least 50% larger than would be required by article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

5. Every J-box shall be secured, independent of conduit entries into the box. Boxes shall be secured to the building structure. Ceiling wire shall not be used to support (secure) J-boxes.

6. Box fill shall be governed by code requirements. Only the allowable amount of conduit entries shall be allowed into the box.

7. Box covers shall be marked so as to indicate the voltage, panel number, and circuit number of the enclosed conductors.

D. Grounding:

1. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

E. Outlets:

1. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4 inch octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8-inch no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a J-box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located at one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide
tile box or a 4-inch square box with tile ring where "drywall" type materials are applied.

F. Pull and J-Boxes and Cabinets:

1. Construct J-boxes or pull boxes not over 150 cubic inches in size as standard outlet boxes, and those over 150 cubic inches the same as "Cabinets," with screw covers of same gauge metal. Removable covers must be accessible at all times.

2. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a J-box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the UCD Project Manager.

3. All cabinets shall be set rigidly in place with fronts straight and plumb, center panel board interiors in door openings.

3.2 TESTING, CLEANING, AND CERTIFICATION

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized finish: Repair damage using a zinc-rich paint recommended by the manufacturer.

C. Painted finish: Repair damage using matching corrosion inhibiting touch-up coating.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section provides standards for wiring devices including the following:
   1. Receptacles
   2. Switches
   3. Wall plates

1.2 REFERENCES

A. Section 16010 - Basic Electrical Requirements
B. Section 16130 - Boxes
C. Section 16170 - Grounding and Bonding
C. Section 16195 - Electrical Identification

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. The extent of wiring device work is indicated by drawings and schedules.
B. Wiring devices shall be utilized to meet the requirements of the project.

1.4 DEFINITIONS

A. Wiring devices are defined as single discrete units of electrical distribution systems that
   are intended to carry but not utilize electric energy.

1.5 SUBMITTALS

A. Submittal of manufacturer’s catalog cut sheets electrical wiring devices shall be made in
   accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE

A. Wiring devices shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Wiring devices shall be delivered, stored and handled in accordance with the
   requirements of Section 16010.

1.8 WARRANTY

A. Wiring devices warranties shall be provided in accordance with the requirements of
   Section 16010.

PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide wiring devices of one of the following:

1. Devices:
   a. Harvey Hubbell Inc.
   b. Leviton Mfg. Co.
   c. Pass and Seymour Inc.
   d. Bryant Electric Co.
   e. General Electric Co.

2. Wall (Local) Switches: Numbers used below are those of Hubbell. Equivalent Bryant, P & S, Leviton, or General Electric are acceptable.

<table>
<thead>
<tr>
<th>Single-Pole Switches</th>
<th>#1221</th>
<th>20 amps</th>
<th>277 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-Way Switches</td>
<td>#1223</td>
<td>20 amps</td>
<td>277 volts</td>
</tr>
<tr>
<td>Four-Way Switches</td>
<td>#1224</td>
<td>20 amps</td>
<td>277 volts</td>
</tr>
<tr>
<td>Switch with Pilot</td>
<td>Series 1200</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Receptacles: Hubbell 5262 or equivalent by Bryant, P&S, Leviton, or General Electric.


2.2 MATERIALS, GENERAL

A. Receptacles:

1. Duplex receptacles shall be of the heavy-duty type, NEMA 5-15R configurations. They shall be capable of being side or back wired, with clamp type terminals for back wiring. The grounding blades shall be aligned in such a manner that they are parallel to the longitudinal plane of the receptacle.

2. All duplex, single, and special receptacles shall be heavy duty, standard grade listed by Underwriter’s Laboratories, and have a metal mounting strap with self-grounding and have a hex-head green grounding screw and be side and back wired. Each device shall bear the UL/FS Label.

3. Convenience Receptacle Configuration: NEMA WD 1; Type 5-20R, with ivory nylon face. All receptacles connected to emergency circuits shall have a red face. Color selection shall be verified with Engineer prior to ordering.

4. Standby Receptacles: Single or duplex minimum 20-amp, color gray.

5. Dedicated Circuit: Single or duplex minimum 20-amp, color orange, with isolated ground.
6. Telephone or CRT Receptacles: 4 inch square box with one gang plaster ring and 5/8 inch diameter grommet hole split plate.

7. Special Purpose Receptacles: Provide where shown on drawings. Standard grade, standard color, and of the appropriate code and NEMA configuration to match the supply circuit and load involved. Provide proper grounding through receptacle for equipment.

8. Fire Rated Poke-through: Provide where shown on drawings. Poke-through shall provide services as shown on drawings and have a carpet saver feature.

B. Switches:

1. Wall Switches for Lighting Circuits: NEMA WD1; FS W-S-896E; AC, quiet type, specification grade, listed by Underwriter’s Laboratories with toggle handle, rated 20 amperes or greater at 120-277 volts AC, unless noted otherwise. Mounting straps shall be metal and be equipped with a green hex-head ground screw. Each switch shall bear the UL/FS Label.

2. Handle: Ivory for normal power circuits, red for emergency power circuits. Verify color with Engineer prior to ordering.

3. Pilot Light Type: Lighted handle lit when switch is "on."

4. Locator Type: Continuously lighted handle.

C. Wiring Device Accessories:

1. Wall Plates: Provide Wall plates for single and combination wiring devices, of types, sizes, and with ganging and cutouts as indicated. Select plates which mate and match wiring devices to which attached. Construct with metal screws for securing plates to devices; screw heads colored to match finish of plates. Identify all wall plates used for receptacles with branch circuit number per requirements of Section 16195 - Electrical Identification. Provide blank wall plates for all cable, data, telephone and junction and outlet boxes. Where cables are routed through the wall plate, provide grommets in wall plate openings to protect cables. Provide plates possessing the following additional construction features:

   a. Material and Finish: Stainless steel smooth for plates or match existing.

D. Wire Connectors:

1. For wires size #8 AWG and smaller, insulated pressure type (with live spring) rated 105 degree C, 600 volt, for building wiring and 1000 volt in signs or fixtures. 3M or Ideal.

2. For wires size #6 AWG and larger, T & B or equivalent compression type with 3M #33 or #88 tape insulation.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify boxes are installed at proper height and openings are neatly cut and will be completely covered by wall plates.

B. Verify branch circuiting wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 INSTALLATION, GENERAL

A. Install wiring devices of type as indicated on drawings. All connections shall be made up tight and device set plumb. Use care in installing device in order to prevent damage to device and wire in outlet box. Install wiring devices as indicated, in accordance with manufacturer’s written instruction, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

B. Coordinate with other work, including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices with other work.

C. Install wiring devices only in electrical boxes that are clean; free from excess building materials, dirt, and debris.

D. Install wiring devices after wiring work is completed.

E. Install wall plates plumb and level, after painting work is completed. Provide a device plate for each outlet to suit device installed and install blank plates or covers for J-boxes and empty outlets.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for wiring devices. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A.

G. Upon installation of wall plates and receptacles, advise Contractor regarding proper and cautious use of convenience outlets. At time of Final Completion, replace those items that have been damaged, including those burned and scored by faulty plugs.

H. Provide equipment grounding connections for wiring devices, unless otherwise indicated. Tighten connections to comply with tightening torques specified in UL Standards 486A to assure permanent and effective grounds.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Refer to Standard Section 16010 for testing, cleaning, and certification requirements.

B. Prior to energizing circuitry, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energization, test wiring devices to demonstrate compliance with requirements.

C. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16170
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for power system and communication system grounding.

1.2 REFERENCES
A. Section 16010 - General Electrical Requirements
B. Section 16111 - Cable Trays
C. Section 16140 - Wiring Devices
D. Section 16461 - Dry Type Transformers
E. Manual Part 3, Section 3.3 - UCD Information Systems G/C

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. Ground each separately derived system neutral to nearest metallic cold water pipe, 2" diameter or larger, building steel or the referenced ground bar as shown on drawings.
B. Provide grounding for telecommunications systems in accordance with the requirements of Manual Part 3, Section 3.3, J.
C. Minimum conductor size between ground bar 3/0.
D. Interconnect all ground bars in the building.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submittals for grounding and bonding shall be made in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE
A. Grounding and bonding systems shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE AND HANDLING
A. Grounding and bonding materials shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Grounding and bonding warranties shall be provided in accordance with the requirements of Section 16010.
PART 2 – PRODUCTS

2.1 MANUFACTURES

2.2 MATERIALS, GENERAL

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Provide a separate insulated equipment-grounding conductor in all feeders. Terminate each ground conductor to the bushing and ground lug.

B. All grounding materials shall be copper with the exception of ground rod, which may be copper clad steel.

C. Use minimum No. 6 AWG copper conductor for telecommunications system grounding conductor. Leave 10 feet slack conductor at terminal board or cabinet.

D. Provide code-sized ground cable bonding jumpers, installed with ground clamps, across all conduit expansion couplings and fittings.

E. Provide a corrosion-resistant finish to field connections, buried metallic bonding products, and where factory applied protective coatings have been destroyed, where subject to corrosive action.

F. All continuous runs of cable tray and all isolated sections of cable tray shall be grounded at intervals not to exceed 20 feet.

G. Provide an equipment-grounding conductor in all nonmetallic and flexible conduits.

H. Provide equipment-grounding conductor in all branch circuits. Route to switches, receptacles, equipment enclosures, equipment, and panels etc. and ground as required.

I. Use mechanical grounding connectors for all grounding connections. Exothermic welded connections may be used underground or to building steel.

J. Minimum ground resistance:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Earth Ground Resistance to Equipment (Ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad Mount Transformer</td>
<td>5</td>
</tr>
<tr>
<td>Secondary neutrals and other ground</td>
<td>10</td>
</tr>
<tr>
<td>Lightning protection grounds</td>
<td>5</td>
</tr>
</tbody>
</table>

3.3 TESTING, CLEANING AND CERTIFICATION
3.4 COMMISSIONING

3.5 SCHEDULES

END OF SECTION
SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides standards for conduit and equipment supports from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.2 REFERENCES

A. Section 16010 - General Electrical Requirements
B. Section 16110 - Raceways
C. Section 16111 - Cable Trays

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. All equipment supports shall meet the requirements of this section.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submittals for supporting devices shall be made in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE

A. Supporting devices shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE AND HANDLING

A. Supporting devices shall be delivered, stored and handled in accordance with the requirements or Section 16010.

1.8 WARRANTY

A. Warranties for supporting devices shall be provided in accordance with the requirements of Section 16010.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Fire Seals: Flame Stop V Putty/Caulk
2.2 MATERIALS, GENERAL

A. Conduit Hangers: Galvanized steel with special accessories for purpose and adequate to support load imposed.

B. Coatings: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using NEMA/UL approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

C. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, and wall brackets.

D. Fasteners: Types, materials, and construction features as follows:
   1. Expansion Anchors: Carbon steel wedge or sleeve type.
   2. Toggle Bolts: All steel springhead type.

E. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for no armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

G. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

H. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:
   1. One-Hole Conduit Straps or Minerallac: For supporting 3/4 inch and smaller conduit, galvanized steel.
   2. Two-Hole Conduit Straps or Minerallac or industry approved equal: For supporting 1 inch and larger conduit, galvanized steel; 3/4 inch strap width; and 2-1/8 inch between center of screw holes.

I. Fabricated Supporting Devices:
   1. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
   2. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.
   3. Pipe Sleeves: Provide pipe sleeves of one of the following:
      a. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint.
Fabricate sleeves from the following gauge metal for sleeve diameter noted:

1) 3-inch and Smaller: 20 gauge
2) 4-inch to 6-inch: 16 gauge
3) Over 6-inch: 15 gauge

b. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

c. EMT, IMC, or Rigid Conduit.

J. Fire Seals:

1. Material: Fire stopping material shall be asbestos free, 100% intumescent, have code approval under BOCA, ICBO, SSBC, NFPA 101, NFPA 70, and be capable of maintaining an effective barrier against flame and gases in compliance with the following requirements.

2. Flame Spread: 25 or less, ASTM E84

3. Fire Resistance and Hose Stream Tests: Fire stopping materials shall be rated “F” and “T” in accordance with ASTM E 814 or UL 1479. Rating periods shall conform to the following:

   \[
   \begin{array}{ccc}
   \text{Time-rated floor or wall assemblies.} & T & F \\
   \text{Openings between floor slabs \& curtain wall.} & \frac{3}{2} & \frac{3}{2}
   \end{array}
   \]

K. J-Hooks and Bridle Rings

1. J-hooks and bridle rings maybe used to support low voltage wiring systems.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Conduit Hangers: Support individual conduit 1-1/2 inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.

B. Supports and Hangers:

1. Support and align all raceways, cabinets, boxes, fixtures, etc., in an accepted manner and as herein specified. Support raceways on accepted types of wall brackets, specialty steel clips or hangers, ceiling trapeze hangers or malleable iron straps. Plumbers perforated straps not permitted. Do not suspend raceways or equipment from steam, water or other piping, or ductwork. Provide lead expansion shields in concrete, machine screws, bolts or welding on metal surfaces, and wood screws on wood construction. Use of powder-driven studs is prohibited without express permission from the UCD Project Manager.
a. Mount all conduits to structure a minimum of 7 inches above any accessible type ceiling, or with spacing as required to permit relocation of recessed fixtures to any location.

2. Structural and post tensioned concrete members shall not be drilled or pierced without prior approval from the UCD Project Manager.

3. Where outlets are installed in steel stud type systems, provide additional cross bracing, bridging and/or straps as required to make outlet completely rigid prior to application of wall facing material.

4. Design hangers and wall brackets so that maximum deflection will be no greater than 1/8 inch.

5. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

6. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer’s recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Use of ceiling support wires is unacceptable.

5. Support parallel runs of horizontal raceways together on trapeze-type hangers. Use 3/8-inch diameter or larger threaded steel rods for support. Threaded rod shall be covered by ½ inch conduit from bottom of (trapeze) support to 6-inches above cable tray.

6. Support individual horizontal raceways by separate pipe hangers.

7. Space supports for raceways in accordance with NEC.

8. In all runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

9. Threaded rod supports to have bottoms cut off at a maximum length equal to rod diameter below bottom double nut. Remove sharp edges.

D. Miscellaneous Supports: Support miscellaneous electrical components separately and as required to produce the same structural safety factors as specified for raceway supports.
Install metal channel racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

E. In open overhead spaces, support metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an engineer approved type of fastener not more than 24 inches from the box.

F. Sleeves: Install in walls and all other fire-rated floors and walls for raceways and cable installations as required. Where sleeves through floors are installed, extend above finish floor. For sleeves through fire rated-wall or floor construction, apply UL listed fire stopping sealant in gaps between sleeves and enclosed conduits and cables. See Engineering plans for location and extent of fire rated assemblies.

G. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, bus ways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Powder-driven studs are not acceptable. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25% of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.

H. Telecommunications Systems Cable Supports: Use cable tray or telecommunications approved cable supports.

3.3 TESTING, CLEANING AND CERTIFICATION

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for identification of electrical materials, equipment, and installations.

1.2 REFERENCES
A. Section 16010 - Basic Electrical Requirements

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. All electrical equipment and systems shall be properly labeled in accordance with this section. It includes requirements for electrical identification components including but not limited to the following:
   1. Identification labeling for raceways, cables, and conductors.
   2. Equipment labels and signs.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submittal shall be made in accordance with the requirements of Section 16010 for the following:
   1. Product Data for each type of product specified.
   2. Schedule of identification nomenclature to be used for identification signs and labels.
   3. Samples of each color, lettering style, and other graphic representation required for identification materials; samples of labels and signs.

1.6 QUALITY ASSURANCE
A. Identification products shall be provided in accordance with the quality assurance requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Identification products shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Identification product warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Ideal Industries, Inc.

2. LEM Products, Inc.

3. Markal Corp.

4. Panduit Corp.

5. W.H. Brady, Co.

2.2 MATERIALS, GENERAL

A. Adhesive Marking Labels for Raceway and Metal-clad Cable: Pre-printed, flexible, self-adhesive labels with legend indicating voltage and service (Emergency, Lighting, Power, Power dc, HVAC, Communications, Control, Fire).

   1. Label Size: as follows:


      b. Raceways Larger than 1-Inch: 1-1/8 inches high by 8 inches long.

   2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

C. Pre-tensioned Flexible Wrap-around Colored Plastic Sleeves for Raceway and Cable Identification: Flexible acrylic bands sized to suit the raceway diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the raceway or cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wrap-around, cable/conductor markers with pre-printed numbers and letter.

E. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face for normal and on red face for emergency, yellow face for UPS, and punched for mechanical fasteners. Where required for ground connections, provide engraved legend in black letters on green face.

F. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.
G. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50 pound minimum tensile strength, and suitable for a temperature range from minus 50 degree F to 350 degree F. Provide ties in specified colors when used for color-coding.

H. Adhesive Marking Tape for Device Cover Plates: Kroy tape or Brother labels or equal with 3/16 inch minimum height letters. Kroy tape shall have black letters for normal and red letters for emergency. Brother labels shall be white letters on black background for normal and on red background for emergency. Embossed Dymo-Tape labels are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

B. Install identification devices in accordance with manufacturer’s written instructions and requirements of NEC.

C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

D. Conduit Identification: Use adhesive marking labels at 40 foot intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible. Use the following colors:

1. 600 Volt and Below: Black letters on orange background indicating feeder identification and voltage.

2. Other Systems: Provide color banding as specified below.

E. Identify System Raceways with Color Banding: Band exposed or accessible raceways of the following systems for identification. Bands shall be pre-tensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Install bands at changes in direction, at penetrations of walls and floors, and at 40-foot maximum intervals in straight runs. Apply the following colors:

1. Security System: Blue and Yellow

2. Telecommunications System: Green and Yellow

F. Identify Junction, Pull, and Connection Boxes: Identification of systems and circuits shall be pressure-sensitive, self-adhesive label indicating system voltage and identity of contained circuits on outside of box cover. Color code shall be same as conduits for pressure sensitive labels. Use pressure-sensitive plastic labels at exposed locations and indelible marker (black or red) at concealed boxes. All fire alarm boxes shall have covers painted red.
G. Power Circuit Identification: Tag or label conductors as follows:

1. Multiple Circuits: Where multiple branch circuits or control wiring or communications/signal conductors are present in the same box or enclosure (except for three-circuit, four-wire home runs), label each conductor or cable. Provide legend indicating source, voltage, circuit number, and phase for branch circuit wiring. Phase and voltage of branch circuit wiring may be indicated by means of coded color of conductor insulation. For control and communications/signal wiring, use color coding or wire/cable marking tape at terminations and at intermediate locations where conductors appear in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tapes.

2. Match identification markings with designations used in panel boards shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

H. Install equipment/system circuit/device identification as follows:

1. Apply equipment identification labels of engraved plastic-laminate on each major unit of electrical equipment in building, including central or master unit of each electrical system. This includes communication/signal/alarm systems, unless the unit is specified with its own self-explanatory identification. Text shall match terminology and numbering of the Contract Documents and shop drawings. Apply labels for each unit of the following categories of electrical equipment.

   a. Panel boards and enclosures

   b. Access doors and panels for concealed electrical items

I. Apply circuit/control/item designation labels of engraved plastic laminate for disconnect switches, breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panel boards and alarm/signal components, where labeling is specified elsewhere.

J. For panel boards, provide framed, typed circuit schedules (label all spares and spaces in pencil) with explicit description and identification of items controlled by each individual breaker.

K. Install labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

L. Provide tape labels for identification of individual receptacle and switch wall plates. Locate tape on front of plate and identify branch circuit serving the receptacle or switch.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Refer to Section 16010 for cleaning and certification requirements.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
PART 1 – GENERAL

1.1 SUMMARY

A. This section provides standards for primary pad-mounted transformers, underground primary distribution, and unit substations.

1.2 REFERENCES

A. Section 02780 - Power and Communications
B. Section 16010 - Basic Electrical Requirements
C. Section 16170 - Grounding and Bonding
D. Section 16195 - Electrical Identification

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Primary Transformers:

1. Electrical transformers will be included as part of the project design and will be located during the design phase.

2. Transformers used to step down from the UCD primary voltage to building utilizable voltage shall be non-PCB liquid-cooled and insulated and installed in accordance with Article #450 of the National Electric Code (NEC).

3. Where building transformer is to be furnished under the building contract, the size is to be determined by the Engineer. All sizing is to be approved through the UCD Project Manager.

4. Transformers shall be specified with a maximum of 115 degree C temperature rise.

5. All transformers to be accessible, floor-mounted-above 6 feet not acceptable.

B. Underground Electrical Primary:

1. Service (primary) – Main Campus primary distribution is owned by the UCD. Assume all systems are ungrounded in cable standards.

2. Unless otherwise stated during the pre-design conference, the UCD will provide and underground junction point or switch point within the contract limits (or close by) for termination of primary building feeder. Contractor will provide and install raceway and conductors between said junction point and the building transformer.

C. Secondary Unit Substations:
1. Substations: Must be equipped with phase selector switch: volt and amp meters either standard or digital; phase + neutral metering with RS 232 output.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submit transformer and power distribution equipment data in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE

A. Transformer and power distribution equipment shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Transformer and power distribution equipment shall delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY

A. Transformer and power distribution equipment warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subjects to compliance with requirements, provide products by the following:

1. Primary Transformers: G.E., Square D, Siemens

2.2 MATERIALS, GENERAL

A. Primary Pad Mounted Transformers:

1. Liquid-filled Transformers: ANSI C57.12.22; three phase, pad mounted, self-cooled, copper wound transformer unit.

2. Transformer capacity, primary voltage, secondary voltage, and impedance shall be as specified on the drawings.

3. Provide standard primary taps, with externally operated tap changer.

4. Cooling and Temperature Rise; ANSI C57.12.22; Class OA. 65 degree C, self-cooled.

5. Liquid: Oil

6. Accessories: ANSI C57.12.22 standard accessories including magnetic liquid level gage and dial type thermometer.
7. Primary Terminations: Bushing wells to ANSI/IEEE 386; provide radial or loop feed as specified on drawings. Include bushings for insulated load break connectors.

8. Primary Switching and Protection: As indicated on drawings.


B. Underground Electrical Primary:

1. Duct Bank (primary): Underground 13.8 kV shall be concrete encased raceway. Raceway may be P.V.C. Type 1 or equivalent. Concrete envelope shall be red color and shall be a minimum of 4 inch all around cover. (Example: 4-inch raceway would require 12 inch cross section of concrete).

2. Primary Cable: 15 kV class cable to be single copper conductor, 220 mil insulated for ungrounded type service, shielded, 90 degree C rated, with copper conductor cable.

3. Ground: No. 4 AWG with THWN 600 volt insulation copper wire in raceway with primary service to building. Tie said ground wire to common system ground of building.

4. All conduits entering or exiting buildings shall be hull wall rigid metal conduit to minimize future shearing of conduits. After leaving building excavation, the transaction to other types of conduits can be made.

5. Warning tape shall be buried 6 inches deep on top of buried electrical and control wiring. The tape shall be inert plastic film highly resistant to alkalis, acids, or other destructive chemical components likely to be encountered in soils. The tape shall be 3 inches wide, colored Red and imprinted with “CAUTION: BURIED ELECTRIC LINE BELOW”.

