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SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. The intent of Division 16 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 16 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. The Division 16 Specifications and the accompanying Drawings are complementary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.
- C. Imperative language is frequently used in Division 16 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.
- D. Provide complete ground systems as specified herein and shown on the Drawings. Maintain ground continuity with: conduit system, transformer housings, switchboard frame and neutral bus, motors, and miscellaneous grounds required.
- E. Clearly and properly identify the complete electrical system to indicate the loads served or the function of each item of equipment connected under this work.

1.2 RELATED WORK:

- A. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and Specifications.
 - 2. Public Ordinances, Permits.
 - 3. Payments and fees required by governing authorities for work included in this Division.
 - 4. Change Orders.
- B. Division 1, General Requirements apply to this Division.
- C. All Sections of Division 16, Electrical Specifications, are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any Section of Division 16.
- D. Where specified materials or methods exceed minimum standards allowed by applicable codes, the more stringent requirement shall apply.

1.3 APPLICABLE PUBLICATIONS:

- A. The latest adopted revisions of the publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
 - 1. International Building Code (IBC).
 - 2. National Electrical Code (NEC).
 - 3. National Fire Protection Association (NFPA).
 - 4. National Electrical Manufacturers Association (NEMA).
 - 5. National Electrical Contractors Association (NECA).
 - 6. American National Standards Institute (ANSI).
 - 7. Institute of Electrical and Electronic Engineers (IEEE).
 - 8. Underwriters Laboratories (UL).

1.4 SITE VISITATION:

- A. The Contractor shall visit the site prior to bidding and become familiar with existing conditions and all other factors that may affect the execution of the work. Include all related costs in the initial bid proposal.

1.5 COORDINATION OF WORK:

- A. Conduct work in a manner to cooperate with all other trades for proper installation of all items of equipment. Consult the Drawings of all other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, etc. In general, the architectural drawings govern but conflicts shall be resolved with the Architect prior to rough-in.
- B. Verify the physical dimension of each item of electrical equipment to fit the available space. Coordination of the equipment to fit into the available space and the access routes through the construction shall be the Contractor's responsibility.
- C. Prepare detailed layout drawings for panel layouts in electric rooms or closets, utilizing dimensioned shop drawing data of equipment to be furnished. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination. Submit layout drawings for approval prior to commencing field installation and shall be included with shop drawings.
- D. Coordinate rough-in and wiring requirements for all equipment provided under other divisions of the work and requiring electrical connections with equipment supplier and installer. Make installation and connections in accordance with rough-in and wiring diagrams provided for Contractor's use. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components. Doors and access panels shall be kept clear.
- E. Coordinate all aspects of maintaining operational systems status of the electrical, telephone, and other utility services with the appropriate serving utility. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment not covered in the Drawings or Specifications which are a result of policies of the serving utility.

- F. Coordinate underground work with other contractors working on the site. Particular coordination shall be performed with contractors installing storm sewer, sanitary sewer, gas, water and irrigation lines to avoid conflicts. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

1.6 WARRANTY:

- A. Provide a written warranty covering the work done under this Division as required by the General Conditions. Incandescent lamps will be excluded from this warranty.
- B. Apparatus:
 - 1. Free of defects of material and workmanship and in accord with the Contract Documents.
 - 2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
 - 3. Operate at full capacity without objectionable noise or vibration.
- C. Systems: Any system damage caused by failures of any system component shall be included.

1.7 ELECTRICAL DRAWINGS:

- A. The Drawings that accompany the Division 16 Specifications are diagrammatic. They do not show all offsets, fittings, or accessories that may be required to install work in the space provided and avoid conflicts. Follow the Drawing as closely as is practical and install additional bends, offsets, fittings, and accessories where required by local conditions from measurements taken at the jobsite. The right is reserved to make minor field order changes in outlet location prior to roughing-in without additional cost to the Owner.
- B. Upper case letters adjacent to devices or luminaires indicate switching arrangement or circuit grouping. Numbers adjacent to devices indicate circuit connection.
- C. The intent of the branch circuiting and switching shown shall not be changed nor homeruns combined without the approval of the Architect. Feeder runs are not to be combined or changed.
- D. Where shown, cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors unless otherwise noted. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated. Include ground, travelers and switchlegs as required by the circuiting arrangement.
- E. Where MC cable is used, provide cable configurations to accomplish the circuiting indicated.

1.8 SUBMITTALS:

- A. Coordinate with the requirements of Section 01300.
- B. Submit five copies of electrical shop drawings and equipment data in expandable folders equal to Smead No. 1524E within 45 days from notice to proceed. Each submitted section

shall include data on all equipment requiring submittals for that section. Include in each folder a complete index for all Sections and materials requiring submittals.

- C. Include manufacturer's detailed specifications and data sheets to fully describe equipment furnished. Assure that all deviations from the Drawings and Specifications are specifically noted in the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.
- D. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations. If discrepancies between the materials or equipment submitted and the Contract Documents are discovered either prior to or after the data is processed, the Contract Documents will govern.
- E. Engineer's review is for general conformance with the design concept of the project and the information given in the construction documents. The contractor is solely responsible for, and this review does not include: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating the work with that of other trades and performing all work in safe and satisfactory manner. Corrections or comments made on the submittal during review do not relieve the contractor from compliance with the requirements of the construction documents or with its responsibilities listed herein.
- F. The Installation Drawings called for under submittals shall show all outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described. Prints of these drawings shall be submitted prior to starting installation. The Contractor submitted drawings will then form the basis for installation.
- G. Record in-progress drawings shall be kept up to date as the work progresses showing all changes, deviations, addendum items, change orders, corrections, or other variations from the Contract Drawings.
- H. The marked up drawings shall be kept at the jobsite and available for the Architect's review. At the completion of the work, all deviations from the installation drawings shall be incorporated on the reproduces to indicate "as-built" conditions. The drawings shall then be submitted to the Architect as Record Drawings for the system.

1.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS:

- A. Coordinate with the requirements of Section 01730.
- B. Prior to the date of Substantial Completion, prepare detailed operating and maintenance manuals for equipment and systems installed. Operating and Maintenance Manuals will be used for training of and use by the Owner's personnel in the operation and maintenance of the systems.
- C. Format of the manuals shall be based on a separate manual or chapter for each class of system as follows:
 - 1. Secondary distribution system.
 - 2. Emergency power system (if provided).

3. Fire alarm system.
 4. Lighting systems, including lamps.
 5. Lighting control system, interior and exterior.
 6. Security/Access control.
- D. Content of each manual or chapter shall include but shall not be limited to the following:
1. Description of system.
 2. Operating Sequence and Procedures:
 - a. Step-by-step procedure for system start-up, including a pre-start checklist. Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
 - b. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).
 - c. Emergency Operation: If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions. Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.
 - d. Shutdown Procedure: Include instructions for stopping and securing the equipment after operation. If a particular sequence is required, give step-by-step instructions in that order.
 3. Preventive Maintenance:
 - a. Provide a schedule for preventive maintenance. State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.
 - b. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
 - c. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
 - d. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.
 4. Manufacturers' Brochures: Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists. Manufacturers' standard brochures shall be edited so that the information applying to the ACTUAL installed equipment is clearly defined.
- E. Submit two draft copies of the complete operating and maintenance manual for review to the Architect for approval.
- F. Submit three copies of the final operating and maintenance manuals bound in 3-ring binders with tabs and index at least five days prior to the inspection for Substantial Completion.

1.10 CONTRACT COST DATA:

- A. Furnish to the Architect a cost breakdown of the Electrical Work.

- B. The cost breakdown shall include separate amounts for material, labor and mark-up for each CSI specification section included (i.e., 16100, 16200, 16300). Include cost data with the shop drawings submittal.