C. Secondary Substation:

1. Ratings: Current and Voltage see drawings, three phase, 60 Hz, 95 kV BIL.


3. Transformer section equipment:
   a. Description: Oil-immersed type distribution transformer.
   b. Capacity: kVA per drawings, self cooled.
   c. Voltage ratings shall be as shown on drawings. Connection shall be Delta-wye grounded.
   d. Temperature Rise: 65 degrees C.

4. Outgoing section equipment:
   a. Description: Switchboard manufactured to NEMA PB 2.
   b. Line and Load Terminations: Accessible from the front, suitable for the conductor materials used.

d. Bus Material: Copper, sized in accordance with NEMA PB 2. Bus connections shall be bolted, accessible from rear for maintenance.

e. Fully insulate bus bars throughout, with bus spacing based on air insulation.


5. Instruments and sensors:

a. Ammeters: ANSI C39.1; indicating ammeters with 4.5 inch square recessed case and 250 degree scale, white dial with black figures and pointer, 5 ampere, 60 Hertz movement, 1% accuracy.

b. Voltmeters: ANSI C39.1 indicating voltmeter with 4.5 inch square recessed case and 250 degree scale, white dial with black figures and pointer, 120 volt, 60 Hertz movement, 1% accuracy.

c. Ammeter Transfer Switch: Rotary multistage snap-action type with 600-volt AC-DC silver-plated contacts, engraved escutcheon plate, pistol-grip handle, and four positions including OFF.

d. Voltmeter Transfer Switch: Rotary multistage snap-action type with 600-volt AC-DC silver-plated contacts, engraved escutcheon plate, pistol-grip handle, and seven positions including OFF.

e. Watt-hour Meters and Wattmeters and Impulse-Totalizing Demand Meter:

f. Current Transformers: ANSI C57.13; 5 ampere secondary, bushing, bar or window type, with double secondary winding and secondary shorting device, primary/secondary ratio as shown on drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

g. Potential Transformers: ANSI C57.13; 120 volt double secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

h. Ground Fault Sensor: Zero sequence type. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.

6. Fabrication:
a. Provide a 1x ¼ inch copper ground bus through the length of the switchboard.

b. Align sections at front and rear.

c. Finish: Manufacturer’s standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

d. Mimic Bus: Indicate bussing, connections and devices in single line form on the front panels of the switchboard using black color plastic strips light metal strips, fastened flat against the panel face with adhesive.


7. Accessories:

a. Surge Arrestors: Station class, rated as shown on the drawings; mount in incoming line compartment.

b. Incoming Cable Terminations: Clamp-type.

c. Space Heaters: Sized by substation manufacturer.

PART 3 – EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Primary Pad Mounted Transformers:

1. Install in accordance with drawings and manufacturer’s recommendations.

2. Install safety labels to NEMA 260.

B. Underground Electrical Primary:

1. Install duct in accordance with manufacturer’s recommendations. Install duct at depth and locations as indicated on drawings. Install duct with a minimum slope of 4 inches per 100 feet. Provide suitable fittings to accommodate expansion and deflection.

2. Band ducts together before placing concrete. Securely anchor to prevent movement during placing of concrete. Stagger duct joints vertically in concrete encasement. Provide two (2) #4 steel reinforcing bars in top of bank under paved areas.

3. Swab duct. Use suitable caps to protect installed duct.

4. Install cable and accessories in accordance with manufacturer’s instructions.
5. Avoid abrasion and other damage to cable during installation. Use suitable lubricants and pulling equipment. Do not exceed cable pulling tensions and bending radius.

6. Ground cable shield at each termination and splice.

7. Install cables in manholes along wall providing longest route. Arrange cable in manholes to avoid interference with duct entrances. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping. Extend fireproofing on inch into duct.

C. Secondary Unit Substation:
1. Install 3-inch house keeping pad for unit substation.
2. Install in accordance with drawings and manufacturer’s instructions.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Refer to Section 16010 for testing, cleaning, and certification requirements.

B. Test dielectric liquid to ASTM D877, using 25,000 volts minimum breakdown voltage, after installation and before energizing from system.

C. Test transformer to ANSI/IEEE C57.12.90.

D. Test unit substation to NEMA 210.

E. Cable Testing: Perform DC high potential test of each conductor in accordance with NEMA WC 3. Connect untested conductors in circuit to ground during test. Apply test voltage in at least eight equal increments to maximum test voltage. Record leakage current at each increment. Allowing for charging current decay. Hold maximum test voltage for ten minutes.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16400

SERVICE AND DISTRIBUTION

PART 1 – GENERAL

1.1 SUMMARY

A. This section provides standards over current protective devices (OCPD) rated 600 volt and below and switching devices commonly used with them.

1.2 REFERENCES

A. Section 16010 - Basic Electrical Requirements

B. Section 16195 - Electrical Identification

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Motors, Starters and Protection: Electrical contractor will supply and install all motor controllers and disconnect switches.

B. Panel boards:

1. Provide a minimum of two (2) - 1” spare conduits out of panels. Run empty conduit to accessible spaces. Label conduits as spare.

2. All lighting and power panels will be specified to provide minimum of 30% spare capacity and spare breaker space.

3. A/E will provide panel indexes on contract drawings. Final indexes to be provided by the Contractor will correspond to final UCD room number schedule.

4. The switching of lights from lighting panels is acceptable only if specifically approved by the UCD CBO, through the UCD Project Manager; and if approved, a separate panel will be provided for circuits, which are to be controlled. No circuits other than lighting will originate in the panel thus provided. In the rare instance of lights being switched by breaker, provide switch-rated breakers.

C. Metering:

1. All buildings are to be provided with master watt-hour meter, 15-minute demand register; voltmeter and ammeter with appropriate selector switches. By-pass switches are to be provided in meter housing for meter removal and testing of meter. Provide primary rated meter per building, including power quality.

2. Install watt-hour meter on centrifugal/reciprocating chiller installations.

L. Grounding and Testing: Transformer neutrals of separately derived systems secondaries will be grounded by way of a grounding conductor between the secondary neutral and grounding buss at the main service entrance equipment. Size determined in accordance with NEC.

1.4 DEFINITIONS
1.5 SUBMITTALS
   A. Submittals for service and distribution systems shall be made in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE
   A. Service and distribution systems shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE AND HANDLING
   A. Service and distribution system shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
   A. Service and distribution systems warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:
      1. Cartridge Fuses:
         a. Bussmann Div., Cooper Industries, Inc.
         b. Littelfuse Inc.
         c. Or equal
      2. Fusible Switches:
         a. Square D Co.
         b. Allen-Bradley Co.
         c. General Electric Co.
         d. Westinghouse Electric Co.
      3. Molded-Case Circuit Breakers:
         a. Square D Co.
         b. General Electric Co.
         c. Siemens Energy & Automation, Inc.
         d. Westinghouse Electric Corp.
e. ABB Power Distribution, Inc.

4. Combination Circuit Breaker and Ground Fault Circuit Interrupters:
   a. Square D Co.
   b. General Electric Co.
   c. Siemens Energy & Automation, Inc.
   d. Westinghouse Electric Corp.

5. Safety Switches:
   a. ITE
   b. Or equal

6. Motor Starters:
   a. Allen-Bradley Co.
   b. Or equal

7. Panel boards:
   a. GE
   b. ITE
   c. Square D
   d. Westinghouse/Cutler Hammer
   e. Panel boards shall match existing throughout facility in remodel situations.

8. Motor Control Centers:
   a. Allen - Bradley
   b. ITE
   c. GE
   d. Square D
   e. Westinghouse/Cutler Hammer

2.2 MATERIALS, GENERAL

A. Motor Starters:

1. Shall be combination circuit breaker (magnetic only) full voltage magnetic type with 3-leg overload protection in NEMA I enclosure. Provide 2 interlock contacts of interchangeable open-close type. Provide hand-off automatic
selector, motor running transformer type red pilot light and long life lamps and reset button in cover. Control circuits shall be provided with individual 120-volt control transformers. Starters shall be furnished under electrical contract. Size starts at 125% of motor size.

2. Starters for fractional horsepower (1/2 HP or less) 120-volt motors shall be manual type, unless shown otherwise, equipped with built-in overload protection. All magnetic starters shall be of one manufacturer. Thermal overload switches shall be General Electric type CR101 or equal of other acceptable manufacturer.

3. All motors larger than 1/2 HP shall be 3 phase.

4. Motors above 50 HP will require step starting or VFDs to limit starting current.

5. All motors to be provided with external overload running protection. This is in addition to any 'built-in' protection inherent in the motor.

6. All motors of 1-1/2 HP and larger shall be of a high or premium efficient type and have an efficiency of not less than those values as stated in the IEEE test procedures, 112A Method B.

B. Panel boards:

1. Panel boards shall be NEMA PB1, circuit breaker type. Panel board bus shall be copper and shall be size to meet the continuous and short circuit rating as shown on the drawings.

2. All panel covers will be factory painted with low gloss enamel (not flat wall paint) suitable for metal. No field painting will be permitted. Toggle type covers not acceptable.

3. Panel boards shall be of door-in-door construction.

C. Power Factor Correction: All motors 20 HP and larger will be power factor corrected to a minimum of 95% at design load. HVAC systems may be corrected at the motor control center.

D. Over current Protective Device:

1. General: Provide OCPDs in indicated types, as integral components of panel boards, switchboards, motor control centers, and other related equipment; and also as individually enclosed and mounted single units.

2. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

3. Where OCPDs are to be installed in existing panel boards, switchboards, and motor control centers, they shall be of the same manufacture and type as those existing in the equipment.

E. Cartridge Fuses:

1. General: NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types,
classes, and current ratings that have voltage consistent with the circuits on which used.

2. All fuses used for main, feeder, or branch-circuit protection shall be UL listed, current limiting fuses with 200,000 ampere interrupting rating and shall be so labeled. Fuses used for supplementary protection (other than branch circuit protection) shall be as specified above or shall be UL approved or component recognized for such purposes. The same manufacturer shall furnish all fuses provided. Should equipment provided require a different UL class or size of fuse, the engineer shall be furnished sufficient data to ascertain that system function will not be adversely affected.

3. Fuses over 600 amperes shall be UL Class "L" fuses; and shall have minimum time-delay of 10 seconds at 500% rating.

4. To simplify fuse replacement, reduce spare fuse inventory and insure adequate thermal protection, all fuses 600 amperes and below shall be true dual-element time-delay fuses with separate spring-loaded thermal overload elements in all ampere ratings. All ampere ratings shall be designed to open at 400 degree F or less when subjected to a non-load oven test.

5. To eliminate induction heating, all fuse ferrules and end caps shall be non-ferrous and shall be bronze or other alloy not subject to stress cracking.


7. Class RK1 and RK5 Dual Element Time-delay Fuses: UL 198E, “Class R Fuses.”

F. Fusible Switches:


2. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.

3. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.

4. Operation: By means of external handle.

5. Interlock: Prevents access to switch interior except when in “off” position.

6. Fuse Clips: Rejection type.

7. Padlocking Provisions: For 2 padlocks whether open or closed.

8. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting where indicated.

10. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.

11. Contacts shall be NEMA rated 75 degree C.

12. Provide fuses for safety switches and other equipment of classes, types, and rating needed to fulfill electrical requirements for services indicated.

13. Provide auxiliary contacts for disconnects supplied from variable frequency drives.

G. Safety Switches:

1. Heavy-duty type, horsepower rated for motors.

2. Standard enclosure indoors and weather-tight outdoors.

H. Molded-case Circuit Breakers:


3. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical for 120 and 208 volt devices and 14,000 amperes symmetrical for 277 and 480 volt devices, unless a greater rating is indicated or required to match existing devices or equipment.

4. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous over current trip protection for each pole.

5. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.

6. Enclosure for Switchboard or Panel board Mounting: Suitable for panel mounting in switchboard or panel boards where indicated.

7. Enclosure for Switchboard or Motor Control Center Mounting: Provide individual mounting where indicated.

8. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.

I. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UL 943, “Ground Fault Circuit Interrupters,” arranged for sensing and tripping for ground fault current in addition to over current and short-circuit current. Provide features as follows:

1. Match features and module size of panel board breakers and provide clear identification of ground fault trip function.

2. Trip Setting for Ground Fault: Recalculate / reset as required by additional loads in excess of 100A @ 480v 3-phase.
J. Distribution Switchboard:

1. NEMA PB 2 with electrical ratings and configurations as indicated. Main section shall be individually mounted. Distribution devices shall be panel mounted. Provide for future provisions.

2. Bus material shall be copper and shall be fully insulated. Bus connections shall be bolted and shall be accessible from the back. Ground bus shall run the entire length of the switchboard.

3. Line and Load Terminations: Accessible from the front. Suitable for the conductor size and type shown.


5. Align sections in front and rear. Switchboard height shall be 90 inches. Finish shall be manufacturer's standard light gray. Mimic bus shall be provided.

6. Instruments and sensors:
   a. Ammeters: ANSI C39.1; indicating ammeters with 4.5 inch square recessed case and 250 degree scale, white dial with black figures and pointer, 5 ampere, 60 Hertz movement, 1% accuracy.
   b. Voltmeters: ANSI C39.1 indicating voltmeter with 4.5 inch square recessed case and 250 degree scale, white dial with black figures and pointer, 120 volt, 60 Hertz movement, 1% accuracy.
   c. Ammeter Transfer Switch: Rotary multistage snap-action type with 600-volt AC-DC silver-plated contacts, engraved escutcheon plate, pistol-grip handle, and four positions including OFF.
   d. Voltmeter Transfer Switch: Rotary multistage snap-action type with 600-volt AC-DC silver-plated contacts, engraved escutcheon plate, pistol-grip handle, and seven positions including OFF.
   e. Watt-hour Meters and Wattmeters & Impulse-Totalizing Demand Meter
   f. Current Transformers: ANSI C57.13; 5 ampere secondary, bushing, bar or window type, with double secondary winding and secondary shorting device, primary/secondary ratio as shown on drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
   g. Potential Transformers: ANSI C57.13; 120 volt double secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

K. Motor Control Center

1. NEMA ICS 2, Class II Type A, B or C. Voltage and current ratings shall be as shown on the drawings. Enclosure shall be NEMA ICS 6 Type 1 or 2.
2. Main over current protection shall be molded case circuit breaker sized as shown on the drawings.

3. Vertical and horizontal bus shall be copper and rated as shown on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Maintenance Stock Fuses: For types and ratings required, furnish spare fuses, amounting to one set of 3 of each kind.

L. Independently Mounted OCPDs: Locate as indicated and install in accordance with manufacturer’s written installation instructions.

C. OCPDs in distribution and branch circuit equipment shall be factory installed.

D. Connections: Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

E. Grounding: Provide equipment-grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

F. Panel boards:

1. Except as otherwise noted, locate panel boards as follows: Dimensions given are from finished floor.

   a. 6'-6" to top of trim.

2. Contractors who are modifying or installing new electrical panels must redo the panel directory making the directory current. In the case of a new panel, the panel directory must coincide with actual (correct) building room numbers. Panel schedules need to be updated when extra circuits are added or when the entire panel is upgraded, such as with remodel jobs, per Section 16195. Provide labeling of circuit using final room numbers.

3. Electrical panels, switchgear, and any kind of electrical distribution boards shall not be worked hot.

4. Only one wire per breaker will be allowed.

5. Wire shall be neatly formed to contour with the panel box. Remove all excess wire lengths.

6. Every panel shall have a grounding bar installed in its interior. Attached to the grounding bar shall be a grounding conductor taken to earth ground and/or a domestic water copper or metal pipe when appropriate as required by NEC.
7. An energized panel shall not be left exposed or unlocked to the general public, such as in a hallway, office, or other pedestrian walkway. Panel covers shall be reinstalled at the end of the workday.

8. Attach panel boards to concrete walls or floors with a concrete type anchor that requires drilling of the concrete and manually driving in the anchor by force. Do not use powder-actuated or plastic anchors to secure panel boards.

9. Panel identification is imperative. The panel shall be identified on the outside of the panel cover per Section 16195.

10. Panel cover hardware shall be replaced if broken or not operating properly.

11. Minimum 3-foot clearance from front is required.

12. Breakers shall be labeled 1, 3, 5, etc., on left side; 2, 4, 6, etc., on right side.

13. Match existing building equipment wherever possible and/or coordinate with the UCD Project Manager.

G. Switchboards: Install switchboard on 3-inch housekeeping pad. Install switchboards in accordance with manufacturer's recommendations. Tighten bus connections after placing switchboard.

H. Motor Control Centers (MCC): Install MCC on 3-inch housekeeping pad. Install MCC in accordance with manufacturer's recommendations.

3.3 TESTING, CLEANING AND CERTIFICATION

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16461
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for dry type two winding transformers.

1.2 REFERENCES
A. Section 16010 - Basic Electrical Requirements
B. Section 16110 - Raceways
C. Section 16170 - Grounding and Bonding

1.3 SYSTEM PERFORMANCE REQUIREMENTS

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submit transformer data in accordance with the requirements of Section 16010.

1.6 QUALITY ASSURANCE
A. Transformers shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Transformers shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Transformer warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptance Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Cutler Hammer
2. Siemens
3. GE
4. Square D
2.2 MATERIALS, GENERAL

A. Description: Transformers shall be NEMA ST 20, factory assembled, air cooled, altitude corrected, copper wound dry-type distribution transformers of sizes, characteristics and ratings indicated, designed to supply a 100% nonlinear load. Winding taps per NEMA ST 20.

B. Transformers shall have Class H insulation. All transformers shall be rated for 115 degree C maximum temperature rise above 40 degrees C ambient.

C. Provide ventilated drip-proof, conventional type metal housings for indoor service. Provide all necessary supports, rods, and hangars to properly and securely support transformer in location indicated.

D. Winding Taps:
   1. Transformers Less than 15 kVA: Two 5% below rated voltage, full capacity taps on primary winding.
   3. Transformers shall have 480 volt, 3 phase, 3 wire primary and 120/208 volt, 3 phase, 4 wire, 60 hertz, wye connected secondary unless otherwise noted.

E. Sound Levels: Maximum sound levels are as follows: NEMA ST 20.

F. Basic Impulse Level: 10 kV for transformers less than 300 kVA, 30 kV for transformers 300 kVA and larger.

G. Ground core and coil assembly to enclosure by means of a visible flexible copper-grounding strap.

H. Mounting: Floor mounting wherever possible.

I. Coil Conductors: Continuous windings with terminations brazed or welded.

J. Enclosure: NEMA ST 20; Type 1, ventilated. Provide lifting eyes or brackets.

K. Transformers shall be supplied with factory installed internal vibration absorbing isolators to isolate core and coil from enclosures.

L. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Install transformer in accordance with manufacturer's instructions.

B. Set transformer plumb and level.
C. Use flexible conduit, under the provisions of Section 16110, 2 ft (0.6 M) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

D. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

E. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connections, and any domestic cold water plumbing systems 2” or greater that is available.

F. Provide a separate insulated equipment-grounding conductor in feeder and branch circuits. Terminate each end on a grounding lug, buss or bushing.

G. Provide grounding bushings and bonding jumpers for all conduits terminating in reducing washers, concentric, eccentric or oversized knockouts at panel boards, cabinets, and gutters.

H. Provide bonding wire in all flexible conduits.

3.3 TESTING, CLEANING AND CERTIFICATION

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16510

INTERIOR LUMINAIREs

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides standards for extent, location, and details of interior luminaries.

1.2 REFERENCES

A. Section 16010 - Basic Electrical Requirements
B. Section 16000 - Electrical Design Standards

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. General Information:
   1. All light intensity design will be done in accordance with the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. publication 90-75 for Energy Conservation in New Building Design.
   2. Lighting requirements shall be provided in accordance with the requirements of Section 16000.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submittals for interior luminaries shall be made in accordance with the requirements of Section 16010 for the following:
   1. Product Data: Submit product data with mounting type and installation instructions for each proposed types of luminary and accessories.

1.6 QUALITY ASSURANCE

A. Interior luminaries shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE AND HANDLING

A. Interior luminaries shall be delivered, stored and handled in accordance with the requirements of Section 16010.
   1. Deliver luminaries in factory-fabricated containers or wrappings, which properly protect them from damage.
   2. Store luminaries in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat, and blocked off ground.
   3. Handle luminaries carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.
1.8 WARRANTY

A. Interior luminaries warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURES

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

   Ballasts:
   a. Motorola
   b. Advance
   c. Universal
   d. Osram

2.2 MATERIALS, GENERAL

A. Provide low-energy fluorescent lamp ballasts, capable of operating lamp types indicated; with high power factor, rapid-start, and low-noise features; Type 1, Class P; sound-rated A.

B. Wiring: Provide electrical wiring within luminary suitable for connecting to branch circuit wiring as follows:

   1. NEC Type THHN for 120 volt, minimum #18 AWG
   2. NEC Type THHN for 277 volt, minimum #18 AWG
   3. Provide a green grounding wire in flexible conduit connection to all recessed fixtures. Provide green grounding wire to all power outlets. Provide green grounding wire in all runs from panels to fixtures and devices.

C. Ballasts: Provide with low in-rush current where possible. Dimming ballasts are not acceptable.

D. Lenses: Diffusers for fluorescent fixtures shall be acrylic A12.125.

E. Exit Signs: Housing shall be extruded aluminum. Face shall be translucent white with green lettering. Directional arrows shall be universal for field adjustment. Mounting shall be as indicated on project drawings. Battery shall be provided if an emergency source is not available. Lamp shall be LED type. Input voltage shall be as shown on drawings. H-3 radioactive exit signs must not be specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which lighting is to be installed, and substrate for supporting lighting. Notify Contractor in writing of conditions detrimental to proper
completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION, GENERAL

A. Install lighting at locations and heights as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation,” NEMA standards, and with recognized industry practices to ensure that lighting fulfills requirements.

B. Provide luminaries and/or outlet boxes with hangers to properly support luminary weight. Comply with IBC luminary support requirements.

C. Install flush-mounted luminaries properly to eliminate light leakage between frame and finished surface.

D. Provide plaster frames for recessed luminaries installed in other than suspended grid-type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.

E. Fasten luminaries securely to indicate structural supports; and ensure that pendant luminaries are plumb and level. Provide individually mounted pendant luminaries longer than 2 feet with twin hangers. Mount continuous rows of luminaries with one more aircraft cable support greater than number of luminaries in the row.

F. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B, and the National Electrical Code (NEC).

G. Support surface-mounted luminaries greater than 2 feet in length at a point in addition to the outlet box stud.

H. Overall dimensions of incandescent or fluorescent fixtures recessed in suspended grid ceilings shall be such that they will fit into grid ceiling with no distortion or field repair to fixtures and with no distortion of ceiling grids. If field repair is required, the engineer shall be notified immediately. All fixtures must be supported independent of the ceiling grid per NEC. Coordinate installation of the fixtures with installer of ceiling so that ceiling will be absolutely level after completion.

I. Grounding: Provide equipment-grounding connections for lighting as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

J. Install exit signs per manufactures recommendations.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Clean luminaries of dirt and construction debris upon completion of installation, and again prior to project turnover. Clean fingerprints and smudges from lenses.

B. Protect installed luminaries from damage during remainder of construction period.
C. At Date of Final Completion, replace lamps in luminaries that are observed to be noticeably dimmed after Contractor’s use and testing, as judged by Engineer.

1. Refer to Division 1 sections for the replacement/restoration of lamps in lighting where used for temporary lighting prior to Date of Final Completion.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16530
SITE LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides standards for site lighting.

1.2 REFERENCES

A. Manual Part 2, Section 2.17 - Exterior Lighting Guidelines

B. Section 16010 - Basic Electrical Requirements

1.3 SYSTEM PERFORMANCE REQUIREMENTS

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submittals for site lighting shall be made in accordance with the requirements of Section 16010 for the following:

1. Product Data: Submit manufacturer’s product data with mounting type and installation instructions on each proposed type of luminary and accessories.

1.6 QUALITY ASSURANCE

A. Site lighting shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Site lighting shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1. Deliver lighting in factory-fabricated containers or wrappings, which properly protect luminaries from damage.

2. Store lighting in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, humidity, laid flat, and blocked off ground.

3. Handle lighting carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.

1.8 WARRANTY

A. Lighting system warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Parking Lots Lighting:
   a. Primary Manufacturer - Gardco “Round Form 10” CA Style:
      CA22; light distribution depends on whether single or double configuration and location, use Q or 3 distribution; 277v, 250 MH max; finish to be campus standard color RAL7038. Pole: RA5, 30 ft high, fixed base, accommodates single or double configuration as required, finish color RAL7038
   b. General Description: Pole mounted, aluminum type luminary (single and double-head), thirty (30) foot aluminum pole, both with optional color paint (RAL7038)

2. General Campus Lighting:
   a. Primary Manufacturer - Gardco “Round Form 10” MP Style:
      Form 10; MP17; P12 yoke fitter; light distribution depends on location, use Q or 3 distribution; 277v, 50MH; finish to be campus standard color RAL7038. Pole: RA4, 10 ft high, fixed base, finish color – RAL7038.
   b. General Description: Pole-mounted, aluminum type luminary (single head), ten (10) foot aluminum pole, both with optional color paint – RAL7038

3. Exterior of Building Walls, Above Entries (Fixtures can be specified per building):
   a. Primary Manufacturer - Gardco “Square Form 10” wall mount - WE
   b. General Description: Rectangular aluminum type, wall mounted luminary, 14 inch, anodized, color bronze (“BRA”), FM distribution, 277 volt ballast, 100MH max
   c. Other fixtures as approved per location

4. Exterior at Colonnades:
   a. Primary Manufacturer - McPhilben / Gardco 100 Line; 105 - FT(Forward Throw); 100MH; , finish color – RAL7038.
   b. General Description: Wall mounted, quarter sphere, glow sconce
   c. Other fixtures as approved per location

5. Exterior at service yards:
   a. Primary Manufacturer – None provided
   b. General Description: Wall mounted, aluminum housing dark bronze finish or other color as approved for location.
   c. Fixture style as appropriate for location; Wall-PAK used only with prior approval

6. Accent Lighting Near Walkways:
   a. Primary Manufacturer - Gardco “Bollard Ten” BR160 (head only):
      16 inch diameter, campus standard finish – RAL 7038
b. General Description: Concrete bollard mounted, cylindrical, aluminum luminary, 16 inch diameter, painted aluminum, Type 3 distribution, 277 volt ballast, Type 0 mounting, 100MH max

c. Other fixtures as approved per location

7. Landscape Areas:

a. Type GM2: Hydrel, 4710 MHM50, provide with stem.

b. General: Ground-mounted cast aluminum adjustable HID up light stemmed up in plant areas. Integral components including electrical parts, lamps, and optical assembly are totally enclosed, rain tight, dust tight, and corrosion resistant. Dark bronze baked enamel finish

2.2 MATERIALS, GENERAL

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which lighting is to be installed. Notify Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION, GENERAL

A. Install lighting at locations and heights as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC, NECA’s “Standard of Installation,” NEMA standards, and with recognized industry practices to ensure that lighting fulfills requirements.

B. Fasten luminaries securely to structural supports and ensure that luminaries are plumb and level.

C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer’s published torque tightening values for equipment connectors. Where manufacturer’s torque requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and 486B, and the National Electrical Code (NEC).

D. Grounding: Provide equipment-grounding connections for lighting as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Refer to Section 16010 for testing, cleaning, and certification requirements.

1. Clean lighting of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses.

2. Protect installed luminaries from damage during remainder of construction period.

3. At Date of Final Completion, replace lamps in luminaries, which are observed to be noticeably dimmed after Contractor’s use and testing, as judged by Engineer.
a. Refer to Division 1 sections for the replacement/restoration of lamps in lighting where used for temporary lighting prior to Date of Final Completion.

4. Upon completion of installation of lighting and after circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then re-test to demonstrate compliance; otherwise, remove and replace with new units and proceed with re-testing.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES
SECTION 16622

PACKAGED ENGINE GENERATOR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standard for packaged engine generator systems.

1.2 REFERENCES
A. Section 16000 - Basic Electrical Requirements.

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. Locate generators down wind taking into account the location of future buildings. Also if possible place generators on opposite side of building air intakes.
B. Provide lighting and receptacles on individual circuits inside and outside of the generator enclosure.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submittals for packaged engine generator systems shall be made in accordance with the requirements of Section 16010 for the following:
   1. Drawings to indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.
   2. Drawings showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, and remote radiator.

1.6 QUALITY ASSURANCE
A. Packaged engine generator systems shall be provided in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING
A. Packaged engine generator systems shall be delivered, stored, and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Packaged engine generator systems warranties shall be provided in accordance with the requirements of Section 16010.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufactures: Subject to compliance with requirements, provide products by the following:

1. Onan
2. Caterpillar
3. Cummins
4. Stewart & Stevenson

2.2 MATERIALS, GENERAL

A. Package Engine Generator System

1. Provide 24-hour fuel tank unless otherwise approved by the UCD CBO.
2. Provide integral day tank, size as required.
3. Provide double containment.

B. Engine:

1. Type: Water-cooled V-type, four stroke cycle, compression ignition Diesel (No. 2 fuel oil) internal combustion engine.
2. Rating to equal the load and compensated for elevation with 70% overload for 1 hour.
3. Governor: Isochronous type to maintain engine speed within 0.5 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.
4. Safety Devices: Engine shutdown on high water temperature, low oil pressure, over speed, and engine over crank. Limits as selected by manufacturer.
5. Engine Starting: DC starting system with positive engagement.
6. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F, and suitable for operation on 208 volts AC.
7. Radiator: Radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F. Radiator airflow restriction will be 0.5 inches of water maximum. Provide low-level indicator alarms.
8. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil circulation pump, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.
9. Mounting: Provide unit with suitable spring-type vibration isolators and mount on structural steel base.

C. Generator:

1. Generator: NEMA MG1, three phase, four pole, re-connectible brushless synchronous generator with brushless exciter.

2. Voltage Regulation: Include generator-mounted volts per hertz exciter-regulator to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Manual controls to adjust voltage drop, voltage level (plus or minus 5 percent) and voltage gain.

3. AC Waveform Total Harmonic Distortion (THD), less than 3% for any single harmonic.

4. Telephone Influence Factor (TIF), less than 50% per NEMA MG1-22.43.

D. Accessories:

1. Dual Wall day tank.

2. Exhaust Silencer: Critical type silencer, with muffler companion flanges and flexible stainless steel exhaust fitting, sized in accordance with engine manufacturer's instructions.

3. Batteries: Heavy duty, diesel starting type lead-acid storage batteries, 24 volt system 240 ampere-hours minimum capacity. Match battery voltage to starting system. Include necessary cables and clamps.

4. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage. If in a cool area, provide heating pads.

5. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet NEMA 250, Type 1 requirements.

6. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA 70. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Unit mount in enclosure to meet NEMA 250, Type 1 requirements. Circuit Breaker to be 100% rated.

7. Engine-Generator Control Panel: NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

   a. AC Output Voltmeter: 3.5-inch dial, 2 percent accuracy, with phase selector switch.

   b. AC Output Ammeter: 3.5-inch dial, 2 percent accuracy, with phase selector switch.

   c. Output voltage adjustment.
d. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, over speed, and over crank.

e. Engine start/stop selector switch.

f. Engine running time meter.

g. Oil pressure gauge.

h. Water temperature gauge.

i. Auxiliary Relay: 3PDT operates when engine runs, with contact terminals pre-wired to terminal strip.

j. Additional visual indicators and alarms as required by NFPA 110.

k. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110.

l. Frequency Meter: 45-65 Hz. range, 3.5 inch dial.


8. Remote Annunciator Panel: Surface mounted panel with brushed stainless steel. Provide alarm horn, and indicators and alarms as follows:

a. High battery voltage (alarm).

b. Low battery voltage (alarm).

c. Low fuel (alarm).

d. System ready.

e. Anticipatory-high water temperature.

f. Anticipatory-low oil pressure.

g. Low coolant temperature.

h. Switch in off position (alarm).

i. Over crank (alarm).

j. Emergency stop (alarm).

k. High water temperature (alarm).

l. Over speed (alarm).

m. Low oil pressure (alarm).

n. Line power available.

o. Generator power available.
p. Lamp test and horn silence switch.

**PART 3 - EXECUTION**

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

3.3 TESTING, CLEANING, AND CERTIFICATION

   A. Provide full load test utilizing portable test bank for four hours minimum. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown and return to normal.

   B. Record in 20-minute intervals during four hour test:

      1. Kilowatts.
      2. Amperes.
      3. Voltage.
      4. Coolant temperature.
      5. Room temperature.
      6. Frequency.
      7. Oil pressure.

   C. Test alarm and shutdown circuits by simulating conditions.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16666
UCD OUTSIDE PLANT CONSTRUCTION STANDARD FOR INFORMATION TECHNOLOGY

1.1 INTRODUCTION

A. This section describes the codes, standards, specifications, recommendations, and practices required for outside plant (OSP) construction at the University of Colorado Denver (UCD) for the Information Technology (IT) Services department. Section 16666 applies to all IT outside plant projects at all UCD campuses.

B. The project general contractor (GC) is responsible for building OSP pathways and spaces as per the requirements described in this document. The IT Services department is responsible, through its contractor, for providing copper and fiber media placed in the OSP pathways and spaces.

C. Corrections, comments, questions, or omissions about this OSP standard shall be submitted to the IT Services department via the UCD project manager.

1.2 REFERENCES

A. Applicable Codes, Standards, and Specifications.

1. The following table of codes, standards, specifications, recommendations, and methods and procedures are applicable to the provisioning of OSP at UCD. They are incorporated by reference. The most current version is referenced.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE C2</td>
<td>National Electric Safety Code (NESC)</td>
</tr>
<tr>
<td>ANSI/IEEE 802.3</td>
<td>Information Technology−Local and Metropolitan Area Networks − Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications</td>
</tr>
<tr>
<td>TIA/EIA−568−B</td>
<td>Commercial Building Telecommunications Cabling Standard (Parts 1, 2, and 3)</td>
</tr>
<tr>
<td>TIA/EIA−569−B</td>
<td>Commercial Building Standard for Telecommunications Pathways and Spaces</td>
</tr>
<tr>
<td>TIA/EIA−606−B</td>
<td>Administration Standard for the Telecommunications Infrastructure of Commercial Buildings</td>
</tr>
<tr>
<td>J−STD−607−A</td>
<td>Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications</td>
</tr>
<tr>
<td>TIA/EIA−758</td>
<td>Customer−Owned Outside Plant Telecommunications Cabling Standard</td>
</tr>
<tr>
<td>TIA/EIA−862</td>
<td>Building Automation Systems Cabling Standard for Commercial Buildings</td>
</tr>
<tr>
<td>OSHA</td>
<td>Standard 29 CFR 1910.268</td>
</tr>
</tbody>
</table>

2. Requests for variations from code shall be submitted to the UCD Code Official via the UCD project manager and must have IT Services approval. The UCD Code Official will either disapprove or approve the request. In general, requests for code variations shall not
be looked upon favorably. Variations from OSP standards may be authorized by UCD IT Services on a case-by-case basis and must be requested in writing by the designer through the UCD project manager.

3. UCD IT Services will provide design parameters for all campus OSP systems, and IT Services shall be consulted during the OSP project design through the assigned UCD project manager.

1.3 OVERVIEW

A. Planning.

1. To facilitate expansion of telecommunications services via OSP pathways and spaces, the architect/engineer shall provide UCD IT Services with floor plan drawings for new building construction and major renovation projects during design and at construction. CAD drawings of the Electrical/Communications plans shall be provided to IT Services upon release of construction document through the UCD project manager. These documents will serve as a baseline for OSP build out and expansion.

2. The preliminary plans, indicating service locations and space requirements, will be returned to project managers for inclusion in the final plans.

B. Consult with UCD IT Services for the following:

1. Acceptability for specific substitutions of specified products.

2. Guidance in the application of a standard or specification in a non-listed or design situation.

3. Approval for deviation from standards and specifications or industry-standard methods and procedures if indicated by special circumstances.

C. Workmanship. All materials and equipment shall be installed in accordance with recommendations of the manufacturer as approved by the architect, to conform to initial design requirements or specification’s and contract documents.

1.4 DEFINITIONS

A. Telecommunications. Any transmission, emission, or reception of signs, signals, writings, images, and sounds, or information of any nature by wire, radio, visual, or other electromagnetic systems. Includes, but is not limited to, voice communications networks, Local Area Networks (LAN), Wide Area Networks (WAN), and Local Exchange Carriers (LEC).

B. OSP Spaces. Consists of maintenance holes (MH), handholes (HH), pedestals, cabinets, and vaults. MHs are used as access points for pulling and splicing cables. HHs are smaller than MH and are used for pulling cables. HHs do not typically serve as splice points. Pedestals provide access to smaller splices, interconnects, and cables. Cabinets are used as cross-connects for aerial and direct buried solutions. Vaults provide environmentally protected spaces either above grade or below grade.

C. OSP Pathways. Pathways are the conduits that interlink OSP spaces and end points such as buildings. Pathways can be direct buried or underground infrastructure. The third pathway method, aerial pathways, is not used on campus.

D. Telecommunications Entrance Facility (TEF). Serves as the entry point into a building for the campus backbone media. TEFs interconnect the building backbone to campus.
backbone. The TEF is where conductive copper media receives its primary protection from sustained hazardous voltages. Also called the Service Entrance (SE).

E. OSP media. Copper and fiber optic media placed in the OSP pathways to link structures back to the campus core. These materials are typically placed by IT Services or their approved contractor.

F. Campus backbone. The pathways and media that provide connectivity between buildings.

G. UCD Information Technology (IT) Services. Department responsible for telecommunications on the University of Colorado Denver (UCD) campuses.

H. Outside Plant (OSP). The pathways, spaces, and media that provide telecommunications external to buildings. OSP is used to support voice, data, video, electronic security, building automation systems, fire, life, and safety systems, and other low voltage systems as they evolve.

I. OSP Consultant. A firm or member of a firm that has considerable technology and OSP design experience and possesses working knowledge and subject matter expertise in telecommunications code (NEC and NESC), industry standards (see TIA/EIA standards in references), and BICSI methods and procedures (Telecommunications Distribution Methods Manual, Network Design Reference Manual, and Customer-Owned Outside Plant Design Manual).

1. IT Services maintains a list of pre-screened technology consultants that can be obtained from the UCD project manager via IT Services.

2. Technology consultants used for UCD projects shall be selected from the pre-screened technology consultant list.

3. Technology consultants not listed on the pre-screened technology consultant list must meet with IT Services for certification and possible inclusion on the list. Firms vying for campus technology consultant designation must possess a registered communication distribution designer (RCDD) with outside plant (OSP) certification on staff. The RCDD/OSP must be thoroughly familiar with campus standards and methods and procedures and be dedicated to the assigned project. Contact the IT Services Director of Communications, Infrastructure Development, and Technical Support Services (303.724.0440) for possible interview times.

2.0 OSP DESIGN SPECIFICATIONS AND CONSTRUCTION REQUIREMENTS

A. OSP Spaces.

1. Maintenance Hole (MH).
   a. General description. MHs are concrete enclosures with a removable lid that permits internal access. MHs house splice closures, racking, a grounding and bonding system, drainage, sump, and other components. MHs are placed to facilitate placement of fiber and copper cables. MHs are considered confined spaces.
   b. Safety. MHs are considered confined spaces containing possible hazardous atmospheres such as flammable, explosive, asphyxiating, or toxic environments. Prior to entry, all MHs shall be checked for hazardous atmosphere conditions. Mitigate all conditions found. Ensure the MH area is free of other hazards such as engulfing, immersion, entrapment, auto emissions, etc. MHs on or near roadways...
require traffic control, signage, and safety cones to prevent vehicular accidents. Two-person crews are required when entering campus MHs.

c. No joint use. Joint use of IT Services MHs is prohibited. IT Services MHs are not shared with other utilities except those needed to directly service IT Services requirements.

d. Precast concrete MHs are preferred. These ASTM standards apply ASTM C 478, ASTM C 857, ASTM C 858, ASTM C 891, and ASTM C 1037. Precast MH vendors include Amcor and Vaughn Concrete Products, among others. MH shall be placed on a minimum 12” bed of gravel, sand, or squeegee (pea-sized gravel mixed with sand).

e. Maximum conduit run length. The maximum conduit run length between campus MHs is 600 feet.

f. Physical placement. Place MH out of roadways, if possible. MHs shall not be placed within 50’ of the curb radius of intersecting roads. The desired location for MH location is under sidewalks paralleling campus roads. MHs are placed to provide convenient telecommunications access to buildings.

g. Sizing. Campus MHs are 10’ wide x 10’ long x 7’ high.

h. Loading. H-20 loading or better desired. Minimum concrete strength shall be 3500 PSI. Higher strength may be required depending upon MH placement locale.

i. Orientation. MH shall be placed so their four walls are oriented north-south and east-west.

j. Windows. MH windows shall be placed in each wall. Each window shall be capable of supporting 16 bells. All four walls and windows may support cable placement.
k. Equipment. All MH shall be equipped with a cast iron 32” cover, minimum 12” sump, corrosion-resistant pulling irons with minimum 7/8” pulling eyes, grounded cable racks (if metallic), grounding and bonding system, and a fixed ladder. MH copper grounding rods shall be a minimum ½” in diameter by 8’ in length. Bond and ground all metallic parts to the grounding rod with a minimum 6-AWG green insulated conductor.

l. Water infiltration and seepage mitigation. MH bells shall be sealed to preclude water infiltration and seepage. Sump pumps may be specified to mitigate unusual conditions. MH-to-building underground conduit runs shall be placed uphill so that water infiltration and seepage flows to the MH, as shown in the sketch below. A minimum drain slope of 12.5” per 100 feet is required when extending conduits away from building structures. MH-to-MH conduit runs shall be bowed upwards to preclude MH-to-MH water infiltration and seepage, as illustrated below. A minimum drain slope of 12.5” per 100 feet shall extend from the middle of the span to each MH.

m. MH designator. Campus MHs shall be assigned a letter and number designator by IT Services. The current campus OSP layout is illustrated below.

n. Opening. Each MH shall have a single opening, given the 10’ x 10’ x 7’ dimensions.
o. Covers. MH covers shall be 32” in diameter. Covers larger than 32” may be needed on occasion. Covers larger than 32” diameter shall be approved by IT Services prior to placement. If larger covers are required, they shall be 38” in diameter, if approved by IT Services. The 38” cover, if approved, shall also have a reducer cover for easier access and removal.

(1) Cover labeling. All campus IT Services MH covers shall be permanently labeled “COMMUNICATIONS”.

(2) Cover material. Cast iron covers are required.

(3) Cover loading. MH covers shall be rated for the expected dynamic and static loads, typically H-20 or better.

(4) Cover locks. MH covers shall include a lock down device, as specified by IT Services. The locking cover shall use the UCD IT Services registered key.

(5) Flush mounted covers. MHs covers shall be placed so they are flush with road surfaces or the ground level.

p. Documentation. As-builts of the MH system shall be delivered to IT Services, in the prescribed format and media.

2. Handholes (HH).

a. General description. HH facilitate placing of cables in a conduit system. HH shall not be used in place of a MH or in the main campus conduit system. HH support connections to the campus conduit system. HH shall not be used for splicing cables together.

b. No joint use. Joint use of IT Services HHs is prohibited. IT Services HHs are not shared with other utilities except those needed to directly service IT Services requirements.

c. Placement. HH are placed when the bends exceed two 90-degree bends or a total of 180-degrees. HH are also placed when the secondary in-tract run length exceeds 200 feet to the main campus conduit system or other pathway. HHs are placed out of roads and other heavy load areas.

d. Sizing. HH shall not exceed 4 feet in length by 4 feet in width by 4 feet in depth.

e. Conduits supported. HH shall not house more than four 4” Trade Size 4 conduits.

f. Covers. MH covers shall be of about the same size as the HH and rated for the expected load.

g. Water infiltration and seepage mitigation. HH conduit bells shall be sealed to preclude water infiltration and seepage. HH-to-building underground conduit runs shall be placed uphill so that water infiltration and seepage flows to the HH, as shown in the sketch below. A minimum drain slope of 12.5” per 100 feet is required when extending conduits away from building structures. HH-to-HH or
HH-to-MH conduit runs shall be bowed upwards to preclude HH-to-HH or HH-to-MH water infiltration and seepage, as illustrated below. A minimum drain slope of 12.5” per 100 feet shall extend from the middle of the span to each HH. HH shall have provisions for drainage such as an open bottom, drain holes, sump-hole, etc. HH shall be placed on a 12” bed of gravel, sand, or squeegee.

<table>
<thead>
<tr>
<th>Building or Structure</th>
<th>OSP water infiltration and seepage mitigation construction rules</th>
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<tbody>
<tr>
<td>Building-to-HH runs</td>
<td>HH-to-HH runs</td>
</tr>
<tr>
<td>HH-to-HH runs</td>
<td>HH-to-MH runs</td>
</tr>
<tr>
<td>Uphill conduits to building</td>
<td>Upward bowed conduits between HHs</td>
</tr>
</tbody>
</table>

h. HH designator. Campus HHs shall be assigned a three-letter and number designator by IT Services (NAC1 for example). The HH designation letters are associated with the project the HH is supporting.

i. Documentation. As-builts of the HH shall be delivered to IT Services, in the prescribed format and media.

3. Pedestals.
   a. General description. Pedestals house splice closures and terminals. A BD3 primary distribution pedestal housing a 50-pair cable and a 100-pair splice is the largest pedestal permitted on campus.
   b. Limited use. Pedestals may be used to support temporary structures such as construction trailers.
   c. Mounting. Pedestal may be mounted on concrete pads or directly on the ground.
   d. Security. Pedestals shall be secured via hasp or padlock.
   e. Cables supported. Pedestals shall not house more than 4 cables.

   a. No campus use. Cabinets are not used in campus backbone OSP infrastructure.

5. Vaults.
   a. No campus use. Vaults are not used in campus backbone OSP infrastructure.

B. OSP Pathways.

1. Underground conduits.
   a. General description. Underground conduits are the required pathway in main campus conduit system runs, also known as the IT campus backbone.
   b. Material. Underground conduits shall be constructed of Rigid Nonmetallic Conduit Schedule 40. Trade Size 4, 4” conduits shall be used. IT Services shall specify the number of conduits to be placed in each run.
c. Innerduct. IT Services may specify Carlon Multi-Gard multiple cell PVC in lieu of innerduct installed in Schedule 40 conduits. Carlon Multi-Gard PVC Type C, Schedule 40 outer shell with four 1.25” multiple cells (innerduct maximum inside diameter is 1.19” and the maximum outside diameter is 1.31”) is the standard prefabricated innerduct used on campus, as illustrated in the picture.