1.11 CHANGE ORDERS:

- A. All supplemental cost proposals by the Contractor shall be accompanied with a complete itemized breakdown of labor and materials without exception. At the Architect's request, Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Electrical products installed in this project shall be listed by a recognized testing laboratory or approved in writing by the local inspection authority as required by governing codes and ordinances.
- B. Materials shall be new, of the best quality, and American made. The materials shall be manufactured in accordance with NEMA, ANSI, U.L. or other applicable standards.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Provide a complete properly operating system for each item of equipment called for under this work. Installations shall be in accord with the equipment manufacturer's instructions, the best industry practices and the contract documents. Where a conflict in these guides appear, the Architect shall be requested to provide proper clarification before work is roughed in and the Architect's decision will be final. Work installed without such clarification shall be removed and corrected by the Contractor at no cost to the Owner.
- B. Make installation in a neat, finished, and safe manner according to the latest published NECA Standard of Installation under competent supervision.
- C. Install intumescent material around ducts, conduits, etc., to prevent spread of smoke or fire where installed in sleeves or block-outs penetrating rated fire barriers. The penetration sealing system must be capable of passing a 3-hour test per ASTM E-814 (UL 1479) and must consist of a material capable of expanding nominally eight times when exposed to temperatures of 250-350°F. An alternate method utilizing intumescent materials in caulk and/or putty form may be used.

3.2 NOISE CONTROL:

- A. Outlet boxes at opposite sides of partitions shall not be placed back to back nor straight through boxes be employed, except where specifically permitted on the Drawings by note to minimize transmission of noise between occupied spaces.
- B. Conduit shall be routed along corridors or other “noncritical” space to minimize penetrations through sound rated walls. All penetrations through sound rated partitions shall be grouted solid and airtight. Conduit and its associated attachment shall not rigidly connect (i.e., bridge) independent wall structures. Flexible connections or attachments are required.
- C. Contactors, transformers, starters, and similar noise producing devices shall not be placed on walls which are common to occupied spaces unless specifically called for on the Drawings. Where such devices must be mounted on walls common to occupied spaces, they shall be shock mounted or isolated in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.
- D. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

3.3 EQUIPMENT CONNECTIONS:

- A. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices, and labor necessary for a finished working installation.
- B. Verify the location and method for connecting to each item of equipment prior to roughing-in. Check the voltage and phase of each item of equipment before connecting.
- C. Make motor connections for the proper direction of rotation. Minimum size flex for mechanical equipment shall be 1/2 inch except at small control devices where 3/8-inch flex may be used. Exposed motor wiring shall be PVC jacketed metallic flex with 6 inches minimum slack loop. Pump motors shall not be test run until liquid is in the system.
- D. Control devices and wiring relating to the HVAC systems will be furnished and installed under Division 15 except for provisions or items specifically noted on the electrical Drawings or specified herein.

3.4 EQUIPMENT SUPPORT:

- A. Each fastening device and support for electrical equipment, luminaires, panels, outlets, and cabinets shall be capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.
- B. Properly and adequately support luminaires installed under this work from the building structure. Seismic restraint and “fall out” limiting supports are required. Supports shall provide proper alignment and leveling of luminaires. Flexible connections where permitted

- to exposed luminaires shall be neat and straight, without excess slack, attached to the support device.
- C. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.
 - D. Conduits:
 - 1. Support suspended conduits 1 inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of 4. Conduits smaller than 1 inch, installed in ceiling cavities, may be supported on the new mechanical system supports when available space and support capacity has been coordinated.
 - 2. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.
 - 3. Expansion anchors set into existing concrete and not conflicting with structural integrity will be used as required.
 - E. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

3.5 ALIGNMENT:

- A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines. Switchgear panels and all electrical enclosures shall fit neatly without gaps, openings, or distortion. Properly and neatly close all unused openings with approved devices.
- B. Fit surface panels, devices, and outlets with neat, appropriate trims, plates, or covers without overhanging edges, protruding corners, or raw edges to leave a finished appearance.

3.6 CUTTING AND PATCHING:

- A. Include cutting, patching and restoration of finishes necessary for this work. Surfaces damaged by this work and spaces around conduits passing through floors and walls shall be neatly patched and finished to match the adjacent construction including painting or other finishes. Clean up and remove all dirt and debris. This work shall all be performed to the satisfaction of the Architect.
- B. Where equipment installations or connections require the installation of an access panel, arrange with General Contractor to provide a properly sized and installed access panel similar to those used for mechanical equipment access.

3.7 PROTECTION OF WORK:

- A. Protect all electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.

- B. Switchgear, transformers, panels, luminaires, and all electrical equipment shall be kept covered or closed to exclude dust, dirt, and splashes of plaster, cement, or paint and shall be free of all such contamination before acceptance. Enclosures and trims shall be in new condition, free of rust, scratches, and other finish defects. Properly refinish in a manner acceptable to the Architect, if damaged.