(1) IT Services may alternately specify Maxcell Innerducts in lieu of Carlon Multi-Gard. Each Trade Size 4 conduit shall have two (2) 4” 3-cell Maxcell Innerducts placed in it. Maxcell Innerducts are factory lubricated and have pull tapes pre-installed.

d. Length. No section of underground conduit shall exceed 600 feet between pulling points (i.e. MH or HH).

e. Depth. The tops of underground conduits shall be placed a minimum of 48” below grade.

f. Loading. Underground conduits shall be constructed to dissipate H-20 dynamic loads.

g. Electrical underground clearances. The minimum clearance between electrical conduits and underground IT conduits is 12” of well-tamped earth or 3” of concrete.

h. Foreign structure underground clearances. The minimum clearance for parallel underground foreign structures such as gas, oil, or water pipelines is 12” of well-tamped earth. The minimum clearance for crossing underground foreign structures is 6” of well-tamped earth.

i. Water infiltration and seepage mitigation. MH- or HH-to-building underground conduit runs shall be placed uphill so that water infiltration and seepage flows to the MH or HH, as shown in the sketch below. That is, all conduits entering a building shall be pitched to drain away from the building. A minimum drain slope of 12.5” per 100 feet (0.125 inch per foot) is required when extending conduits away from building structures. MH-to-MH conduit runs shall be bowed upwards to preclude MH-to-MH water infiltration and seepage, as illustrated below. A minimum drain slope of 12.5” per 100 feet shall extend from the middle of the span to each MH. Conduits entering a window’s bell shall also be compound sealed.

<table>
<thead>
<tr>
<th>Building or Structure</th>
<th>OSP water infiltration and seepage mitigation construction rules</th>
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<tbody>
<tr>
<td></td>
<td>Building-to-MH runs</td>
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<tr>
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<td>MH-to-MH runs</td>
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<td></td>
<td>Uphill conduits to building</td>
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<tr>
<td></td>
<td>MH</td>
</tr>
<tr>
<td></td>
<td>Upward bowed conduits between MHs</td>
</tr>
<tr>
<td></td>
<td>MH</td>
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</tbody>
</table>

j. Vacant conduit sealing. Vacant conduits shall be sealed with duct plugs at all MHs, HHs, and building entrance points to preclude water infiltration and seepage. Duct plugs shall be adjustable with a metal base and a screw-type expandable outer rubber surface.
k. Bends. There shall be no more than the equivalent of two 90-degree bends, or 180-degrees total, between pulling points, including kicks (a pipe bend of less than 45-degrees made to change the pipe’s direction) and offsets (two mirror-image bends made to avoid an obstruction). Manufactured bends shall be used where possible. Back-to-back 90-degree bends placed closer together than 10 feet shall be avoided.

l. Sweeps. Sweeps are preferred to 90-degree bends. Trade Size 4, 4” conduit sweeps should possess a minimum 48-inch bend radius.

m. Diverts. The maximum divert or change in direction in any plane between lengths of straight rigid conduit without the use of bends or sweeps shall be limited to 5 degrees.

n. Pulling tape. Each underground conduit shall be equipped with a minimum 3/8” diameter pulling tape, rope, or strap with a rated tensile strength meeting or exceeding 2500 pounds. Pull rope tails of a minimum of 36” shall be secured at the end of each conduit.

o. Measuring tape. A pre-lubricated conduit measuring tape shall be provided in at least one conduit in every run. The conduit measuring tape shall be waterproof with permanent printed footage.

p. Warning tape and markings. Concrete encasements shall be permanently dyed red. Orange detectable warning tape shall be placed within 12” to 18” of the surface for the length of the underground conduit run.

q. Conduit supports. Pre-manufactured conduit support saddles/seats are required. Saddles shall allow a minimum of 2” between conduits and a minimum of 3” of perimeter concrete encasement. Saddle supports shall be interlocked and placed a minimum of every 5 feet along the entire run. The conduits shall be staked down at each saddle and #3 crossties installed.

r. Encasement. All underground conduits shall be encased in minimum 2500 PSI concrete with #4 rebar run parallel with the conduit on all four corners. The concrete encasement shall be permanently dyed red. A typical main campus conduit system run (campus backbone) is shown below.
s. Soil compaction. After encasement, the trench shall be backfilled with native soil in lifts no greater than 12". The replaced soil shall be mechanically compacted by tamping so as to maintain a minimum relative density of 90 percent. The university shall conduct field tests to verify compaction compliance in accordance with ASTM D 2922 (Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)), ASTM D 1556 (Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method), or ASTM D 2167 (Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method).

i. Certification and commissioning. All underground conduits shall be tested prior to commissioning. Underground conduits shall be certified by pulling a mandrel through them. The mandrel shall be equivalent to the nominal inside conduit diameter and not less than 12" long. If the mandrel does not pass through the conduit, the conduit must be repaired or replaced at the failure point. IT Services personnel shall witness the certification test and commission the underground conduits in writing.

u. Documentation. As-builts of the underground conduit system shall be delivered to IT Services, in the prescribed format and media.
2. Direct buried cables.
   a. General. Direct buried cable is placed under the ground surface in such a manner that it cannot be removed without disturbing the soil.
   b. Limited campus use. Direct buried infrastructure is suitable for use in short-term infrastructure such as construction trailers.
   c. Marking. Direct buried cable shall be marked every 50 feet along its run length to preclude inadvertent damage during project construction. The run length markings may be stakes, placards, or other suitable signage.
   d. Depth. Direct buried cable shall be placed a minimum of 24” below grade.

3. Aerial pathways.
   a. No recognized campus use. Aerial pathways shall not be used on campus.

B. OSP Media.
   1. All OSP media is provided by the IT Services department under a separate contract.
   2. Between the campus core and each building or structure, 48 strands of single mode fiber (SMF) and 24 strands of 50-micron multimode fiber (MMF) are placed. Prior to 2005, the fiber placement numbers were reversed. Additionally, the MMF placed was 62.5 micron.
   3. Copper media is placed to support telephony and other miscellaneous circuitry. The numbers of pairs placed is reflected in the structure’s predicted load. Depending upon distance, 22 (0.64 mm) or 24 (0.5 mm) AWG copper wire is used.
   4. OSP media is labeled according to the campus standard, as specified by IT Services.
SECTION 16667

EMERGENCY POLE INSTALLATION STANDARD

1.0 INTRODUCTION

A. Section 16667 describes the codes, standards, specifications, recommendations, and practices required for emergency communications pole placement and installation at the University of Colorado at Denver and Health Sciences Center (UCD). Section 16667 applies to all UCD campuses.

B. The project general contractor (GC) is responsible for installing emergency poles as per the requirements described in this document.

C. Corrections, comments, questions, or omissions about this standard shall be submitted to the University Police via the UCD project manager.

1.1 REFERENCES

A. Applicable Codes, Standards, and Specifications.

1. The following table of codes, standards, specifications, recommendations, and methods and procedures are applicable to the provisioning of emergency poles at UCD. They are incorporated by reference. The most current version is referenced.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
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<tbody>
<tr>
<td>IEEE C2</td>
<td>National Electric Safety Code (NESC)</td>
</tr>
<tr>
<td>ANSI/IEEE 802.3</td>
<td>Information Technology – Local and Metropolitan Area Networks – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications</td>
</tr>
<tr>
<td>TIA/EIA–568–B</td>
<td>Commercial Building Telecommunications Cabling Standard (Parts 1, 2, and 3)</td>
</tr>
<tr>
<td>TIA/EIA–569–B</td>
<td>Commercial Building Standard for Telecommunications Pathways and Spaces</td>
</tr>
<tr>
<td>TIA/EIA–606–B</td>
<td>Administration Standard for the Telecommunications Infrastructure of Commercial Buildings</td>
</tr>
<tr>
<td>J–STD–607–A</td>
<td>Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications</td>
</tr>
<tr>
<td>TIA/EIA–758</td>
<td>Customer-Owned Outside Plant Telecommunications Cabling Standard</td>
</tr>
<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
</tr>
<tr>
<td>OSHA</td>
<td>Standard 29 CFR 1910.268</td>
</tr>
<tr>
<td>Code Blue</td>
<td>Code Blue Install Guides</td>
</tr>
</tbody>
</table>

2. Requests for variations from code shall be submitted to the UCD code official via the UCD project manager and must have University Police approval. The UCD code official will either disapprove or approve the request. In general, requests for code variations shall not be looked upon favorably. Variations from standards may be authorized by UCD University Police on a case-by-case basis and must be requested in writing by the installer or designer through the UCD project manager.
3. UCD University Police will provide design parameters for all campus emergency communications systems, and University Police shall be consulted during the project design through the assigned UCD project manager.

1.2 OVERVIEW

A. Planning.

1. To facilitate expansion of emergency communications services, the architect/engineer shall provide University Police with floor plan drawings for new building construction and major renovation projects during design and at construction. CAD drawings of the Electrical/Communications plans shall be provided to University Police upon release of construction document through the UCD project manager. These documents will serve as a baseline for emergency communications build out and expansion.

2. The preliminary plans, indicating service locations and space requirements, will be returned to project managers for inclusion in the final plans.

B. Consult with University Police for the following.

1. Acceptability for specific substitutions of specified products. Code Blue emergency communications solutions are the campus standard.

2. Guidance in the application of a standard or specification in a non-listed or design situation.

3. Approval for deviation from standards and specifications or industry-standard methods and procedures if indicated by special circumstances.

C. Workmanship. All materials and equipment shall be installed in accordance with recommendations of the manufacturer as approved by the architect, to conform to initial design requirements or specification’s and contract documents.

2.0 EMERGENCY POLE INSTALLATION REQUIREMENTS

A. Free Standing Emergency Pole (FSEP) Placement.

1. Free Standing Emergency Poles (FSEP) are placed to provide ready access to emergency services. University Police shall be consulted with prior to the placement of any FSEP.

2. No joint use. Joint use of FSEP infrastructure is prohibited. FSEP infrastructure is not shared with other utilities except those needed to directly support FSEP requirements.

3. FSEPs shall be thoughtfully placed so they do not impact sidewalk or parking lot snow removal or pedestrian traffic flow.

B. Installation Practice.

1. Safety. Follow all campus safety policies when installing FSEP. FSEP may be placed near high vehicular traffic areas. Care should be used when working in congested areas.

2. FSEP designator. Campus emergency poles shall be assigned a designator by University Police to aid in maintenance and repair.
3. Venting air gap. Installers shall provide a minimum ½-inch air gap between the concrete base and the FSEP pedestal. This gap facilitates moisture (dew) evaporation. A venting gap of no larger than 1 inch is desired. A gap larger than 1 inch would possibly allow snow, dust, and trash to blow into the FSEP. Larger gaps would also allow rodents to nest in the pole.

4. Grounding rod. A grounding rod shall be placed in each concrete pad that supports a FSEP pedestal. The copper grounding rods shall be a minimum ½ inch in diameter by 8 feet in length. Bond and ground all metallic parts to the grounding rod with a minimum 6-AWG insulated, green conductor.

5. IT conduits. IT Services requires one Trade Size 2, 2-inch conduit to support voice and data connectivity to the FSEP.

6. Electrical conduits. One Trade Size 1, 1-inch conduit shall be placed to support the FSEP power requirements.

7. Electrical service. Place a dual gang four-plex 120V, 20A electrical box in the lower portion of each FSEP. The receptacle shall be a minimum of 8 inches above the base.

8. Conduit depth. The tops of underground conduits supporting FSEP installations shall be placed a minimum of 30 inches below grade.

9. Direct buried cables. Direct buried cable shall be placed a minimum of 24 inches below grade, if used.

10. Water infiltration and seepage mitigation. FSEP conduits shall be sealed to preclude water infiltration and seepage. Conduit runs serving FSEPs shall be placed so that water infiltration and seepage flows away from buildings and towards maintenance holes or handholes. A minimum drain slope of 12.5 inches per 100 feet is required when extending conduits away from building structures.

11. Electrical underground clearances. The minimum clearance between electrical conduits and underground IT conduits is 12 inches of well-tamped earth or 3 inches of concrete. Joint trenches are permitted if these clearances can be maintained.

12. Foreign structure underground clearances. The minimum clearance for parallel underground foreign structures such as gas, oil, or water pipelines is 12 inches of well-tamped earth. The minimum clearance for crossing underground foreign structures is 6 inches of well-tamped earth.

13. Conduit bends. There shall be no more than the equivalent of two 90-degree bends, or 180-degrees total, between pulling points, including kicks (a pipe bend of less than 45-degrees made to change the pipe’s direction) and offsets (two mirror-image bends made to avoid an obstruction). Manufactured bends shall be used where possible. Back-to-back 90-degree bends placed closer together than 10 feet shall be avoided.

14. Sweeps. Sweeps are preferred to 90-degree bends. Trade Size 2, 2-inch conduit sweeps should possess a minimum 24-inch bend radius.

15. Diverts. The maximum divert or change in direction in any plane between lengths of straight rigid conduit without the use of bends or sweeps shall be limited to 5 degrees.

16. Soil compaction. The trench shall be backfilled with native soil in lifts no greater than 12 inches. The replaced soil shall be mechanically compacted by tamping to maintain a minimum relative density of 90 percent.
17. Certification and commissioning. All underground conduits shall be tested prior to commissioning. Underground conduits shall be certified by pulling a mandrel through them. The mandrel shall be equivalent to the nominal inside conduit diameter. If the mandrel does not pass through the conduit, the conduit must be repaired or replaced at the failure point. University personnel shall witness the certification test and commission the underground conduits in writing.

18. Warning tape and markings. Orange detectable warning tape shall be placed within 12 inches to 18 inches of the surface for the length of the IT underground conduit run used to support FSEP. Red detectable warning tape shall be placed within 12 inches to 18 inches of the surface for the length of the electrical underground conduit run used to support FSEP. Use red detectable tape if a joint trench was used.

19. FSEP installation documentation. As-builts of the installed FSEPs shall be delivered to University Police, in the prescribed format and media.

C. ADA Telephony Requirements.

1. Access pad. The FSEP shall have a minimum clear access pad of 30 inches by 48 inches in front of the operational part of the pole as shown in the sketch.

2. The highest operational part of the FSEP shall be no higher than 48 inches above the ground (access pad).

3. Barriers to FSEP access by wheelchairs, crutches, and walkers shall be eliminated. Curbs, rough terrain, unpaved access pads, etc shall be avoided when placing a FSEP.

4. The FSEP installation shall comply with the following ADA side reach requirements.
   a. Maximum side reach height shall be 54 inches.
   b. Minimum side reach height shall be 9 inches.
   c. Maximum side reach height over an obstruction that is 24 inches wide and 34 inches high shall be 46 inches.

5. The FSEP installation shall comply with the following ADA front reach requirements.
   a. Maximum forward reach height shall be 48 inches.
   b. Minimum forward reach height shall be 15 inches.
   c. Maximum front reach height over an obstruction shall be 44 inches.

D. Communications Media.

1. All FSEP communications media is provided by the IT Services department and is managed under a separate contract.
2. Fiber optic media. IT Services shall place 6 strands of single mode fiber (SMF) or 6 strands of 50-micron multimode fiber (MMF) to the FSEP, as required by distance and application.

3. Copper media. IT Services shall place 6-pairs of copper wire to each FSEP. Depending upon distance, 22 (0.64 mm) or 24 (0.5 mm) AWG shall be used. The outside plant copper cable shall be shielded twisted pair (STP) or other copper media as selected by IT Services. IT Services will bond and ground all copper media entering campus buildings.

4. Phone line current. To reliably operate, the Code Blue phone requires a minimum of 20mA line current.

E. Installation Examples.

1. Picture 1, as shown below, shows a properly installed FSEP. It has an access pad exceeding 48 inches by 30 inches in front of the operating panel. The highest operable mechanism is below 48 inches. Finally, it has a ½-inch to 1-inch gap at its base to facilitate moisture evaporation.

2. Picture 2, below, illustrates an improperly installed FSEP. The FSEP does not have an ADA compliant access pad in front of the operating panel. The pad space is too small. Additionally, the highest operating mechanism exceeds 64 inches in height, well above the ADA required 48 inches. The FSEP does have a ½-inch air gap at its base to facilitate moisture evaporation.

3. Picture 3, on the next page, shows an improperly installed FSEP. The FSEP does not have an ADA compliant access pad in front of the operating panel. Additionally, the
highest operating mechanism exceeds 48 inches in height. Finally, the FSEP does have a \( \frac{1}{2} \)-inch air gap at its base to facilitate moisture evaporation.

4. Picture 4 is presented below. It portrays an improperly installed FSEP. The FSEP does not have ADA compliant access. That is, the 360-degree curb prevents access by wheelchairs. Additionally, the access pad in front of the operating panel is inadequate.

5. Picture 5, as shown below, is an improperly installed FSEP. The FSEP lacks a minimum \( \frac{1}{2} \)-inch air gap to prevent moisture build up inside the pole. Note the apparent seepage.
END OF SECTION
SECTION 16670
LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for lightning protection systems.

1.2 REFERENCE
A. Section 16010 - Basic Electrical Requirements

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. Air terminal maximum size 24". Install Per UL Master label requirements.
B. Down-lead conductors to be routed in PVC conduit. Minimum size one-inch.
C. Install a lightning protection loop around the building perimeter. Locate within 3'-0" of the building. Minimum size to match the down lead conductor.
D. Install ground rods Per UL Master label requirements.
E. Bond every third column to the roof lightning protection cable and underground lightning protection loop.
F. Each individual system (building) shall be UL Master labeled.
G. Except for special environments, all material shall be copper and bronze.

1.4 DEFINITIONS

1.5 SUBMITTALS
A. Submittals for lighting protection systems shall be made in accordance with the requirements of Section 16010 for the following:
   1. Shop Drawings: Indicate layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details. Include mounting detail of air terminals and conductors.

1.6 QUALITY ASSURANCE
A. Lightning protection systems shall be provided in accordance with the requirements of Section 16010 including the following:
   1. Manufacturer: Company specializing in lightning protection equipment with minimum three (3) years documented experience and member of the Lightning Protection Institute.
2. Installer: Authorized installer of manufacturer with minimum three (3) years documented experience and certified by the Lightning Protection Institute.

1. Obtain the services of Underwriters Laboratories, Inc. to provide inspection and labeling of the lightning protection system in accordance with UL 96A.

1.7 DELIVERY, STORAGE AND HANDLING

A. Lighting protection systems shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY

A. Lighting protection warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Thompson Lightning Protection, Inc.
2. American Lightning Rod Co.
3. Capitol Lightning Protection Co., Inc.
4. Independent Protection Co., Inc.

2.2 MATERIALS, GENERAL

A. Product Listing: UL 96 – Master Cable

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Connect conductors using mechanical connectors above grade and exothermic welding process below grade. Protect adjacent construction elements and finishes from damage.

B. Bond exterior metal bodies on building to lightning protection system.

3.3 TESTING, CLEANING AND CERTIFICATION

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
SECTION 16720
INTELLIGENT LIFE SAFETY FIRE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.1 SUMMARY
A. This section provides standards for an Intelligent Fire Alarm System.

1.2 REFERENCES
A. Section 15300 - Fire Protection
B. Section 16010 - Basic Electrical Requirements

1.3 SYSTEM PERFORMANCE REQUIREMENTS
A. The system shall be microcomputer based and shall use multiplex techniques for alarm reporting, central monitoring, signaling, and selection of audible and visual signal circuits. The fire alarm system should be capable of making reverse 911 messages and emergency announcements. The fire alarm subcontractor should work closely with the campus Information technology department working through the UC Denver Project Manager to make this work.

B. The system shall provide individually identified fire alarm sensors; pull stations, indicating devices, and compatible monitor and control devices. Each identified device shall be given a unique address, with operator-assigned English language descriptor.

1. The system shall include the following major components
a. Fire Alarm Control Panel (FACP)
b. Fire Alarm Annunciator Panel (FAAP) and LCD Display.
c. Fire Alarm Voice/Evacuation Panel (FVEP)
d. Fire Alarm Computer Terminal (FACT)
e. Fire Alarm System Printer (FAP)
f. Fireman Two Way Telephone Panel (FTP)

2. The intelligent fire sensors shall send data corresponding measured fire-related phenomena to the FACP. The FACP shall determine the normal, pre-alarm, alarm or trouble condition of each sensor by comparing the sensor value to stored values.

3. Conventional fire alarm initiating devices (manual stations, water flow and tamper switches, pressure switches) shall each be individually addressable via addressable modules, and shall report to the FACP.

4. Control relays shall be individually commanded by the system to respond automatically in case of an alarm by related sensors or other devices. Manual
control of fans, dampers and required relays shall be provided, as well as automatic control where required. Control sequences shall be as indicated on related mechanical systems control drawings.

C. The system shall operate as a low voltage, zone-annunciated Fire Management System and shall include the following subsystems:

1. FACP to monitor addressable initiating and control devices, annunciate the alarm device exact location, initiate alarm and evacuation signals, and capture and recall elevators.

2. FACP will provide the ability to manually override automatic operations of the smoke control equipment and shall be provided with networking capability to allow interconnection of all FACP in a loop or ring configuration such that any FACP can access data contained in any other FACP.

3. Interconnection of FACP, including supervision, shall be via fiber optic (FO) cable between buildings and via copper cable in the buildings.

4. All FO transmit and receive modules and required hardware shall be integral with associated fire alarm equipment.

D. Fire Alarm equipment shall be UL listed in accordance with UOJZ standard and the Fire Alarm System shall be certified by the installer in accordance with the UUJZ standard. If required as a condition requisite to establishing UL listing of the entire installation as a system, the Contractor shall arrange for, and pay all costs associated with, any required off-site or on-site review, supervision, and/or inspection which may be required for gaining such UL listing.

E. The system shall conform to the following NFPA requirements:

1. Initiating Device Circuits (IDC) shall be Class B (Style D).

2. The Signaling Line Circuits (SLC) shall be configured as follows:
   
a. Class A (Style 5x) for signaling line circuits connecting intelligent devices to the FACP.
   
b. Loss of connectivity between FACP and the facility's Central Control FACP shall not hamper functions of the fire alarm system within the building.

3. The Notification Appliance Circuit (NAC) shall be Class B (Style Z).

F. ANSCHUTZ MEDICAL CAMPUS SYSTEM LAYOUT

1. General:
   
a. Each low-rise occupancy building will be equipped with a FACP located near the main entry and a FVEP located near the FACP per the building design.
   
b. Each high-rise occupancy building will be equipped with a FACP, FAAP, FVEP, FAP and FTP per the building design. A FACT is optional.
c. The Campus Fire Command Center (FCC) will be equipped with a FACP, FAAP, FAP, and FACT.

d. Any FACP shall be accessed from the Campus FACT. Any FVEP shall be accessed from the Campus FCC FVEP microphone and/or the Campus Police Station FVEP microphone.

e. A logical FO loop between buildings and copper cable in the buildings will connect all the FACPs on the Campus.

f. One FACP and FACT in one UCD high-rise building FCC and one UCH high-rise building FCC will be designated alternate locations for the Campus FCC FACP. All information residing in the FACP/FACT of the Campus will be duplicated at these two locations.

g. A FACT with FAP or a FAAP with LCD indicating building in alarm shall be located at the University Police Building. The Police Station shall be capable of accessing any FVEP via local microphone.

h. Every building will be equipped with a weatherproof speaker/strobe located at each exterior door.

i. Front Panel Control:
   1) Each floor shall have a disable button
   2) Disable all
   3) Elevator disable
   4) Fan/shut-down disable
   5) Pager disable
   6) Door disable
   7) Separate speaker and strobe disable
   8) Manual page by floor

G. SYSTEM OPERATION

1. General:
   a. Normal operator interface shall be through the FACP located in each individual building where required, and at the designated FACT located in the Anschutz Medical Campus University Police Building in the Police Dispatch. All system early-warning pre-alarm, alarm, and trouble messages shall be annunciated on the FACT in a color-graphic format with English language descriptors.

   b. Full system functional capabilities shall be resident in the FACP and FACT in the University Police Building in the Police Dispatch, and at each building FACP/FACT.

2. Automatic Actions:
   a. Activation of an alarm-initiating device, as specified in 1.3, J. Sequence of Operation, shall cause the following:

      1) Annunciation of the alarm condition, type, and device address at the FACP, FACT and FAAP in a LCD format at the building FAAP. An audible signal shall sound and the alarm condition shall flash until acknowledged. The alarm condition
and its location shall also be displayed at the Central Control Center FACP, FACT, and FAAP per the building design.

2) Each building at the Campus shall notify the University Police Dispatch Center via dedicated FO underground and copper cabling inside the buildings.

3) The appropriate audio and visual alarms shall be transmitted throughout the building in alarm or to predetermined zones of the building in alarm.

4) Acknowledge the alarm at the FACP of the building in alarm to silence the FACP alert. The visual strobe shall continue without interrupting the emergency signal.

5) Disable the elevator call system and recall the elevators to the level of discharge exit or to the alternate floor.

6) Initiate smoke control procedures and functions automatically (position dampers and control fans) from the building FACP. Such actions shall be controlled by regular Mechanical Systems Controls. When an alarm is detected by the Building FACP, it shall signal the Building Management System (BMS) to initiate smoke control per the building design. Manual override capability of the automatic control mode shall be via the BMS.

7) Release self-closing fire and smoke doors in specified control zone when the system goes into alarm.

8) Unlock all secured doors in activated control zone through an interruption of power by the individual control module for each door.

b. For increased reliability, all smoke detector circuits shall be provided with alarm verification with field-adjustable time from 0 to 60 seconds. Only verified alarms shall initiate the specified sequences.

c. Activation of a sprinkler valve supervisory switch shall initiate supervisory alarm at the corresponding building FACP, FAAP, FACT, and FAP and initiate a supervisory alarm signal at the University Police FACT. Supervisory alarms shall be differentiated from a trouble condition on the circuit.

d. A break in the initiating circuit or detector power wiring shall be annunciated as a trouble condition on the building FACP and the University Police FACT.

e. A break in the audio/visual circuit wiring shall be annunciated as a trouble condition on the building FACP and the Campus Police FACT.

3. Fire Management System Manual Operation: Only authorized Aurora Fire Department (FD) and UCD Facilities Operations personnel shall be able to manually operate the FACP/FACT to accomplish functions such as:
a. Silence horns without deactivating strobes - Facilities Operations and FD.

b. Unlock doors in area where smoke control is activated - FD.

c. Override the operation of fans or dampers connected to the system - FD.

d. Bypass the operation of speakers, strobes, smoke control, fans and dampers, security doors, magnetic door holders and elevator recall during testing – Facilities Operations and FD.

e. Reset of the fire alarm system shall be accomplished from a primary and/or alternate location as indicated below:

1) The primary control shall be the FACP/FACT serving that building.

4. Failsafe Operation: To increase the system's ability to survive damage from fire, malicious or accidental damage, premature component failure, etc., the fire alarm system shall provide the following functionality:

a. Each building FACP shall operate in a stand-alone manner, independent of any other FACP or FACT. The building FACP shall contain the complete data file for all connected devices, regardless of the building, and shall operate the same way whether connected to any other FACP or FACT. This includes:

1) Annunciation of device address and condition. One hundred percent of all connected devices shall be capable of operating for alarm simultaneously.

2) Logical Point Grouping annunciation and control. Each Logical Point Group shall contain up to 15 physical points and shall be capable of initiating a sequence of control actions.

3) Event-initiated control, signaling and/or annunciation sequences. One hundred percent of all connected devices shall be capable of being operated simultaneously.

4) Priority display of multiple alarms.

5) Complete supervision of all connected devices with no degraded operation.

6) Complete reset capabilities at FACP and FACT.

b. Standby batteries capable of operating the FACP, FACT (except those supported by non-interruptible power supply systems), FAAP, FVEP, smoke detectors and alarm horns, strobes, secondary PC terminals, video display units and printers, shall be provided to automatically back up the emergency power source. The system shall have the capacity to operate FACP for 24 hours, PCs for two hours, and then operate the fire alarm indicating devices for at least five minutes, per NFPA requirements. When commercial power is restored, the system shall transfer automatically to primary power. System power supply shall be
equipped with battery charging circuits sufficient to recharge fully depleted batteries to within 70 percent of their maximum capacity within 12 hours.

c. System operating software and data file shall be resident in nonvolatile memory. Loss of power, momentary or for a sustained period shall not require reloading of the software.

d. All plug-in circuit boards shall be electrically supervised to assure that the proper board is in the proper position. Systems that use electrical continuity to supervise the presence of plug-in boards, but that do not assure that board positions have not been exchanged, shall provide additional means for the specified supervision, beyond that provided by locking covers.

e. The FACT shall be provided with battery backup or individual dedicated UPS.

H. Color code and minimum wire sizes for the fire alarm system as follows:

1. All wire is solid copper:

2. All insulation colors shall be continuous for the full length of the wire.

3. Wire Jackets shall be stamped with the “Circuit Type” designation or shall have an affixed label designating the “Circuit Type” every twenty lineal feet at a minimum.

<table>
<thead>
<tr>
<th>Circuit Type</th>
<th>Colors</th>
<th># Of Conductors</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiating Circuits</td>
<td>(+) Red (-) Black</td>
<td>2</td>
<td>18 (THHN)</td>
</tr>
<tr>
<td>Signaling Circuits</td>
<td>(+) Red (-) White</td>
<td>2</td>
<td>16 Twisted</td>
</tr>
<tr>
<td>Speaker Circuits</td>
<td>(+) Orange (-) Brown</td>
<td>2</td>
<td>14 Twisted</td>
</tr>
<tr>
<td>Strobe Circuits</td>
<td>(+) Yellow (-) Blue</td>
<td>2</td>
<td>14 Twisted</td>
</tr>
<tr>
<td>Fire Fighter Phone Circuit</td>
<td>(+) Red (-) White</td>
<td>2</td>
<td>14 Twisted/ Shielded</td>
</tr>
<tr>
<td>Fire Fighter Phone Riser Circuit</td>
<td>(+) Red (-) White</td>
<td>2</td>
<td>14 Twisted/ Shielded</td>
</tr>
<tr>
<td>RS-485 Circuit</td>
<td>(+) Blue (-) Gray</td>
<td>2</td>
<td>16 Twisted</td>
</tr>
<tr>
<td>Damper Control</td>
<td>(+) Red (-) Black</td>
<td>2</td>
<td>14 THHN</td>
</tr>
<tr>
<td>AHU Shutdown Circuit</td>
<td>(+) Red (-) Black</td>
<td>2</td>
<td>14 THHN</td>
</tr>
<tr>
<td>24VDC Power Circuit</td>
<td>(+) White (-) Black</td>
<td>2</td>
<td>14 THHN</td>
</tr>
<tr>
<td>Fire Alarm Remote Light Circuit</td>
<td>(+) Red (-) Black</td>
<td>2</td>
<td>18 THHN</td>
</tr>
<tr>
<td>Speaker Phone Cut Out Circuit</td>
<td>(+) Orange (-) Brown</td>
<td>2</td>
<td>14 Twisted</td>
</tr>
</tbody>
</table>
### Low Level Audio Riser Circuit

| (+) Red | (-) Black | 2 | 14 Twisted/ Shielded |

### High Level Audio Riser Circuit

| (+) Red | (-) Black | 2 | 14 Twisted |

### Door Holder Circuit

| (+) Red | (-) Black | 2 | 14 Twisted |

**I. Intelligent Features:**

1. The following additional features shall be provided:

   a. Alarm verification should be field-adjustable time from 0 to 60 seconds.

   b. The fire alarm detector cleaning shall be annunciated at the FACP as a trouble condition by the device.

   c. Dual Alarm threshold for day or night settings.

**J. Sequence of Operation:**

1. General: The operation of the fire alarm system in each of the functional areas of the facility is defined by the applicable mechanical, fire protection and electrical drawings of the particular building, and by the sequence of operation as described herein.

   a. The activation of any single initiating device (i.e. smoke detector, pull station, flow switch, etc.) shall:

      1) Sound the alarm and activate the strobes for the floor in alarm.

      2) Send an alarm signal to the FACT at the Campus Police Station.

      3) Annunciate the alarm condition and location to the building FACP/FAAP and to the FACT and printer of the Campus Control Center.

      4) Initiate paging via agency approved pager system.

   b. The activation of any consequent fire alarm initiating device shall:

      1) Sound the alarm and activate the strobes for the entire building.

      2) Transmit the alarm signal to the FACT at the Campus Police Station.

      3) Annunciate the alarm condition and location to the building FACP, FAAP, the corresponding FACT, and to the Campus Police FACT.

      4) Annunciate the alarm conditions and location to the building FAAP.
5) Release the fire zone security door, or doors, through the loss of power to the door lock apparatus.

6) Recall elevators to main exit level or alternate floor.

7) Release held-open doors.

8) Initiate the automatic smoke control sequence of operation as defined for each building.


a. The fire alarm sequence of operation shall be in accordance with the requirements for high-rise buildings, including but not limited to the following:

1) Sound the alarm and activate the strobes for the floor in alarm and the floors above and below.

2) Initiate stair pressurization and pressurization of the floors above and below the floor in alarm.

3) Release of stair, held-open doors, and re-entry doors.

4) Upon activation of the elevator, elevator shafts, or elevator lobby detectors, recall the elevators to the main exit level or alternate floor.

5) Activate refuge area communications link.

6) Annunciate the alarm to the building FACP, and FAAP, and to Campus Police FACT.

7) Annunciate the alarm condition and location to the building FAAP and local floor FAAP.

8) Transmit the alarm signal to the Campus Police FACT.

b. The Command Center of the High Rise Buildings shall also be equipped, under another contract, with the following remote status/control panels:

1) Buildings electrical distribution system.

2) Building fire pump.

3) Elevator status and control panel.

4) Building voice paging system and/or voice evacuation system (i.e., Office Building) via zone interface panel and microphone.

5) CCTV system monitors and keyboard.

c. The FD will use these panels for viewing or controlling each of the above systems.
3. The FD will respond to the FACP of the building in alarm and to the Campus Police. The Campus Police FACT shall be automatically activated into the graphics mode to show the current status of all devices in alarm. The FD will take command of the Building's FACT to monitor the current response to the fire alarm condition. Using a "mouse driven" graphic menu, the FD shall be able to "zoom in" or "zoom out" of the graphic screens to view the current alarm condition.

   a. The FD will use the building's FCC PC graphic system to view and control the response of the fire alarm system by viewing special graphic screens such as:

      1) A smoke control system status and control screen.

      2) Any building within the complex connected to the fire alarm system.

      3) Any preprogrammed screen existing within the fire alarm system.

      4) Or other specialty screens that may be created at the request of the UCD Facilities Operations.

   b. Using the assigned FD Identification Code (ID password), the FD may use the FCC PC to alter the preprogrammed fire fighting response to the present alarm condition. A printer will provide hard copy documentation of all alarm conditions, ID password log on commands, and the system response to the specific fire alarm condition.

4. The Campus Control Center fire alarm computer will provide monitoring and secondary back up of the fire alarm computers located in the various fire command centers. If an equipment trouble alarm is initiated from a fire alarm device, it shall be reported at the FCC FACP of the building in alarm and the Campus Control Center PC.

5. If a fire alarm condition is received and the FD cannot initiate an appropriate response from the building's FCC PC (i.e., fire in the Buildings' FCC room, or a failure of the FCC PC), then an override ID password command can be used by the FD to make any system PC the primary PC for the manual fire fighting override response. The selected PC shall be able to alter a building's preprogrammed response to the alarm condition. The selected PC shall be able to access and control all PC graphic screens that reside within the system.

6. Smoke and heat detectors shall be zoned in a logical point group priority matrix. Activation of any two initiating devices within any logical point group shall automatically cause the FACP to initiate the speakers and strobes to activate, release all security doors in the zone, initiate the mechanical system smoke evacuation response in that zone only, and transmit an alarm to the Building's FCC and the Control Center PCs. This sequence of operation shall occur even if the PCs or FO communication links are inoperative.

7. Manual pull stations shall be treated as single detector activation within the respective logical point group.
8. Sprinkler flow switch activation in a wet pipe sprinkled area shall be treated as a single detector actuation within all applicable logical point groups.

9. It shall be possible for all authorized personnel, using the proper ID password, to place the facility into smoke control operation through the graphic screens from the Campus Control Center PC (FACT), or the Building's FCC FACP.

K. Interface With Other Systems:

1. Interface design of fire alarm system with closed circuit television (CCTV) system and FO signal transmission system.

2. The Electronic Security Department (ESD) will provide software to interface with the CCTV and fire alarm systems. CCTV and fire alarm manufacturers shall provide software protocol, for their systems, to ESD.

3. Consultant may purchase copy of specifications for interfacing systems from the UCD for the purpose of determining interfacing requirements.

1.4 DEFINITIONS

1.5 SUBMITTAL

A. Submittals for Intelligent Fire Management System shall be made in accordance with requirements of Section 16010 for the following:

1. Provide shop drawings as follows:
   a. Floor plans with device layout, address and wiring.
   b. FACP layout.
   c. Riser diagrams.
   d. Battery calculation.
   e. Sequence of operation
   f. Equipment cut sheets
   g. FAAP layout.

2. CADD generated layouts for FACT screen graphics.

3. Operating and Maintenance Manuals.

4. Project Record Documents:
   a. Prior to submittal of the as-built documents, submit a complete package of shop drawings to UCD Facilities Operations Fire and Safety office for review. Drawings shall include floor plans and graphic maps for each building and/or floors.
   b. Submit record documents in accordance with the requirements of Section 01720 and the following:
1) As-built point-to-point wiring diagrams depicting every device, including correct UCD room numbers.

2) Revised schematic, wiring, and interconnection diagrams of all circuits, internal and external, for all equipment installed and exact locations for all devices. These schematics shall include the conductor color-coding and terminal number identification system, location of all terminal boxes complete with numbering and each device address.

3) Complete, as-installed, riser diagrams indicating the wiring sequence of all alarm initiating devices, supervisory devices, and all signaling appliances on all signaling circuits.

4) A complete description of the system operation, including a schedule of relay abbreviations used on the drawings, list of relay functions, and the sequence of relay operation during supervisory trouble and alarm conditions.

5) Complete wiring and control diagrams for control and shutdown circuits for fan systems.

1.6 QUALITY ASSURANCE

A. Intelligent Fire Management System shall be provided in accordance with the requirements of Section 16010 including the following:

1. Manufacturer: Company specializing in Intelligent Fire Management Systems.

2. Installer: Company with certified personnel specializing in smoke detection and fire alarm systems with five years' documented experience as a fire alarm installing contractor.

3. Fire Management system installer shall keep all smoke heads in the building covered until final building turn over. Failure to comply will mandate a complete cleaning of the individual heads on the system.

1.7 DELIVERY, STORAGE AND HANDLE

A. Intelligent Fire Management System shall be delivered, stored and handed in accordance with the requirements of Section 16010.

1.8 WARRANTY

A. Intelligent Fire Management System warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURES

A. Edwards System Technology

2.2 APPROVED INSTALLERS

A. Metroplex Control System (MCS) – 6950 South Tucson Way, Unit D, Centennial, CO 80112, (720) 875-0303.
B. Advanced Electronic System – 801 Main Street, Windsor, CO 80550, (970) 686-6200
C. FAS (Fire Alarm Services) – 4800 W 60th Ave, Arvada CO, 80003 (303) 466-8800
D. Meridian Fire and Security – 7173 S. Havana St Ste 400 Centennial CO, 80112 (303) 790-2520
E. Other Edward System Technology installers will be considered if they have successfully completed 3 similar projects (in size and complexity) in the past 5 years in the Denver Metro area. The installer must have a demonstrated ability to provide ongoing service to any system it installs. Alternate installers must be approved in writing by the UCD Project Manager through Facilities Operations 5 working day prior to Bidding on the project. Installers should be NICET certified.

2.3 MATERIALS, GENERAL
A. All equipment and materials used shall be standard components, regularly manufactured, and regularly utilized in the manufacturer's system.
B. All systems and components shall have been thoroughly tested and proven in actual use.
C. All equipment shall be listed and labeled by Underwriters Laboratories.
D. All sensors shall be of the intelligent type and shall mount on a common base. This base shall be incompatible with conventional detectors.
E. Where equipment of different manufacturers is used, such equipment shall be included under the required over-all UL system listing as a component of the integrated fire alarm system.
F. The system shall be designed to operate with unshielded wire, to the maximum practicable extent. Shielded wire may be used. FO cable shall be utilized, as required or as indicated by the design documents.
G. Except for FACP, FAAP and FVEP and other instances, all electronic monitoring and control assemblies shall be configured for installation in a 19-inch relay-rack assembly system.
H. Zero to one-hundred-twenty-five detectors and/or control and monitor modules may be supported on a single initiating circuit. Each sensor and module shall be capable of being operated for alarm simultaneously.
I. Three-hundred-eighty-four individually identified sensors and modules, or more, as well as conventional initiating and indicating circuit zones, may be supported within a single FACP.
J. FACPs shall be provided with tamper switches on cabinet doors to protect against unauthorized access to internal devices. The panel shall provide commandable outputs, which can operate relays or logic level devices.
K. Memory data shall be contained in EEPROM non-volatile memory. If non-volatile battery-backed RAM provides memory, removal of the board shall not cause loss of memory contents.
L. The Fire Alarm enunciator panels shall be LCD types.
M. Operator Station Software:

1. General:
   a. Real time operating system shall provide true multi-tasking.
   b. Data Base Manager is to manage all data on an integrated and non-redundant basis. It shall allow additions and deletions to the database without any detriment to the existing data.

2. Operator Interface Software:
   a. Provide a hierarchical linked dynamic graphic operator interface for accessing and displaying system data, commanding, resetting and modifying equipment operation.
   b. Operator access to the system is to be under personal ID and password control to system.
   c. Contractor shall assume responsibility and any cost involved for loading Owner-supplied CADD information. Include details of fire alarm installation down to the initiating device.

N. Site Specific Customizing Software:

1. General:
   a. The system shall be provided with software that will allow the user to modify and tailor the system operation to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices.
   b. On-line modification of the system configuration, program parameters, and database shall be provided via menu selection and keyboard entry of data into preformatted self-prompting templates.
   c. Provide software and Programs with technical support and training for UC Denver’s Facilities Operations staff during installation of system and completion.
   d. Display and change sensor sensitivity from FCC Central FACP.
   e. Alarms shall be displayed in a dialogue box of the color monitor. Display shall include, as a minimum:
      1) Indication of alarm condition, i.e. ABNORMAL OFF, HI ALARM/ LO ALARM, analog value or status, and English group and point identification such as "SMOKE DETECTOR BUILDING “A” - 2ND FLOOR- ROOM 202".
      2) A discrete per point alarm action taking message, such as "CALL MAINTENANCE DEPT, EXT 5561", of up to 480 characters.
   f. Alarm silencing shall be by selecting the "silence" button or by authorized operators or FD acknowledgement.
g. System shall automatically transmit alarm and troubles to selectable UC Denver pagers via a commercial carrier such as "AT&T Wireless".

h. The network routing properties for a panel's common controls determine which panels will respond when an operator presses the corresponding control command switch (Reset, Alarm Silence, Panel/Trouble Silence, Drill, Alternate Sensitivity) on the 3-LCD module. Only the panels defined in the selected network routing group will respond to the command. Any building connected by a bridge or other structure shall annunciate to its opposite number(s) alarm, supervisory, and trouble conditions via single LEDs on its front panel.

2 Point summary reports:

a. Point summary reports shall include the current value/status and condition.

b. Trend reports shall allow the operator to randomly select logical arrays of points.

c. Dynamic trends shall provide up to six points and show real time activity of the associated points.

d. Alarm reports shall be automatically issued.

e. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only.

O. Fire Alarm System Devices:

1. General:

a. Each device shall be assigned a unique address via easily understood decade (01 to 96) switch. Address selection by jumpers is not acceptable. Devices, which take their address from their position in the circuit, are unacceptable because, if devices are added later, existing address descriptors and commands must be reprogrammed.

b. It is preferred that the address of the intelligent device be part of the device base rather than the device itself.

c. Devices shall receive power and communication from the same pair of wires. For fault-tolerant circuits, any separate power wiring shall also be made fault-tolerant.

d. Each device shall contain screw terminals with rising plates for positive termination of up to #14 AWG wire.

2. Analog Sensors (Photoelectric and Thermal):

a. Each sensor shall contain an LED, which blinks each time it is scanned by the FACP. The sensor LED is to remain illuminated to indicate alarm. All sensors not visible from the corridor shall have a remote light mounted in the corridor as shown on the drawings.
b. Each sensor shall be capable of being tested for alarm via command from the FACP or FACT. The values of the sensor shall be displayed at building FACP and FACT, and the Campus Police FACT.

3. Monitor Modules:
   a. The Monitor Module shall provide an addressable input for N.O. or N.C. contact devices such as manual stations, water-flow switches, sprinkler supervisory devices, door contacts, intrusion detectors, etc.
   b. The Module shall mount in a standard electrical box.

4. Control Modules:
   a. The Control Module shall provide an addressable output for a separately powered alarm-indicating circuit or for a control relay.
   b. The relay contacts shall be SPST (Form "C" rated at 2 amps at 28V DC).
   c. The module shall mount in a standard electrical box.
   d. Control voltage’s connected to intelligent control relays shall not exceed 24VAC/24VDC. Isolation relays shall be used on control voltages on excess of 24VAC/24VDC.

5. Fault Isolator Module (only if approved by the UCD Project Manager):
   a. The Fault Isolator Module shall detect and isolate a short-circuited segment of a fire-alarm loop.
   b. Modules shall be placed on every floor to limit the number lost addressable devices in case of a short-circuit on the intelligent circuit.

6. Intelligent manual pull stations shall be single action, mounted on standard electrical box.
   a. For public places, use single action pull stations with "Stopper II" cover.

7. Magnetic door holders shall be wall- or floor-mount on a standard electrical box.

8. Linear beam smoke detectors shall have cross-zone capabilities and be provided where shown on the drawings. Detectors shall consist of a transmitter and receiver unit utilizing infrared light to detect smoke between the units. These detectors shall have discriminating circuitry to differentiate between actual smoke, momentary blockage of the beam, and long-term blockage.
   a. Contractor shall provide a weatherproof enclosure for each pair of devices, utilizing transparent panels to allow light transmission. Ensure range of detector is adequate to compensate for passage through this glass.