3.8 MAINTENANCE OF SERVICE:

- A. Electrical service shall be maintained to all functioning portions of the building throughout construction, except as noted below, during all normal working hours of the building occupants. Outages to occupied areas shall be kept to a minimum and be pre-arranged with the Architect or Owner's Representative. This Contractor will be liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times.
- B. Signal and communication systems and equipment shall be kept in operation wherever these serve occupied or functional portions of the building. Outages of these facilities shall be treated the same as electrical power outages.
- C. Telephone services where required during the construction work will be maintained by the Owner's communications personnel. This work shall be coordinated with the Owner's Representative and Architect in such a manner that service, as required by the building occupants, can be readily installed and maintained.
- D. Include all costs for temporary facilities, overtime labor and necessary provisions to maintain electrical services in the initial bid proposal. Temporary wiring and facilities, if used, shall be removed and the site left clean before final acceptance.

3.9 DEMOLITION AND SALVAGE:

- A. Remove or relocate all electrical wiring, equipment, luminaires, etc., as may be encountered in removed or remodeled areas in the existing construction affected by this work. Disconnect electrical service to hard wired equipment scheduled for removal under other Divisions of Work. Wiring which serves usable existing outlets shall be restored and routed clear of the construction or demolition. Safely cut off and terminate all wiring to be abandoned and remove to leave site clean.
- B. Existing concealed conduits in good condition may be reused for installation of new wiring where available. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, provided that the installation meets all workmanship requirements of the Specifications. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, all existing wires shall be replaced with new.
- C. Removed materials not scheduled for reuse shall become the property of the Contractor for removal from the site, except for those items specifically indicated on the Demolition Drawings for salvage or reuse. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.

3.10 COMPLETION AND TESTING:

- A. Upon completion, systems shall be tested to show the equipment installed operates as designed and specified, free of faults and unintentional grounds. The system tests shall be set up for as many at one time as possible to work into construction phasing. Tests shall be done in the presence of the Architect or his representative, and shall be scheduled 48 hours in advance.
- B. A journeyman electrician with required tools shall be available to conduct all tests, with or without the equipment factory representative present.
- C. Systems shall include, but not be limited to the following systems:
 - 1. Fire alarm
 - 2. Lighting control systems
 - 3. Emergency egress lighting
- D. A written record of performance tests shall be compiled, dated, witnessed, and submitted along with operating and maintenance data to the Architect prior to final acceptance.

END OF SECTION

SECTION 16110
CONDUITS, RACEWAYS, BOXES, FITTINGS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide raceways and conduits of specified types for all electrical systems wiring, except where clearly shown or specified otherwise. All fittings, boxes, hangers and appurtenances shall be included.
- B. Size raceways and conduits as indicated on the Drawings. Where no size is indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THWN insulation.

PART 2 - PRODUCTS

2.1 METALLIC CONDUITS:

- A. Galvanized Rigid Conduit (GRC): Smooth surfaced heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process. GRC shall comply with NEC Article 346.
- B. Electrical Metallic Tubing (EMT): Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior. EMT shall comply with NEC Article 348.
- C. Flexible Conduits (Flex):
 - 1. Flexible Metallic Conduit: Interlocking single strip steel construction, galvanized inside and out after fabrication. Flex shall comply with NEC Article 350.
 - 2. Liquid Tight: Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core, and shall comply with NEC Article 351.
- D. Type MC Cable with copper, #12 THWN conductors and copper #12 THWN ground may be used in interior spaces, concealed and protected from occupant contact.

2.2 WIREWAYS:

- A. Troughs: Steel, painted, square in cross section, preformed knock-outs on standard spacing, screw cover.
- B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.3 FITTINGS:

- A. GRC:
 - 1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4 and 12 enclosures.
 - 2. Threaded Bushings: 1 1/4 inch and larger, insulated, grounding type as required under Section 16450.
 - 3. Threaded Couplings: Standard threaded of the same material and as furnished with conduit supplied. Erickson type couplings may be used where required to complete conduit runs larger than 1 inch.
- B. EMT:
 - 1. Connectors: Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used. Use lay-in grounding type bushings where terminating grounding conductors.
 - 2. Couplings: Steel compression ring or steel set screw type, concrete tight.
- C. Threadless: GRC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1 inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.
- D. Weatherproof Connectors: Threaded.