P. Other Devices:

1. Speaker/Strobes:
INTELLIGENT LIFE SAFETY FIRE MANAGEMENT SYSTEM

1. Strobes shall be synchronized.
   b. The speaker shall provide for minimum sound level of 95 dBA at 10 feet.
   c. Strobes shall provide 30 candela of luminous intensity, minimum.

2. Analog Air Duct Detectors:
   a. Detectors shall operate on 24V DC, and shall be powered from the FACP panel via separate 24V DC supervised supply circuit.
   b. Detectors shall be programmed for status indication only.

3. Fire alarm remote light shall be red LED, mounted on a standard plate fitted to a standard electrical box. When device is not visible, labeled plate with the name of the device served.

4. Fire alarm remote light/test switch combination shall be utilized for each duct detector. The device shall have a red LED and two positions test switch mounted on a standard plate fitted to a standard electrical box. Plates shall be labeled with the name of the equipment served.

5. Tamper Switches: Installed under Division 15.


7. Sprinkler Pre-action Solenoid and Deluge Valves: Installed under Division 15.


10. Relays provide addressable control and/or monitor module for each device indicated in paragraphs P. 3, 4, 5, 6 And 7 above. Include wiring to the device and to the fire alarm loop as required.

11. Provide control relays as required to accomplish functions such as fan shutdown, damper positioning, door release, etc. Relays shall have 24V DC coils, with DPDT contacts rated: 10A minimum, at 120V AC. The relays shall be provided with screw terminals and shall be UL listed as fire alarm control accessories.

12. Fire/Smoke dampers and smoke dampers will be provided under Division 15. The 24V wiring, including low voltage transformer P.E. switch, will be provided under Division 15. The 120V AC wiring will be provided under this section.

13. Voice Evacuation Speaker/Strobe units shall be UL listed for use in voice evacuation systems. Audible and visual indications shall operate independently or in unison.
   a. Speakers shall be suitable for voice communications and tone signals, with frequency response flat within 3 dB from 400 to 4000 Hz. Speakers shall be provided with not less than 4 transformer taps providing for power outputs ranging from 1/8 to 10 watts. Mountings
shall be surface or ceiling-recessed (as indicated on the drawings) on standard electrical boxes.

b. Strobe lights shall be provided with white or clear Lexan lenses with the word "FIRE" engraved in red letters. Strobe lights shall provide a minimum light output of 30 candelas, and shall be synchronized.

Q. Special System Requirements:

1. Each individual building FACP shall be linked via dedicated FO underground and copper inside the buildings.

2. Contractor shall provide jumper cables required making interconnections to that system.

3. The communications board shall include two FO transmit and two FO receive modules mounted as an integral part of the board. Detached FO transmit and receive modules will not be permitted. All FO transmit and receive modules shall include automatic gain control.

R. FO System Requirements:

1. Signal Transmission Format Code: All FO equipment for the same application shall use the same transmission format code. The FO links shall be designed to have a gain margin of a minimum of 3 dB. The error rate shall be not greater than one error bit in one million bits for each FO link, including transmitters and receivers.

S. FO Transmitter and Receiver Modules:

1. FO transmitter and receiver modules shall be housed in the FACP enclosures, and shall serve as interface between the electrical systems and the FO cable. Modules shall derive their DC operating power from either the device power supply or from their own dedicated power supplies. FO transmitter and receiver modules shall be compatible with each other, the FO cable, and the required type ST connectors.

   a. FO Transmitter Module shall accept electronic digital signals and shall modulate a light-emitting diode (LED). The LED shall be coupled into a FO cable.

   b. FO Receiver Module shall receive light from the FO cable and shall convert this light into an electronic signal identical to the signal applied to the FO transmitter module. The FO receiver module shall have a minimum dynamic signal range of 23 dB.

T. FO Jumper Cable:

1. FO cable shall be plenum-rated, tight buffer type, with attenuation less than 3.5 dB/Km at 850 nm.

2. Jumper shall consist of two type ST connectors and the required length of 50/125 or 62.5/125 micron FO cables. Jumper cable to match trunk system cable to which the FACP is to be connected to.

3. Connectors shall meet or exceed the following requirements:
a. Attenuation: < 1.0 dB at 850 nm per mated pair.

b. Durability: < 0.2 dB increase in attenuation per 1000 matings.

c. Operating temperature: -40°C to +60°C.

d. Connector construction shall incorporate ceramic ferrule, nickel-plated zinc housing and estane boot.

U. Voice Evacuation System:

1. The Contractor shall provide all work required for installation of a Voice Evacuation System for the buildings indicated by the drawings. Scope of this Contractor's work will be as described by this section of the specifications and as shown on the drawings.

2. Buildings that are defined as high rise shall have the following: An Audible Alarm on the floor where that event is detected and a general message to all other floors stating, "A fire Alarm has been detected on (indicate floor number). Remain alert and evacuate if there are indications of fire. If no danger is noted, you may await further instruction. Elevators have been recalled to level 1 (or alternate floor if the fire alarm is on level 1) until the fire alarm is over."

3. Fire Alarm Voice Evacuation Panel (FVEP):

   a. The FVEP shall be located in the FCC in conjunction with the FACP and shall provide evacuation signals, pre-recorded fire alarm messages, and one-way communication (paging) on a selective.

   b. FVEP equipment shall include the following:

      1) Voice paging, hand-held, push-to-talk microphone with dynamic noise canceling. Frequency response shall be flat within ± 3 dB from 200 to 5,000 Hz.

      2) Zone paging selector switches and LED's, with one selector switch and two LED's provided for each speaker zone.

      3) "Manual Fire Evacuation Tone" switch and LED.

      4) "Silencing" fire evacuation tones (self-restoring switch) and LED.

      5) "Pre-recorded Message" switch and LED.

      6) "All Call", switch and LED, with the switch enabling the operator to simultaneously page all speaker zones on both risers.

      7) Reset switch.

      8) Lamp test switch.
9) "Page" LED, which will light when the paging microphone is used.

10) The FVEP shall also be equipped with LED's to indicate trouble conditions for the following:
    a) Each individual speaker zone.
    b) Amplifier, preamplifier, fire tone, pre-recorded messages, and voices paging.

11) All switches and LED's shall be clearly identified with engraved labels.

12) Each group of LED's shall have distinctive colors, such as:
    a) Fire Tone - Red
    b) Silence - Yellow
    c) Page - Green
    d) Trouble - Yellow
    e) Pre-recorded Message - Red

c. The fire evacuation signal shall be applied to any specific zone automatically from the FACP or FACT, or shall be selected manually by the speaker zone switch.

4. FVEP Audio Cabinet:
   a. The audio cabinet shall house the tone generators, pre-recorded message module, preamplifiers, amplifiers, power supplies, and supervisory electronics. Redundant tone generators, preamplifiers, and amplifiers shall be provided.
   b. The audio trunk shall be electronically supervised and shall be automatic switchover from one audio signal path to the other.
   c. Each amplifier module shall be provided with two 40-watt amplifiers, and shall power a minimum of 8 speaker zones.
   d. Backup amplifier modules shall have the same power rating as the primary modules.
   e. Pre-recorded message shall be programmed and recorded in a memory chip. Tape cassette players are not acceptable.
   f. The FVEP audio cabinet shall be capable of remote "All Page" activation via local microphone from the Campus FCC and Campus Police Station. The system shall allow the selection of individual building or "All" buildings for "Disaster Messages".

V. Spare Parts:
1. All spare stock shall be delivered in manufacturers standard shipment packaging, and each item shall be clearly identified as to package contents.

2. Include a complete parts list with the O & M Manuals.

3. The list shall include catalog cuts and catalog numbers.

4. Include one type of system service tool.

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Installation shall be supervised and tested by the manufacturer of the system equipment.

B. All 120 volt Fire Alarm wiring shall be installed in metal conduit. Do not exceed 40% conduit fill.

C. Low Voltage/Wire and Cable: All LV/W&C shall be run in conduit in floors and walls spaces. In hallways, LVW/C can be run in bridle rings attached to the common telecom and other low voltage system cable tray. LV/W&C must be run in a conduit sleeve, minimum 2” dia. with plastic bushings, from the point it leaves the bridle ring on the cable tray to the interior side of a room. Once the LV/W&C enters the room it can be supported from bridle rings or j-hooks. Wiring shall comply with Section 16720 and approved NEC.

D. Low Voltage/Wire and Cable and Hallway Devices: LV/W&C running from the cable tray to devices in the hallway shall be protected by plenum rated flexible sleeving or flexible metal conduit. LV/W&C in sleeving or flexible metal conduit shall be supported per NEC and installed with UL approved connectors and plastic bushings on both ends.

E. Outlet pull and junction boxes shall be painted red on the exterior.

F. Devices: Except as otherwise noted, locate devices per ADA standards

G. In construction areas where there is existing equipment, the equipment must be protected during construction and the devices taken off line to eliminate false alarms.

H. Contractor shall be liable for damage. Owner must be notified at the completion of each project to ensure that the system is returned to normal.

I. If room numbers are changed or new room numbers established, the UCD Project Manager must be notified before implementation so that the system can be re-programmed and is accurate in the event of an alarm.

J. All devices mounted in ceiling tile to be supported by T-bar hanger bracket and appropriate box. Plaster ring is not acceptable.

K. Labeling:

1. Observe UCD fire alarm color code guide.

2. Label each splice with correct information.
3. Label each initiating device with correct device address. Use Kroy labeler or equal.

4. Device address information must be obtained from the vendor.

5. All junction boxes to have covers labeled fire alarm.

6. Final, correct UCD room numbers (not design/construction room numbers) must be provided for correct programming.

7. All detectors to have factory dust covers installed until after the final inspection and clean up is complete.

8. All duct detectors to have individual remote LED/test stations installed. Mount at 6'-0" AFF in main corridor adjacent to area served. Label as directed by UCD Project Manager.

9. All shielded wiring to be bonded together at each device and insulated from contact with the conduit or box.

10. All equipment and associated wiring removed from service will be returned to UCD Project Manager for proper disposal.

11. Avoid locating detectors above countertops and/or shelving.

12. Locate detectors at least eight feet from supply or return air diffusers.

13. Use fixed heat detectors near autoclaves and steam sterilizers.

14. Mount remote lights for room detectors above door to corridor, centered.

K. Construction Requirements:

1. Integrity of Structure: Do not drill or pierce structural members without prior approval from the UCD Project Manager.

2. Penetration of Walls, Etc.: Fire caulks or seal all penetrations made through walls, floors, and ceilings around the conduit. Maintain the integrity of fire ratings within the structure. Where visible, paint to match surface.

3. Wherever possible, install conduits and raceways in a concealed manner, except at surface-mounted cabinets.

4. Access to Existing Facilities: Install all conduit and pull boxes to maintain or provide access to existing valves; covers to existing pull boxes; wire ways or access doors; electrical outlets; switches; motors, etc.

5. Bridle rings/"J" Hooks shall be independently supported from structure, may have separate point of attachment to cable tray.

6. No other wiring or systems to be installed with fire alarm.

7. No AC circuits to be installed in the same conduit with fire alarm wiring.
8. Raceways: Route all raceways parallel or perpendicular to building lines with right angle turns and symmetrical bends.


10. Expansion Joints: Provide raceway expansion joints with necessary bonding conductor at building expansion joints and where required to compensate for raceway or building thermal expansion and contraction.

L. Prior to start of construction, disable existing fire alarm devices, as necessary. A minimum of two working days notice, prior to construction, shall be coordinated through the UCD Project Manager.

3.3 TESTING, CLEANING AND CERTIFICATION

A. When installation is complete, system shall be tested in accordance with NFPA72 requirements. A representative of the system manufacturer shall submit a written report of the findings to the A/E with copy of to the FD. System testing shall include, at the least, verifying the following:

1. The functional operation of each re-settable initiating device (manual stations, detectors, etc.) and circuit.
2. All indicating appliances shall be tested for a minimum of ten minutes under normal alarm conditions.
3. The functional operation of each and every alarm device and circuit.
4. The functional operation of each monitored device circuit.
5. The functional operation of each control circuit, including fan controls.
6. Control station automatic signaling.
7. That all software protocol, access codes and operation instructions have been supplied.
8. All installed or modified fire alarm systems for remodels or new projects shall be tested and certified by a Factory Representative. Upon a system test completion a “Letter of Certification” shall be issued to the owner.

B. All testing and verifications shall be conducted in the presence of UCD Facilities Operations Fire and Safety personnel.

C. There shall be an operational test by the FD.

3.4 COMMISSIONING (DEMONSTRATION)

A. The equipment supplier shall provide a minimum of 8 hours of free system training for UCD Facilities Operations personnel every year in addition to the training required for each new system.

3.5 SCHEDULES
SECTION 16722
SECURITY CONSTRUCTION STANDARDS AND EXPECTATIONS

PART 1 - GENERAL

1.1 SUMMARY

The University has tasked The Electronic Security Department (ESD) with the design and management of the physical security and access control features of the campus structures. In support of that responsibility, the ESD and its contractor(s) will need to participate in the various planning and design conferences for each renovation and new construction effort. Consistent with the Projects Planning Process, the ESD Director/Staff and any/all contractors will need to participate in the following Security Design Phases.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

1.2.1 Security Design Process

Concept Design (5%)

1. Two sets of drawings and two sets of specification books to the ESD and its contractor(s). Drawings to also be provided to security contractors in electronic format, (AutoCAD 2000 or higher, .dwg), where possible.

2. Security requirements identified, after initial and concept design conferences:
   a. Controlled Portals
   b. Monitored Portals
   c. CCTV Surveillance
   d. High Value and High Risk Areas
   e. Interior compartmentalization needs
   f. Adjacency and Campus Integration Issues
   g. Areas of regulatory or compliance requirement

3. Hand out worksheets and conference notes

4. Discuss project and establish security preliminary budgets as part of the overall construction budget.

Schematic Design (35% documents)

1. Two sets of revised drawings to ESD and security contractor(s) (electronic and paper)

2. Continued participation in all design conferences

3. Review space configuration and design narrative

4. Security conferences with tenants to ascertain work processes, occupant flow, risk analysis, hours of operation, compartmentalization issues, public access, high value areas, etc.

5. Security conferences with security contractor(s) to ensure security overlays are sent to architect

6. Security conferences with the electrical contractor and the supplier of door hardware regarding the integration of components
Design Development (65% Documents)

1. Two sets of revised drawings to ESD and security contractor(s)
2. Continued participation in all design conferences
3. Review interior building configuration and elevations
4. Resolve security specifications and update overlays
5. Continued refinement of project costs and schedule with security contractor(s)
6. Construction Documents (95% Documents)
7. Two sets of revised drawings to ESD and security contractor(s)
8. Continued participation in all design conferences
9. Continued audit of revised drawings to security specifications
10. Continued revision of costs and construction schedule with security contractor(s)

Construction (100% Documents Final)

1. Two sets of revised drawings to ESD and security contractor(s)
2. Continued participation in all design conferences
3. Construction schedule with security contractor(s)
4. Construction delivery and coordination
5. Participation in contractor/subcontractor site conferences

Accepting the Security System by ESD

1. Review security processes and signoff requirements of GC
2. A commissioning check list will be developed for each project
3. A functional test of all systems before acceptance is complete.

1.2.2 UCD Physical Security Standards

1.2.2.1 The UCD physical security standards for the UCD campuses set the baseline of security requirements for each building and all controlled access structures/areas. The primary objective the UCD physical security policies and standards is to protect people first, with property, research protocols, and intellectual property behind it.

When incorporated into building design, the University will enjoy a continuity of application between each building and each zone. Architectural considerations for the presentation of buildings should incorporate these standards and the CSI, as a whole, as representative of the University's security position.

The University uses a layered approach to security provision. It defines this as the provision of barriers and distance between the area protected and public areas, with
security provided to the object(s) of protection first and then working outward with additional layers, as needed. Layers will be added to ensure that response time by the University Police is always less than the attack time against the object(s) of protection. Barriers will allow permitted passage but will also provide a time delay or physical deterrent for non-permitted entry. Alarm, CCTV, and/or data logging by the Security Department monitor the effectiveness of these barriers. The University Police Department also monitors these barriers by foot and vehicle patrol. The greater the value or risk of the protected area, the greater the perimeter and barrier protection.

The standards are dynamic in that they are an appropriate and timely reaction to identified risks with reasonable mitigation to those risks, consistent with physical, technical, and fiscal restraints. As the risk changes, the associated security will react and change appropriately. However, the University will provide a baseline level of protection to all structures.

The standards are oriented to support the widely varied work processes; to promote the fact and perception of personal security and safety; and to address compliance with state, municipal, and industrial standards set in code, law, or policy.

The cost of security includes the cost of design/installation; procurement of components, monitoring of alarms and trouble alerts; response to alarms; periodic design review, and system maintenance. Indirect costs of security include the monitoring staff, the Badging Offices staff, training, and supplies.

1. All primary exterior entry portals, loading dock portals, and other frequent access points in the perimeter wall will have card reader controlled access. The equipment set for these doors will include HID RP40 (CR), Von Duprin 6000 Series Electric Strikes or Locknetics Maglocks, Request for Exit device (RTE), Door Position Sensor (DSM), and Code Blue 2-button CB-3000-d Intercom Device (IC) to reach Access Control or the Police.

2. All exterior secondary portals used for unrestricted daytime passage and night egress after building closure, will be monitored. These doors will have DSM and RTE. This kit will allow egress without alarm initiation but no reentry after building closure.

3. All exterior portals used for fire or emergency exit only will have DSM only. Exit at any time will initiate alarm. Entry is not permitted at any time. No exterior door hardware is installed.

4. Exterior portals that access mechanical and electrical rooms but do not allow further access into the building will be monitored with a RTE only and will have time zone alarms.

5. Interior portals that serve to restrict access to a variable, large, or logged population during or after business hours will have HID RP40 CR, Electronic Door Lock Hardware, DSM, and RTE. Depending upon the work process, these portals can be unlocked during certain hours. If the door is in the egress path and there are no mechanical over-rides on the door, a fire pull device may be required.

1.2.2.2 The University uses CCTV systems as an integral part of its physical security system. Cameras may be placed on building roofs, at key buildings entries, at central interior junctions, and in areas of high value or high risk. The placement and visibility of cameras should not infer that each or any camera is monitored at all times, that a particular action or reaction may take place because of the presence of a camera, or that a camera, by itself adds to the security or safety of a particular area.
1. Interior portals that provide security only during non-business hours and where free flow of traffic is necessary, may be held in the open position with magnetic hold-backs (MH) which will release at a specified time allowing the door to close to secured and monitored state. These portals require MH(s) and DSM(s). Access can be via key for emergency over-ride or access control card key, depending upon the size and type of the permitted population.

2. Interior portals that secure office, classroom, electrical, mechanical, audio-visual, maintenance, conference and similar areas will typically be secured by door hardware only, tied to the keying schema of the university.

3. High Value, High Risk, or Privacy Protection Areas will be secured by the normal CR, RTE, and DSM kit with the CR replaced or supplemented by a Biometric Device (BD) that incorporates the proximity reader and digital fingerprint to gain access. Use of these devices is dependent upon the risk mitigated by the locked door. These portals will be locked and controlled at all times and may have CCTV surveillance to support the security controls.

4. Closed Circuit Television (CCTV) devices whether fixed or pan, tilt, zoom (PTZ) will be placed to record access to and activity in sensitive areas; areas where cash, drugs, merchandise, and other high value items are maintained; and where personal protection, property theft, or personal safety risks are identified. These will typically be in selected interior spaces, at primary entry portals, and selected roof locations.

5. Certain grants, contracts, donors, work processes, etc. have unique security requirements attached to their funds, equipment being used, or processes in the university setting. The Security Department will respond to those with developments, as needed and requested.

6. Emergency Communications – The University has adopted the “Code Blue” emergency telephone system placed in parking, pedestrian, selected entry portals, and others areas as noted in the Master Plans for the site. If the construction of a structure, pathway, road, etc. or the combination of adjacencies among structures increases the need for additional telephone units, these should be proposed and coordinated with the Security Department and the Police Department. The Information Technology Department is responsible for this telephone system, although placement and selection is coordinated with the Security Department.

7. Elevators, passenger and freight, may have access control features to provide floor by floor compartmentalization during or after business hours. These may include a card reader at entry floors to open a car and interior readers to support permitted access to selected floors. Supporting features may include CCTV surveillance at elevator entry points or inside the cars to record tail-gating events, movements of property, or irregular access events.

8. Fire Stairwells will have access controls to particular floors when the elevators on corresponding floors have access controls. As with elevators and all fire egress paths, the fire system will shunt any security devices in the egress path. Egress to the roof will be prevented by locked keyway only. Re-entry to intermediate floors, though not required by code, may be designed to provide escape routing should an occupant be confronted by criminal or other personal threat between the tenant and ground level egress. Where those floors are identified, a fire pull station will be installed. Initiating this alarm will summon fire and police. The Security Department and the University’s Fire Marshal will work with the Architect on this issue.

9. The CCTV and Security systems will terminate in the IT/Telecom room(s) core in each structure. Security will typically have one wall for its low voltage power supplies, controllers, etc. and a portion of the rack system for its DVR, UPS, etc. These rooms also support the fiber optic breakout, the structure’s telephone and network features. Security will bridge to the campus network in these areas.
1.2.2.3 The Security Department supports the widely accepted “Crime Prevention Through Environmental Design” concepts that include the security program involvement during the designs of interior, exterior, landscape, lighting, parking, loading, etc. The Security Department also supports the AIA’s “Building Security through Design” concepts that encourage early integration of risk identification and risk mitigation through seamless design features. The Security Department will contribute to the Project Team throughout the structure’s development to ensure clear communication, quick consultation, and solid research.

1.2.3 New Construction, Remodeling and Renovation Standards

UCD has set construction and renovation standards in the areas of physical and electronic security to enhance the efficiency and effectiveness of new construction, renovation, relocation of offices and labs; and the integration of all work functions on both campuses. This document (CSI Division 16722) resides with the Facilities Projects Department and is distributed it to all new building design teams. As projects are developed, the security requirements are incorporated from the concept designs through to commissioning of the structure.

1.2.4 Hours of Operation

The standard and default hours of operation for the security of exterior entrance doors are from 6:00 a.m. to 6:00 p.m. Those enrolled in the Access Control System, will be able to enter any access-controlled door for which they have been granted after-hours access. The main entrances to most buildings will be unlocked and publicly accessible during the weekday/daytime hours. The security system locks and alarms all labs, high-value, high-risk, hazardous or confidential areas are locked and alarmed at all times. Business hours for some buildings may vary depending upon the work process, security needs, and public access.

1.2.5 Secure Perimeters

All exterior doors to all buildings will have access control or door position monitoring enabling UCD to ensure a secure perimeter of each building after the close of business.

The University installs access control devices at a building’s primary entrance(s), where the area secured must limit access to a large and variable population, where the contents of the area present a high value or a high risk of injury; where after-hours access must be logged, and/or where unique circumstances require monitored access control. All buildings will have, by default, at least one card controlled door in its secure perimeter.

1.2.6 Security Installation Costs

The University will provide external perimeter, interior zone security, CCTV coverage, alarms, panic devices, etc. consistent with the design of the building, its function, and University standards.

Security beyond the base level requirements must be addressed by the Electronic Security Department in concert with the tenant department, generally, at the expense of the tenant. However, the tenant is not at liberty to install locking devices that prevent or impede access to law enforcement and life/safety staffs. Should a tenant have additional security needs, the Electronic Security Department will be contacted so that those specific needs can be addressed, coordinated with the University system, and with customer satisfaction ensured.