2.4 METALLIC BOXES:

- A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equal.
- B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.
- C. Large Boxes: Boxes exceeding 4-11/16 inches square when required shall be welded steel construction with screw cover and painted, steel gauge as required by physical size, Hoffman, Circle AW or equal.
- D. Systems: Boxes for systems devices shall be as recommended by the systems manufacturer, suitable for the equipment installed. Equip with grounding lugs, brackets, device rings, etc., as required.

2.5 FLOOR BOXES:

- A. Flush floor boxes shall be cast iron, fully adjustable, brushed aluminum ring equipped with suitable metallic sectionalizing plates. Brushed aluminum duplex flaps for both power and Data/ Telecom. Brushed aluminum carpet flange. Single gang: Hubbell B2437/S3825/SB3083, Steel city, Wiremold, Carlon or approved. Double gang: Hubbell B4214/S3825/S3084, Steel City, Wiremold, Carlon, or approved.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Conduits may be run in finished spaces only with approval of the architect. Concealed conduits shall run in a direct line with long sweep bends and offsets. GRC and IMC embedded in concrete below grade or in damp locations shall be made watertight by painting the entire male thread with Rustoleum metal primer or equal before assembly.
- B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces shall closely follow the surfaces. Conduit fittings shall be used to “saddle” under beams. Drilling or notching of existing beams, trusses on structural members shall be coordinated with Architect and structural engineer prior to commencing.
- C. GRC terminations at boxes, cabinets, and general wiring enclosures shall be rigidly secured with double locknuts and bushings or approved fittings. Conduit shall be screwed in and shall engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Insulating bushings shall be used for conduits 1-1/4 inches or larger.
- D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.
- E. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating moisture barriers.
- F. MC Cable installation shall be supported to structure in compliance with N.E.C. The ground conductor and metal sheath are treated as part of the circuit ground path. Termination fittings recognized as suitable for carrying circuit ground fault current shall be used.

3.2 CONDUIT:

- A. GRC may be used in all areas for wiring systems. GRC shall be installed for wiring underground in cast concrete construction, in damp locations, and in hazardous areas for serving fire pump controllers and where subject to mechanical injury with threaded fittings made up tight. IMC may be used in locations not in contact with earth or fill.
- B. EMT may be used in all other dry protected locations. Provide green equipment bonding conductor where used for power circuit feeders 2-inch and larger. EMT, whether exposed or concealed, shall be securely supported and fastened at intervals of nominally every 8 feet and within 24 inches of each outlet, ell, fitting, panel, etc.
- C. Flex shall be used for connections to vibration producing equipment and where installation flexibility is required with a minimum 12 inches slack connection. Limit flex length to 36 inches for exposed equipment connections and 72 inches in concealed ceiling and wall cavities. PVC jacketed flex shall be used in wet locations, areas subject to washdown, and exterior locations.

3.3 FITTINGS:

- A. Metallic raceways and conduits shall be assembled continuous and secured to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. All conduit joints shall be cut square and reamed smooth with all fittings drawn up tight.
- B. Crimp-on, tap-on, indenter type, malleable iron or cast set screw fittings shall not be used.

3.4 BOXES:

- A. Boxes and outlets shall be mounted at nominal center line heights shown on the drawings. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
- B. Outlet boxes shall be of code required size to accommodate all wires, fittings, and devices. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang. Equip all metallic boxes with grounding provisions.
- C. Flush wall switch and receptacle outlets used with conduit systems shall be 4 inches square, 1-1/2 inches or more deep, with one or two-gang plaster ring mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.
- D. Wall bracket and ceiling surface mounted luminaire outlets shall be 4-inch octagon 1-1/2 inches deep with 3/8-inch fixture stud where required. Wall bracket outlets to have single gang opening where required to accommodate fixture canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
- E. Junction boxes installed in accessible ceiling cavities or wall cavities or exposed in utility areas shall be a minimum of 4 inches square, 1-1/2 inches deep with appropriately marked blank cover.
- F. Boxes for the special systems shall be suitable for the equipment installed. Coordinate size and type with the system supplier.
- G. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in any conduit to not more than three 90 degree bends. Use galvanized boxes of code required size with removable covers installed so that covers will be accessible after work is completed.
- H. Recessed boxes shall be flush with finished surfaces or not more than 1/8-inch back and be level and plumb. Long screws with spacers or shims for mounting devices will not be acceptable. No combustible material shall be exposed to wiring at outlets.
- I. Covers for flush mounted boxes in finished spaces shall extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.

- J. Boxes installed attached to a stud in sheet rock walls shall be equipped with opposite side box supports equal to Caddy #760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs shall not cause projections on the face of the stud to prevent full length contact of sheet rock to the stud face.

3.6 PULL WIRES:

- A. Install nylon pull lines in all empty conduits larger than 1 inch where routing includes 25 feet or more in length or includes 180 degrees or more in bends.
- B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36 inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION

SECTION 16120
CONDUCTORS AND CONNECTORS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Conductor sizes shown on Drawings are sized for copper and shall be considered minimum for ampacities and voltage drop requirements.
- B. Conductors for special systems shall be as recommended by the equipment manufacturer except as noted.
- C. Deliver conductors to the job site in cartons, protective covers, or on reels.

1.2 SUBMITTALS:

- A. Product data.
- B. Test reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS - 600V:

- A. Type: Copper: No. 12 AWG minimum size unless noted otherwise, No. 8 and larger, Class B concentric or compressed stranded.
- B. Insulation: Copper: THW, THHN, THWN unless noted or specified otherwise.
- C. Thru wiring in fluorescent luminaires shall be rated for 90 degree C minimum.
- D. Manufacturers: General, Essex, Rome, Southwire, or equal.

2.2 CONNECTORS - 600V AND BELOW:

- A. Branch Circuit Conductor Splices: Live spring type, Scotchlok, Ideal Wire Nut, Buchanan B-Cap, or 3M Series 560 self-stripping type.
- B. Cable Splices: Compression tool applied sleeves, Kearney, Burndy, or equal with 600V heat shrink insulation.
- C. Terminator Lugs for Stranded Wire:
 - 1. No. 10 Wire and Smaller: Spade flared, tool applied.
 - 2. No. 8 Wire and Larger: Compression tool applied, Burndy, Anderson, or equal. Set screw type terminator lugs supplied as an integral part of switches and circuit breakers will be acceptable for terminating only copper conductors.

PART 3 - EXECUTION

3.1 CONDUCTORS:

- A. Pulling compounds may be used for pulling all power conductors. Clean residue from the conductors and raceway entrances after the pull is made.
- B. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer's specifications regarding pulling tensions, bending radii of the cable, and compounds. A dynamometer shall be utilized on all high voltage cable pulls to insure that the maximum allowed cable tension is not exceeded. The Architect and Engineer shall be notified prior to all cable pulls. Record the maximum strain of each pull.
- C. Conductors entering terminal or junction boxes mounted on hermetically sealed refrigeration compressor motors shall be copper.
- D. Make up and insulate wiring promptly after installation of conductors. Wire shall not be pulled in until all bushings are installed and raceways terminations are completed. Wire shall not be pulled into conduit embedded in concrete until after the concrete is poured and forms are stripped.

3.2 CONNECTORS:

- A. Control and special systems wires shall be terminated with a tool applied spade flared lug when terminating at a screw connection.
- B. All screw and bolt type connectors shall be made up tight and retightened after an eight hour period.
- C. All tool applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.

3.3 COLOR CODING:

- A. Secondary service, feeders, and branch circuit conductors shall be color coded. Phase color code to be consistent at all feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code shall be as follows:

<u>208Y/120 volt</u>	<u>Phase</u>	<u>480Y/277 volt</u>
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

- B. Use solid color compound or solid color coating for No. 12 and No. 10 branch circuit conductors and neutral sizes.
- C. Phase conductors No. 8 and larger color code using one of the following:
 - 1. Solid color compound or solid color coating.
 - 2. Stripes, bands, or hash marks of color specified above.
 - 3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Where cable markings are covered by tape, apply tags to cable stating size and insulation type.
- D. Switchlegs, travelers, etc., to be consistent with the phases to which connected or a color distinctive from that listed.
- E. Color coding of the flexible wiring system conductors and connectors shall be the manufacturer's standard.
- F. For modifications and additions to existing wiring systems, color coding shall conform to the existing wiring system.