1.2.7 Closed Circuit Television (CCTV)

1.2.7.1 Physical Standards - Security relative to research laboratories, animal colonies, and other restricted zones adjacent to public areas within the same building will have secure
All doors to the laboratory spaces will have access control devices or will be alarmed and signed for emergency exit only. Each lab will have two secure barriers: the building exterior and an interior door system. The interior doors that are alarmed and controlled will remain secured at all times to ensure that only authorized personnel can enter, that a secure fire perimeter is supported, and that the line between biological, chemical, and radioactive hazards is enforced. The Security Department, the Fire/Safety Office, and the Environmental Health & Safety Department have an interest in the security of the laboratory perimeter.

1.2.7.2 Security Enforcement - The integrity and value of the University rests with the individual commitment of each person to support the objectives of the security system and to self-police all protected areas. This means that everyone notes doors that have been propped open, have tape across the door’s strike, unescorted visitors, the wrong people in the wrong areas, intruders in offices, missing files, equipment, etc. and takes reasonable steps to remedy observations. This would further include notification of department management, the Security Department and/or the University Police Department. Any attempt to circumvent the electronic security or to violate the Access Control policy, cannot be tolerated by the University. The software that controls the electronic security for both campuses monitors and records the status of each controlled portal.

1. When the cause of the alarm can be attributed to an intentional act, the Dean of the appropriate school will be notified and will have five days with any mitigating causes for the security compromise.

2. At the end of the five day period, the Chief of Police will consider any mitigation submitted toward the resolution of the violation.

3. A charge of an amount no less than $100 will be placed against the appropriate school, for each violation. The charge will partially offset the cost of investigation, monitoring and resetting of intentional security violations.

1.2.8 Personnel Security

The most valuable and irreplaceable of the University’s assets are its people. The primary focus of the security standards is the protection of people. To this end, each person should understand the risks before them when working in their particular area, trade, or function; when transiting open areas, traffic areas, etc. At each primary door entry and in all parking areas, “Code Blue” pylons have been installed. Each of these provide direct 9-1-1 access to the Police Dispatcher and are operable at all times.

1.2.9 University Security Committee

The University will form a Security Committee to address security issues within the University setting as well as the campus settings. Representatives from the various departments, schools, and divisions will be called together periodically by the Director of the Electronic Security Department to discuss trends, issues, requirements, and solutions. The committee will also expand periodically to include representatives of other hospitals, clinics, and tenants on the campuses to ensure open communication in areas of physical, personnel, and electronic security. The Security Committee will also plan and present exercises, tests and drills of the coordination efforts of all components on each campus using realistic scenarios with all aspects participating.

PART 2 – PRODUCTS

2.1 Electronic Access Control System
Command and Control – Access Control Center
C•CURE/8000 FOUNDATION SECURITY FEATURES
- Event and Alarm Monitoring
- Database Partitioning
- CCTV Integration
- Local/Global Anti-Passback within a Cluster
- Elevator Control
- Monitoring Station with Split Screen Windows
- Muster/De-muster
- Alternate and Extended Shunt by Door
- Escort Management
- Intrusion Zones/Keypad Commands
- Email and Paging
- IT-based Password Protection
- N-man rule
- Occupancy Restrictions
- Open Journal data format for extended reporting capability
- Automated Personnel Import
- ODBC Support
- Windows NT/2000/XP
- Expanded Audit Trail
- Enhanced Partitioning
- Event triggered backup for iSTAR

C•CURE/8000 EXTENDED APPLICATIONS
- C•CURE ID Badging Solution
- Biometric Support
- Integrated Digital Video (NetVue)
- Central Monitoring
- Guard Tour
- Bi-directional Serial Interface
- Broadcast Messenger (unlimited paging)
- Visitor Management Systems
- Real Time API licensing
- Area Lockout
- Fail-over WAN and Redundancy
- Asset Management and Hands free Access Control
- Cardholder Access Events
- Advanced Door Monitoring
- Carpool Anti-Passback

ADVANCED ENTERPRISE CAPABILITY
- Dynamic Host Configuration Protocol (DHCP) support for iSTAR controllers
- Dual Network Support for iSTAR controllers
- Web Architecture for Centralized Personnel Administration
- Advanced Integration with Select ERP systems
- Dual network failover support/redundant communications
- Ethernet ready
- Embedded operating system
- Seamless integration with C•CURE 800/8000
- Wide range of alarm monitoring
- Advanced clustering
- Global Anti-Passback within a cluster
- Intrusion zones & keypad commands
- Supports up to 16 RM or Wiegand readers
- Web diagnostics
- Expandable on-board memory to 64 MB
- Secure communications
- Easily upgradeable
- Worldwide compliance

2.2 Wiring specifications for all Physical Security Management System (PSMS) in section 16722

2.3 ESD is the primary contractor for security features on the campus. ESD will provide the equipment specifications for all security and CCTV systems.

2.4 ESD will resolve subcontractor issues regarding wire installation, etc. with the Project Manager and the General Contractor.

2.5 Card Reader Door set ups
   i. Primary Door/s
      HID RP40 Card Readers (Exterior doors), DS150i Request to Exits, Sentrol 1076-N Door Position Switches, VonDuprin 6000 Series Electric Strikes or Locknetics Maglocks
   
   ii. Other Door/s
      HID RP40 Card Readers (Interior doors), DS150i Request to Exits, Sentrol 1076-N Door Position Switches, VonDuprin 6000 Series Electric Strikes or Locknetics Maglocks
      
      HID RP15 Card Readers (Mullion Mount), DS150i Request to Exits, Sentrol 1076-N Door Position Switches, VonDuprin 6000 Series Electric Strikes or Locknetics Maglocks

2.6 Non Card Reader Doors
   i. Electronic Controlled/Programmed
      DS150i Request to Exits, Sentrol1076-N Door Position Switches, VonDuprin 6000 Series Electric Strikes or Locknetics Maglocks
   
   ii. Electronic Monitored
      T-REX-XL2ADT Request to Exits, ADT1076-N Door Position Switches

2.7 Security Systems and Alarm Types
   i. Door alarms
   ii. Intrusion Alarms
   iii. Panic alarms
   iv. Holdup Alarms
   v. Motion (infrared) Alarms

2.8 Access Control for Elevators

2.9 Uninterrupted Power Supply (UPS) must be identified for all Digital Video Equipment. The UPS must be able to support the loss of power for .25 hours. It shall provide power conditioning and EPS (Emergency Power System) buffering.

2.10 Closed Circuit T.V. Cameras (American Dynamics, Pelco, Extreme, Kalatel)
   (Catalogs with Facilities Projects)
   a. Internal/External Cameras
   b. Interface with Digital Video Recording
   c. Connectivity to TV. Monitor and/or Computer
   d. Interface with EACS alarms
   e. Interface with AEGIS graphic system
   f. Wiring/Equipment specifications I.S. information, tentative plans call for I.S. to contract wiring.
Refer to the Camera Specification Catalogs from American Dynamics (PTZ), Pelco (Fixed), or Extreme (Specialty) or any vendor that can provide equivalent product.

The recommended camera wiring is:

**Fixed Cameras require**
- RG6/18-2 Siamese for runs 750’ or less
- RG59/18-2 Siamese for runs 500’ or less
  Other wiring requirements will be determined by application
  (All Camera wire jackets to be Grey in color)
**PTZ Cameras require**
- RG6/18-2 Siamese for runs 750’ or less (Video)
- RG59/18-2 Siamese for runs 500’ or less (Video)
- 18-2 type wiring (Data) Or as specified by the Manufacturer(s)
  Other wiring requirements will be determined by application
  (All Camera wire jackets to be Grey in color)

2.11 CCTV Monitor:

(Catalog with Facilities Projects)

ADMNLCD20, LCD, color, 20", High Resolution, w/ BNC video & computer input,
NTSC/PAL, black bezel

- Front panel controls
- Built in speaker
- Automatic Color Switching System
- VESA Mounting Standard
- Facilitate Rack Mounting
- S-VHS input for separate Y-C signals

2.12 Digital Video Recording

1. American Dynamics Intellex, rack mount, 16 channel, v4.1 or higher software, premier
   480GB, NTSC

There will be other equipment required to connect the cameras and DVR, as well as to send and receive the signal transmissions. (Network Video Transmitter (NVT) and Network Video Receiver (NVR))

**Digital Video Recorder Specifications**

- Requirements and Features of the DVR include:
  - Built-in RAID 5 configuration for fault tolerance
  - Up to 1.5 terabytes of internal mass storage
  - Easily accessible and swappable hard drives for reduced service times
  - Hard drive failure alarm and email notification
  - Supports Intellex Premier software features (see Intellex data sheet)
  - Remote access and management with Network Client™ Remote Management and Configuration Software (included)
  - Integrate video with other software applications using the Intellex API
  - Eight camera inputs
  - Capture up to 120 ips, NTSC (100 ips, PAL)
  - Text recording from devices such as cash registers and ATMs (up to eight devices)
- Integrated live and recorded audio
- Internal floppy drive for saving system setups and saving single images
- Internal CD-RW for exporting video, audio, and text
- Windows® 2000 operating system
- Integrated recording and storage unit in a 4U form factor
- Durable rack mount chassis with slide rails for easy installation

PART 3 – EXECUTION - Not Applicable.

END OF SECTION
SECTION 16740

IT CONSTRUCTION REQUIREMENTS

1.1 INTRODUCTION

A. This section describes the codes, standards, specifications, recommendations, and practices required for construction at the University of Colorado at Denver and Health Sciences Center (UCD) for the Information Technology (IT) Services department. Section 16740 applies to all telecommunications projects at UCD.

B. The project general contractor (GC) is responsible for building telecommunications pathways and spaces as per the requirements described in this document. The project GC shall provide these specific items: spaces (telecommunications rooms, telecommunications entrance faculty, and equipment rooms), pathways (riser and horizontal distribution), grounding system, and fire suppression systems, as described below. The IT Services department is responsible, through its contractor, for providing cabling, data networking, and voice equipment.

C. Corrections, comments, questions, or omissions shall be submitted to the IT Services department via the UCD project manager.

1.2 REFERENCES

A. Applicable Codes, Standards, and Specifications.

1. The following table of codes, standards, specifications, recommendations, and methods and procedures (M&P) are applicable to the provisioning of telecommunications services for UCD. They are incorporated by reference.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>IEEE C2</td>
<td>National Electric Safety Code (NESC)</td>
</tr>
<tr>
<td>ANSI/IEEE 802.3</td>
<td>Information Technology—Local and Metropolitan Area Networks—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications</td>
</tr>
<tr>
<td>TIA/EIA-568-B</td>
<td>Commercial Building Telecommunications Cabling Standard (Parts 1, 2, and 3)</td>
</tr>
<tr>
<td>TIA/EIA-569-B</td>
<td>Commercial Building Standard for Telecommunications Pathways and Spaces</td>
</tr>
<tr>
<td>TIA/EIA-606-B</td>
<td>Administration Standard for the Telecommunications Infrastructure of Commercial Buildings</td>
</tr>
<tr>
<td>I-STD-607-A</td>
<td>Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications</td>
</tr>
<tr>
<td>TIA/EIA–758</td>
<td>Customer-Owned Outside Plant Telecommunications Cabling Standard</td>
</tr>
<tr>
<td>TIA/EIA–862</td>
<td>Building Automation Systems Cabling Standard for Commercial Buildings</td>
</tr>
<tr>
<td>OSHA</td>
<td>Standard 29 CFR 1910.268</td>
</tr>
</tbody>
</table>

2. Requests for variations from code shall be submitted to the UCD Code Official via the UCD project manager and must have IT Services approval. The UCD Code Official will either disapprove or approve the request. In general, requests for code variations shall not be looked upon favorably. Variations from standards may be authorized by UCD IT
Services on a case-by-case basis and must be requested in writing by the designer through the UCD project manager.

3. UCD IT Services will provide design parameters for the distribution systems and for systems in individual buildings, and IT Services shall be consulted during project design through the assigned UCD project manager.

1.3 OVERVIEW

A. Planning.

1. To facilitate provisioning of telecommunications services, the architect/engineer shall provide UCD IT Services with floor plan drawings for new building construction and major renovation projects during design and at construction. CAD drawings of the Electrical/Communications plans shall be provided to IT Services upon release of construction document through the UCD project manager.

2. The project’s technology consultant shall meet with the building’s projected occupants, IT Services Network Services, and IT Services Telecommunications, and other interested parties to determine the telecommunications requirements of the occupants. Compliance with overall campus telecommunications plans will also be validated during these meetings. The technology consultant shall submit all findings to IT Services for review and approval.

3. The preliminary plans, indicating service locations and space requirements, will be returned to project managers for inclusion in the final plans.

B. Consult with UCD IT Services for the following.

1. Acceptability for specific substitutions of specified products.

2. Guidance in the application of a standard or specification in a non-listed or design situation.

3. Approval for deviation from standards and specifications or industry-standard methods and procedures if indicated by special circumstances.

C. Workmanship. All materials and equipment shall be installed in accordance with recommendations of the manufacturer as approved by the architect, to conform to initial design requirements or specification’s and contract documents.

1.4 DEFINITIONS

A. Telecommunications. Any transmission, emission, or reception of signs, signals, writings, images, and sounds, or information of any nature by wire, radio, visual, or other electromagnetic systems. Includes, but is not limited to, voice communications networks, Local Area Networks (LAN), Wide Area Networks (WAN), and Local Exchange Carriers (LEC).

B. Telecommunications Room (TR). A floor serving facility for housing telecommunications equipment, cable terminations, cross-connections, and network electronics. The TR is the recognized transition point between the building backbone and the horizontal pathway facilities.

C. Equipment Room (ER). A campus serving space. An ER houses primary system electronics, power, and media distribution for a campus or groups of buildings. The
Communications Center in Building 500 is an example of a campus serving ER. ERs require extensive planning due to their size, nature, scope, and complexity. ERs are not typically required for most projects.

D. Telecommunications Entrance Facility (TEF). Serves as the entry point into a building for the campus backbone media. TEFs interconnect the building backbone to campus backbone. The TEF is where conductive copper media receives its primary protection from sustained hazardous voltages. Therefore, significant wall space in the TEF may be required for primary protection of copper circuits. Also called the Service Entrance (SE).

E. Telecommunications Main Grounding Busbar (TMGB). The building’s main telecommunications grounding point. The TMGB is busbar placed in the TEF, ER, or a selected TR to provide interconnection to the building’s power ground via a bonding conductor for telecommunications.

F. Telecommunications Grounding Busbar (TGB). A common point of connection for telecommunications systems and equipment for bonding to ground. TGBs are required in all TRs and ERs.

G. Telecommunications Bonding Backbone (TBB). A conductor that electrically interconnects the TMGB to all TGBs.

H. Grounding Equalizer (GE). A conductor used to interconnect two or more vertical TBBs in multistory buildings. Previously called a Telecommunications Bonding Backbone Interconnecting Bonding Conductor (TBBIBC).

I. Network. Backbone media and electronics for transport of electronic information between campus entities.

J. Horizontal Distribution. The facility used for installation of media from the TR to the work area. Usually consists of cable tray and J-hooks to the work area faceplate.

K. Work Area (WA). A building space where the occupant generally interacts with the telecommunications equipment. WAs are typically defined as 100 ft² of usable space.

L. Building backbone. The pathways between floors for distribution of media. Building backbone was previously called riser cabling.

M. Campus backbone. The pathways and media that provide connectivity between the Communication Center in Building 500 and all other buildings on the Anschutz Medical Campus (AMC). The campus backbone provides connectivity between buildings. The campus backbone represents the outside plant (OSP) infrastructure.

N. UCD Information Technology (IT) Services. Department responsible for telecommunications on the University of Colorado at Denver and Health Sciences Center (UCD) campuses.

O. Technology Consultant. A firm or member of a firm that has considerable technology design experience and possesses working knowledge and subject matter expertise in telecommunications code (NEC and NESC), industry standards (see TIA/EIA commercial standards in references), and BICSI methods and procedures (Telecommunications Distribution Methods Manual, LAN Design Manual, and Customer-Owned Outside Plant Design Manual).

1. IT Services maintains a list of pre-screened technology consultants that can be obtained from the UCD project manager via IT Services.
2. Technology consultants used for UCD projects shall be selected from the pre-screened technology consultant list.

3. Technology consultants not listed on the pre-screened technology consultant list must meet with IT Services for certification and possible inclusion on the list. Firms vying for campus technology consultant designation must possess a registered communication distribution designer (RCDD) on staff. The RCDD must be thoroughly familiar with campus standards and methods and procedures and be dedicated to the assigned project. Contact the IT Services Director of Communications (303.724.0440) for possible interview times.

2.1 SPECIFIC DESIGN SPECIFICATION AND CONSTRUCTION REQUIREMENTS

A. Telecommunications Entrance Facility (TEF) or Service Entrance (SE).

1. All buildings require a TEF. The TEF serves as the entry point into a building for the campus backbone media. TEFs interconnect the building backbone to the campus backbone. The TEF shall be solely dedicated to telecommunications services. Space shall not be shared with electrical installations other than those designed and intended for telecommunications. The TEF shall be vertically aligned or stacked with the TRs to facilitate interconnection with the floors above and below. UCD IT Services must be consulted if the TEF does not align with the building’s TRs.

2. TEFs may be co-located inside TRs or ERs, depending on the size of the building they support. Buildings larger than 100,000 ft² may require a dedicated TEF. Buildings with 5 or more stories shall have a shared TR/TEF that is 10’ x 16’. That is, TRs serving as the TEF shall be a minimum of 10’ x 16’. These larger TEFs shall support 5 equipment racks, with one rack being dedicated to fiber optics cable management. TEF ceiling height shall be a minimum of 8’ 6”.

3. The TEF shall be dry and free from the danger of flooding. The TEF shall not be located where water ingress is possible or probable. No water or drain piping shall be routed through the TEF that is not associated with TEF equipment. Steam, heat, and any other source of environmental hazard shall be avoided.

4. TEF location should be carefully considered. Accessibility for the delivery of equipment as well as expansion should be provided for. TR location must also be designed for maximum cable lengths as specified in associated documents listed in References.

5. The TEF location should not be adjacent to any source of electromagnetic interference (EMI). The TEF shall be located away from sources of EMI at a distance which will reduce the interference to 3.0 V/m throughout the deployed frequency range. Interference may not exceed 3.0 V/m throughout the usable bandwidth of the communications cabling. Bandwidth for telecommunications is up to 350 MHz.

6. Typical equipment requirements have a temperature range from 64°F to 75°F (18°C to 24°C) with a desired non-condensing, relative humidity range from 30% to 55%. Humidifiers are not typically required in TEFs. Consult IT Services for TEF cooling requirements.

7. The TEF is where conductive copper media receives its primary protection from sustained hazardous currents. Therefore, significant wall space in the TEF may be required for primary protection of copper circuits. All four TEF walls shall be covered by 3/4” non-combustible A/C plywood mounted 6” above the finished floor (AFF) to...
8’6” AFF. (To see a sample of A/C fire rated plywood, contact Strait Lumber 11150 E. Colfax Avenue, Aurora CO or equivalent lumber supplier 303.366.3561; description: 4x8-23/32” AC Fire Retard Ply PLY34ACNC). The A-side (smooth side) of the sheet shall be outward facing. The A/C plywood shall be securely fastened to the wall.

8. TEF design must conform to vibration requirements specified in TIA/EIA−569.

9. The TEF lighting shall be a minimum of 500-lux (50 foot-candles) measured 1 meter from the finished floor and shall be mounted to meet the design configurations of the room. Emergency lighting is recommended.

10. The TEF door shall be a minimum of 36” wide and 80” high, without doorsill, hinged to open outward, unless restricted by building code, and fitted with a lock compliant with IT Services and Facilities assigned key codes.

11. Floors, walls, and ceiling shall be treated and sealed to eliminate dust. Finish shall be light in color to enhance room lighting. Antistatic flooring materials shall be used.

12. All TEF ceilings shall be a minimum of 8’ 6” high, unobstructed; to provide space over the equipment frames for suspended cable trays or ladder racks. Suspended cable trays and ladder racks are typically installed at 7’ AFF. TEFs shall be free of false or suspended ceilings. Ceiling protrusions (i.e. fire suppression sprinkler heads) must be placed to assure a minimum of 8 feet of clearance from the finished floor.

13. A dedicated electrical panel shall be placed in each TEF to support telecommunications equipment. The panel shall be rated at 100 Amps or higher to facilitate future growth. The panel may not be shared, it is for the exclusive use of the TEF’s equipment. Emergency generator power is required for the TEF, if available in the project. Label the panel per campus standard.

14. A minimum of three (3) dedicated, unswitched 20A, 120-VAC duplex outlets, each on a separate circuit, shall be provided for equipment power at heights and locations specified by IT Services during the design phase. These three dedicated circuits shall be installed from above into the equipment racks as directed by IT Services. Additional convenience duplex outlets, on a separate dedicated unswitched circuit, should be provided at 6’ intervals around the room. Install the convenience receptacles 15” AFF or as directed by IT Services. Label all outlets to the campus standard. Emergency generator power is required for the TEF, if available in the project.

15. Sleeves or slots through walls and floors shall be fitted with approved re-enterable firestopping. Applicable codes, standards, and specifications shall be enforced.

16. Building backbone pathways connecting the TEF to TRs will require a minimum of four Trade Size 4” sleeves/conduits for interconnection, except where cable tray exists. A minimum of two (2) spare conduits must be installed when the TEF is not vertically aligned from floor-to-floor to allow for lower fill ratios.

17. Sprinkler heads shall be provided with wire cages to prevent accidental discharge. Preaction sprinklers are preferred over wet pipe or dry pipe systems. If wet pipe or dry pipe systems are employed, then drainage troughs shall be provided under the sprinkler heads and pipes to prevent leakage onto the TEF equipment. High temperature heads are preferred.

B. Telecommunications Room (TR)
1. A minimum of one TR shall be designated per floor and that TR shall be solely dedicated to telecommunications services. Space shall not be shared with electrical installations other than those designed and intended for telecommunications. TRs shall be vertically stacked to facilitate interconnection with the floors above and below.

2. The TR shall be dry and free from the danger of flooding. The TR shall not be located where water ingress is possible or probable. No water or drain piping shall be routed through the TR that is not associated with TR equipment. Steam, heat, and any other source of environmental hazard shall be avoided.

3. The minimum TR size is 10’ x 12’. Ceiling height shall be a minimum of 8’ 6”. Variations in size shall be approved by IT Services on a case-by-case basis and will be dependent upon the floor size and applications to be served.

4. TRs shall be designed to meet floor loading (minimum floor loading of 50 lbf/ft²) as specified in the references section.

5. TR location should not be adjacent to any source of EMI. The TR shall be located away from sources of EMI at a distance which will reduce the interference to 3.0 V/m throughout the deployed frequency range. Interference may not exceed 3.0 V/m throughout the usable bandwidth of the communications cabling. Telecommunications bandwidth is up to 350 MHz.

6. TRs require a temperature range from 64°F to 75°F (18°C to 24°C). The desired non-condensing, relative humidity range is from 30% to 55%. Humidifiers are not typically required in TRs. Temperature sensors shall be configured for alarm reporting and HVAC support units shall be installed on emergency power. A minimum of one air change per hour is required. Each TR supports 4 racks of equipment, with each rack requiring 5,000 BTUs of cooling. Fan coil units are the required cooling source.

7. All four TR walls shall be covered by 3/4” non-combustible A/C plywood mounted 6” AFF to 8’6” AFE. (To see a sample of A/C fire rated plywood, contact Strait Lumber 11150 E. Colfax Avenue, Aurora CO 303.366.3561; description: 4x8-23/32” AC Fire Retard Ply PLY34/ACNC). The A-side (smooth side) of the sheet shall be outward facing. The plywood shall be securely fastened to the wall.

8. TR design must conform to vibration requirements specified in TIA/EIA−569.

9. The lighting shall be a minimum of 500-lux (50 foot-candles) measured 1 meter from the finished floor and shall be mounted to meet the design configurations of the room. Emergency lighting is desired.

10. The TR door shall be a minimum of 36” wide and 80” high, without doorsill, hinged to open outward, unless restricted by building code, and fitted with a lock compliant with IT Services and Facilities assigned key codes.

11. Floors, walls, and ceiling shall be treated and sealed to eliminate dust. Finish shall be light in color to enhance room lighting. Antistatic flooring materials shall be used.

12. All TR ceilings shall be a minimum of 8' 6" high, unobstructed; to provide space over the equipment frames for suspended cable trays or ladder racks. Suspended cable trays and ladder racks are typically installed at 7’ AFF in TRs. TRs shall be free of false or suspended ceilings. Ceiling protrusions (i.e. fire suppression sprinkler heads) must be placed to assure a minimum of 8 feet of clearance from the finished floor.
13. A dedicated electrical panel shall be placed in each TR to support telecommunications equipment. The panel shall be rated at 100 Amps or higher to facilitate future growth. The panel may not be shared, it is for the exclusive use of the TR’s equipment. Emergency generator power is required for all TRs, if available in the project. Label the panel per campus standard.

14. A minimum of two dedicated, unswitched 20A, 120-VAC duplex outlets, each on a separate circuit, shall be provided for equipment power at heights and locations specified by IT Services. These two dedicated circuits shall be installed from above into the equipment racks as directed by IT Services. These two unswitched circuits shall be homed from the dedicated panel described above. Additional convenience duplex outlets, on a separate dedicated unswitched circuit, should be provided at 6’ intervals around the room. Install the convenience receptacles 15” AFF or as directed by IT Services. Label all outlets to the campus standard. Emergency generator power is required for each TR, if available in the project.

15. Sleeves or slots through walls and floors shall be fitted with approved re-enterable firestopping. Applicable codes, standards, and specifications shall be enforced.

16. Building backbone pathways connecting TR’s will require a minimum of four (4) Trade Size 4” sleeves/conduits for interconnection, except where cable tray exists. A minimum of two (2) spare conduits must be installed when TR’s are not vertically aligned from floor-to-floor to allow for lower fill ratios.

17. Sprinkler heads shall be provided with wire cages to prevent accidental operation. Preaction sprinklers are preferred over wet pipe or dry pipe systems. If wet pipe or dry pipe systems are employed, then drainage troughs shall be provided under the sprinkler heads and pipes to prevent leakage onto the TR equipment. High temperature heads are preferred.

C. Pathways

1. Cable Tray.

   a. Ventilated, solid-sided continuous aluminum cable tray shall be used to provide horizontal pathways for station wiring. Where cable tray is not possible (in renovation projects only), alternative pathways shall be provided, as approved by IT Services. In these cases, cables must be supported every 48” to 60”.

   b. IT Services requires 18” or 24” cable tray (6” deep, with 9” rung spacing) in main corridors, with secondary runs supported by 12” or 18” cable tray (4” or 6” deep, with 9” rung spacing) as specified by IT Services. The actual cable tray size depends upon the floor’s requirements. The cable tray shall be continuous from end-to-end.

   c. Cable tray shall be supported and loaded in compliance with applicable electrical codes.

   d. A minimum of 12” access headroom shall be provided and maintained above the cable tray. Access to cable tray should not be restricted.

   e. A minimum of 3” of clear, vertical space shall be available above ceiling tiles.

   f. Cable tray shall not be installed higher than 11 feet AFF.
g. Cable tray shall use factory T’s, sweeps, and interconnections. The cable tray shall be continuous, without gaps, opening, or breaches.

h. Cable tray shall be unbroken and suitably firestopped with re-enterable firestopping when passing through a firewall. Trade Size 4” sleeves shall be required for connection of cable tray through walls. Approved mechanical firestopping may be substituted for approved nonmechanical firestopping. UCD IT Services approves all firestopping substitutions.

i. Cable tray shall be grounded and bonded to the TBB with a 6 AWG uninsulated conductor. Bond every longitudinal cable tray component.

j. Cable tray may be shared with all low voltage systems, as coordinated with IT Services.

2. J-hooks and conduit.

   a. A 2” minimum reamed and bushed conduit shall be provided from the cable tray to each room. This entrance sleeve shall be shared by all low voltage systems entering the room. A larger sleeve, as specified by IT Services, may be required depending upon the room’s size and low voltage requirements.

   b. A 1” conduit shall be used to provide a pathway inside the wall to each work area outlet. The conduit shall be stubbed out to the top of the wall and be physically oriented towards the floor’s cable tray. The conduit end shall be reamed and bushed.

   c. From the stubbed work area conduit, J-hooks shall be provided and installed by the cable installer to provide a pathway to the cable tray.

      1. The minimum J-hook size is 2”.

      2. J-hooks are required every 48” to 60” along the pathway.

      3. Individual J-hooks may support no more than 50 cables.

      4. J-hooks shall not be shared with other low voltage systems. That is, all other low voltage systems require their own J-hook pathway. J-hook support rods may be shared at pathway crossings or where approved by IT Services before hand.

         a. When J-hook support rods are shared at crossings or at IT Services approved locations, a minimum clearance of 12” is needed between low voltage J-hooks and telecommunications J-hooks.

         b. Telecommunications J-hooks shall be placed at the bottom of any shared support rod to facilitate frequent moves, adds, and changes.

      5. Telecommunications J-hook wire supports shall be distinguished by their blue color.

      6. J-hook wire supports shall be secured at both ends as per NEC 300.11.

   d. If due to obstructions, limited access ceilings, or in clinical areas, conduit may be used in lieu of J-hooks. All conduit runs shall be coordinated with and approved by IT Services.
1. No section of conduit shall be more than 100' in length or contain more than two 90° bends between pull boxes or pull points.

2. Boxes shall not be used in lieu of bends. Electrical 90° elbows (type LB) are not permitted. Corresponding conduit ends must be aligned within boxes.

3. All conduit ends shall be reamed and bushed.

4. Conduit shall comply with NEC and local codes, standards, and specifications. IT Services may stipulate additional specifications as required.

5. The bend radius for < 2” conduits should be 6 times the internal diameter of the conduit. Conduits over 2” OD shall have a bend radius at least 10 times the internal diameter of the conduit. Wide sweeps shall be used for all conduits over 2”.

6. Polyline pull strings with a strength rating of 200 pounds shall be provided for all conduit runs.

3. Work area outlets. A work area telecommunications outlet shall be a four-plex, deep box with a single-gang mud ring unless otherwise specified during design.

4. Building backbone. Building backbone (riser) conduits shall be Trade Size 4” conduit, minimum. Measured pulling tape shall be provided in all horizontal or vertical building backbone conduits.

D. Telecommunications Grounding and Bonding

1. The TEF, TRs, and ERs require grounding and bonding. IT Services does NOT require an isolated grounding system for its voice and data networks.

2. Each building shall have one Telecommunications Main Grounding Busbar (TMGB), which is bonded to the building’s electrical service entrance and is electrically contiguous to the Grounding Electrode Conductor (GEC). The TGMB is usually located in a TEF, ER, or in an IT Services specified TR.

3. Each TR shall have at least one Telecommunications Grounding Busbar (TGB), which is connected back to the TMGB via the Telecommunications Bonding Backbone (TBB).

4. The minimum TBB conductor size is 6 AWG, but consideration shall be given to using 3/0 AWG conductor, as per the J-STD-607-A TBB sizing table shown below.

<table>
<thead>
<tr>
<th>TBB Linear Length (Feet)</th>
<th>TBB Size (AWG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 4</td>
<td>6</td>
</tr>
<tr>
<td>4 to 6</td>
<td>4</td>
</tr>
<tr>
<td>6 to 8</td>
<td>3</td>
</tr>
<tr>
<td>8 to 10</td>
<td>2</td>
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<tr>
<td>10 to 13</td>
<td>1</td>
</tr>
<tr>
<td>13 to 16</td>
<td>1/0</td>
</tr>
<tr>
<td>16 to 20</td>
<td>2/0</td>
</tr>
<tr>
<td>Greater than 20</td>
<td>3/0</td>
</tr>
</tbody>
</table>
5. A TBB may be an insulated conductor. Each telecommunications bonding conductor (from equipment) shall be a 6 AWG insulated conductor, with distinctively green colored insulation. The TBB used to bond cable tray shall be uninsulated, 6 AWG minimum.

6. Whenever two or more vertical TBBs are used in a multistory building, the TBBs shall be bonded together with a Grounding Equalizer (GE) at the building’s top floor and at a minimum of every third floor in between.

7. The TBB, GE, TMGB, and TGB shall be marked with nonmetallic labels, as specified by IT Services.

E. Equipment Room (ER):

1. ERs are not required for most buildings; contact IT Services for need and placement.

2. Generally, each campus requires a minimum of one ER. Buildings may require an ER if they are located at some significant distance from the Communications Center in Building 500. The IT Services department will specify when an ER is required. ERs shall be exclusively dedicated to telecommunications services. ER space must not be shared with electrical services other than those designed and intended for telecommunications. The ER should be centrally located to minimize the size and length of backbone cabling as well as provide easements and pathways for backbone and carrier services required of the room. The room shall not be adjacent to any high-voltage electrical services or water mains. A location should also be selected to allow for movement of large or heavy equipment. Access to cable pathways are required. ER walls should extend to structure and provide a sealed environment for equipment.

3. The ER may also serve as the TEF facility for local exchange carriers (LEC) or competitive local exchange carrier (CLEC) where such a separate facility does not exist. Adjacency to existing carrier entrance facilities is required.

4. Sizing of ER will be calculated using area of service, types of service provided, and projections of growth. IT Services design engineers will provide space requirements based on these factors. The minimum size of an ER is 150 ft². Working clearances of 3 feet must be provided for all scheduled and installed equipment.

5. ERs may require access (raised) flooring to allow for the cable routing from cable vaults to equipment frames and PBX equipment. Cable tray, or equivalent, must be provided for cable management under the raised floor. Finished floor height must be at least 12” from the sub-floor to accommodate the cable management systems. The plenum area may be used for air handling for equipment cooling. All metal parts of the raised floor must be bonded to ground. Floor panels must be covered with high-pressure laminate or a durable, vinyl tile resistant to static electricity.

6. Floor loading capacity shall be sufficient to bear both the distributed and concentrated load of the installed equipment. The ER distributed loading shall be at least 100 lbf/ft² and the concentrated loading must be at least 2000 lbf. Distributed floor loading may range as high as 250 lbf/ft².

7. ER design must conform to vibration requirements specified in TIA/EIA−569.

8. The ER shall be dry and free from the danger of flooding. The ER must not be located where water ingress is possible or probable. No water or drain piping shall be routed through the ER that is not associated with ER equipment. Steam, heat, and any other source of environmental hazard shall be avoided.
9. The floors, walls, and ceilings shall be treated and sealed to eliminate dust.

10. All four walls in the ER shall be covered by 3/4" non-combustible A/C plywood mounted 6" AFF to 8’6” AFF. (To see a sample of A/C fire rated plywood, contact Strait Lumber 11150 E. Colfax Avenue, Aurora CO 303.366.3561; description: 4x8-23/32” AC Fire Retard Ply PLY34ACNC). The A-side (smooth side) of the sheet shall be outward facing. The A/C plywood shall be securely fastened to the wall.

11. ER location should not be adjacent to any source of EMI. Interference may not exceed 3.0 V/m throughout the usable bandwidth of the communications cabling. Sources of EMI should be kept 3 meters from the ER. Bandwidth for telecommunications is currently 350 MHz.

12. ER doors shall be a minimum of 36” wide by 80” high. Due to the nature of the equipment located in the ER, ERs require at least one oversized door (72” by 90”) to allow large equipment to be moved in or out. Doors should open outward if permitted by building code or be removable. ER doors shall be secured with either electronic access or a lockset specified by UCD Facilities.

13. ER ceilings shall be a minimum of 8’6” high, unobstructed; to provide space over the equipment frames for suspended cable trays or racks. ERs shall be free of false or suspended ceilings. Ceiling protrusions (i.e. fire suppression) must be placed to assure a minimum of 8 feet of clearance from the finished floor.

14. ERs require lighting with a uniform intensity of 500 lux (50 foot candles) when measured 1 meter above the finished floor. Indirect lighting is not recommended. Connect lighting fixtures for ERs to separate electrical circuits from those that accommodate the equipment in the room. To avoid blocking or filtering the light, do not place lighting equipment above equipment cabinets, termination frames, or other freestanding equipment. Use a light colored finish to enhance room lighting. Provide emergency lighting in ERs.

15. Specific circuits for equipment in ERs will be designated during the space planning process and shall be placed according to IT Services approved blueprints. In addition to those circuits, additional electrical outlets are required in all ERs. All such electrical outlets shall be grounded, non-switched, and separately fused. ERs require one 120-VAC, 20-amp duplex receptacle per every 6 linear feet of wall space. Emergency generator power is required for ERs.

16. ERs typically house the building’s TMGB, which is connected to the building’s electrical entrance facility by the bonding conductor for telecommunications. An ER shall be equipped with a copper TMGB that is a minimum of 24” long, 4” wide, and ¼” thick. The TMGB shall be bonded to building structural steel, the entrance facility, and electrical service grounds with a minimum 6 AWG stranded copper. The TMGB shall be drilled and tapped to accept standard NEMA compliant grounding hardware. Equipment grounds shall use a minimum 6 AWG stranded, insulated copper to the TMGB and be attached with standard NEMA compliant grounding hardware. All TGBs will be bonded to the TMGB with TBBs that are a minimum 6 AWG insulated, stranded copper, with consideration given to using a 3/0 AWG conductor. Refer to J-STD-607-A and NEC Article 250.

17. Temperature and moisture shall be controlled in all ERs. Typical equipment requirements are:

   a. Temperature range from 64°F to 75°F (18°C to 24°C);
b. Relative humidity range from 30% to 55%; humidifiers are required in ERs;

c. Heat dissipation of 5,000 BTUs per hour per cabinet.

Temperature sensors shall be configured for alarm reporting and HVAC support units shall be installed on emergency power. Consult IT Services for ER cooling requirements.

18. When cable services for any ER exceeds 1800 pairs, provide a separate room (cable vault) for cable splices. This room should be sized according to the requirements of the facility and should be located adjacent to the ER with free pathways to terminating equipment and cross-connect fields.

19. FM-200 fire suppression agent, or equivalent, is the preferred fire suppression agent in ERs. The ER should be free of automatic fire sprinklers, unless specifically required by building code. In such instances, the sprinklers should be a preaction system, not a wet pipe or dry pipe system. Additionally, such sprinkler systems must have troughs to prevent accidental water damage to the equipment.

20. Fire stops (area around sleeves, drilled core floor openings, and cables) shall be sealed or plugged with an 8-to-1 ratio expandable urethane foam with a 1” thick topping of water plug cement or equivalent. All unused sleeves must be plugged and capped with approved firestop.

END OF SECTION
SECTION 16780

AUDIO-VISUAL OR TELEVISION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section provides minimum standards for audio/visual and television systems.

1.2 REFERENCES

A. Section 16010 - Basic Electrical Requirements
B. Section 16195 - Electrical Identification
C. Section 16740 - Telecommunications Voice and Data Systems
D. Applicable Codes and Standards:

1. The following codes and recommended standards are applicable to the provisioning of audio/visual and television services for the UCD. They are incorporated by reference.
   a. NEC (National Electric Code), as revised
   b. EIA/TIA RS 568 (Commercial Building Wiring Standard)

2. Variations from NEC requirements will not be allowed or permitted.

3. Variations from the standard requirements of EIA/TIA RS 568 above, may be allowed, but will be negotiated on a case-by-case basis.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. General:

1. The UCD Office of Educational Support Services has been assigned responsibility for providing audio/visual and television services to the UCD entities. This includes a video, audio, and control wiring distribution system within and between buildings as relates to audio/visual and television. This includes determining suitability of proposed uses, compliance with appropriate codes and standards, periodic removal and/or replacement of components and extensions or additions to distribution system.

2. The Educational Support Services Office will work with all the UCD entities to assist in the design of classrooms, lecture halls, or conference rooms as needed at the UCD and shall be consulted during the project design through the UCD Project Manager.

B. Procedures:

1. To facilitate provisioning of audio/visual and television service to the UCD entities, Facilities Projects will provide Educational Support Services Office with preliminary floor plan drawings for new building construction and/or major remodel projects.
2. Educational Support Services staff members will meet with new building occupants and other interested parties to determine audio/visual and television needs or requirements.

3. The preliminary plans, marked to show service locations and space requirements, will be returned to Facilities Planning for inclusion in final plans.

C. Classrooms:

1. Each classroom is to be connected to the main TV/video distribution center via 2 coax cables, 3 audio cables, and 2 fiber-optic cables.

2. Each classroom shall also have at the front of the room a RJ-11/RJ-45 type/telephone/data jack with a patchable analog phone line (from fiber room), a network “B” connection, and a patchable T-1 line (from fiber room). These lines must be installed by or under the direction and control of UCD IS.

3. Each classroom will have televisions installed with a ratio of 1 per 15 students. Televisions shall be hung from ceiling and elevated as high as possible to avoid becoming “head-bangers.” If this is not possible, alternatives must be agreed upon with Office of Educational Support Services.

4. Locate 110-volt duplex outlet and cable TV outlet at each TV location 90 inches above floor (or just below ceiling level).

5. Switch all TV outlets in a single room from a common switch convenient to the front of the room, labeled “TV.”

6. Junction boxes and conduit from the front to the rear of the room shall be provided to allow front control of projectors located in the rear of the room.

7. Classrooms shall have a mechanical or motorized projection screen for films, slides, or video projection. Bottom of screen shall be 4 feet above the floor when screen is extended.

8. Where multiple banks of lights exist, switching off lights in front section during some teaching conditions is very desirable.

9. Sound amplification systems shall be built into larger classrooms. The minimum number of inputs shall be 4 microphone (low level), 1 auxiliary input, and 1 600-ohm line input. The sound system must include a minimum of 1 600-ohm line output.

10. Electrical outlets shall be provided for audio/visual equipment as needed.

D. Lecture Halls:

1. Lecture halls/auditoriums shall have a control booth/room which will allow sound, light, and TV projector control from a podium. Lighting in the control booth/room shall be incandescent and on a dimmer switch. Height from floor to the top of the projection shelf shall not exceed 42 inches.

2. Each lecture hall/auditorium control room/booth is to be connected to the main TV/video distribution center via 3 coax cables, 5 audio cables, and 2 fiber-optic cables.
3. Each lecture hall/auditorium shall also have at the front of the room a RJ-11/RJ-45 type/telephone/data jack with a patchable analog phone line (from fiber room), a network “B” connection, and a patchable T-1 line (from fiber room). These lines must be installed by or under the direction and control of UCD IS.

2. Each lecture hall/auditorium shall have a motorized project screen(s) for films, slides or video projection. Bottom of screen(s) shall be 4 feet above the floor when screen(s) is extended.

3. Each lecture hall/auditorium shall have a video projector ceiling mount/lift installed for a video/data projector at the ceiling within the proper projection distance from the screen. There shall be a conduit from the video projector to the control booth/room of sufficient diameter to hold 1 video coax cable, 1 R, G, B, and sync cable, 1 SVHS cable, and 1 2-conductor shielded control cable.


7. Each lecture hall/auditorium shall have a minimum of one podium location in front.

8. Junction boxes and conduit from the podium location at the front of the room shall be provided to the control room/booth to allow control of projectors, lights, and sound systems.

9. Where multiple banks of lights exist, switching off lights in front section during some teaching conditions is very desirable.

10. Sound amplification systems shall be built into lecture halls/auditoriums. The minimum number of inputs shall be 4 microphones (low level), 1 auxiliary input, and 1600-ohm input. The sound system must include a minimum of 1600-ohm line output.

11. Electrical outlets shall be provided for audio/visual equipment as needed.

1.4 DEFINITIONS

1.5 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Section 16010 including the following:

1. Data and cut sheets for equipment.

1.6 QUALITY ASSURANCE

A. Specified equipment shall be provided and installed in accordance with the requirements of Section 16010.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Specified equipment shall be delivered, stored and handled in accordance with the requirements of Section 16010.

1.8 WARRANTY
A. Specified equipment warranties shall be provided in accordance with the requirements of Section 16010.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements provide products by the following:

1. Cables:
   a. Video Coax: (Conduit) 8281A Belden, or equal (Plenum) 88281 Belden, or equal
   b. Audio: (Conduit) 8762 Belden, or equal (Plenum) 88761 Belden, or equal
   c. Speaker Cable: 9717 Belden or equal
   d. RGB Coax Cables: 308-319-1167A Anixter 1167B Belden V4-3C Canare
   e. (a,b,c) Equivalent: Anixter Carol Manhattan Chester
   f. AT&T 62.5/125 micron, FDDI, grade fiber terminated in ST connectors

2.2 MATERIALS, GENERAL

PART 3 - EXECUTION

3.1 EXAMINATION

3.2 INSTALLATION, GENERAL

A. Fiber runs must be hard patched to TV studio/distribution or home runned.

B. All cables, except fiber and Telco, will be terminated by TV/video personnel or their designee.

3.3 TESTING, CLEANING, AND CERTIFICATION

A. Refer to Section 16010 for testing, cleaning, and certification requirements.

3.4 COMMISSIONING (DEMONSTRATION)

3.5 SCHEDULES

END OF SECTION
Large Lecture Hall

White Board

Projector (power and data in ceiling)

Floor Box

Rear Wall (rack)

Access Box
- 2-3/4" from Speakers
- 1-3/4" from Screen LVC
- 1-3/4" from Shade LVC
- 2-1" from PZT
- 2-2" from Rack
- 2-2" from Floor Box
- 1-2" to Cable Tray

SC Box Above Rack
- 2-2" from Access Box
- 4-1 1/2" from Seats
- 1-2" from Cable Tray
75 Seat Distance Learning Lecture Hall

Projector (power and data in ceiling)  5 PZT Cameras

Floor Box  Rear Wall

Access Box
1-3/4” from Screen LVC
1-3/4” from Shade(s) LVC
1-2” from SC Box
1-2” to Cable Tray

Stubbed To Control Room
3-1” from PZT
2-1 1/2” from FD
2-2” from Floor Box
2-3/4” from Speakers

SC Box Above Rack In Control Room
1-2” from Control Room
Console Junction Box
4-1 1/2” from Seats
1-2” from Access Box

Note: Device LV connection needs pathway to access box, if device also has wall mounted control, place in control room.
MPC

White Board

Projector (power and data in ceiling)

Rear Wall
SGL

Note: Boxes Centered On West Wall