3.5 TESTS:

- A. Perform insulation resistance tests on all phase and neutral conductors of feeders and circuits over 100 ampacity, 480 volt and below, with a 1000 volt megger. The written test report listing the results of the test to be submitted to Architect. Equipment which may be damaged by this test shall be disconnected prior to the test.

END OF SECTION

SECTION 16140
WIRING DEVICES AND PLATES

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide wiring devices and plates or blank plates only for all outlet boxes shown.

1.2 SUBMITTALS:

- A. Product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Wiring Devices and Plates: Hubbell, Leviton, Lutron, Pass & Seymour.
- B. Dimmers: Cooper, Lutron, Leviton.

2.2 MATERIALS:

- A. Wiring devices shall be specification grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein without reference to catalog number, such device shall be of same grade and manufacture as specified below. Furnish a matching cap for all special purpose devices that do not have the common 120 volt NEMA 5-15R or 5-20R configuration.
- B. All lighting switches and duplex receptacles installed shall have similar appearance characteristics unless noted otherwise.

2.3 WALL SWITCHES:

- A. Line Voltage Switches: 20 ampere, 120 volt, quiet type, back and side wired, gray finish. Hubbell 1221 series.
- B. Switch with pilot, lighted clear toggle, Hubbell 1221-PL.
- C. Momentary Contact Switches: 15A, SPDT, center off, gray finish. Hubbell 1556-T.

2.4 DIMMERS:

- A. General: Solid state silicone gated with RFI filter. Linear slide control with positive on/off switch for standard wall box mounting.
- B. LED Dimmers:

1. Reverse phase and/or ELV dimming type specifically marked for dimming LED lamps/light sources. 120V, minimum 200VA capacity.

2.5 OCCUPANCY SENSORS:

- A. Dual Technology passive infrared and ultrasonic with adjustable time delay. Verify finish color with architect. Greengate OAC-DT for all spaces. Acceptable alternate manufacturers are Leviton, Lutron, Wattstopper and Acuity.

2.6 RECEPTACLES:

- A. Normal Power Duplex: 3-wire, 2-pole grounding, NEMA 5-20R, back and side wired.
 1. General Application: Hubbell 5352 series. Finish to be selected by architect.
- B. Ground Fault Interrupting Duplex: NEMA 5-12R. Finish to be selected by architect.
- C. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.
- F. USB/Power Duplex: Two USB ports 3 Amp, 5VDC, Type A, 2.0, tamper-resistant (TR) decorator duplex, green LED indicator to show USB power available, spec grade, impact/chemical resistant, back and side wired for solid or stranded wire, flush fit design, 15 Amp, 125VAC electrical rating, 125VAC, 60Hz input voltage, 20A, 125VAC circuit feed-through, #10-#14 AWG gauge wire terminals, 2000V dielectric withstand, UL 94, USB BC1.2 compliant, USB 1.1/2.0/3.0 compatibility, FCC Part 15 compliant, UL 498 and UL 1310. Device and coverplate finish color as selected by architect. Hubbell USB15X2(xx).

2.7 PLATES:

- A. Flush Finish Plates: .040" thick, type 302 stainless steel, brush finish.
- B. Surface Covers: Zinc galvanized plated steel, 1/2" raised industrial type with openings appropriate for device installed.
- C. Weatherproof: Leviton 5997-GY cover mounted horizontally with hinges up.
- D. Tamperproof: Locking cover plate, cylinder type lock, master keyed, Pass & Seymour 4600 series
- E. Identification: Identify receptacle plates with press on labels indicating serving panel and branch circuit number.

2.8 THROUGH FLOOR DEVICES:

- A. Through floor devices shall be UL listed for a fire rating equal to or greater than the fire rating of the floor being penetrated and be designed for concrete floors up to 7 inches thick.

The complete assembly shall be Hubbell PT7 series or approved equal, brush aluminum finish, and shall consist of the following assembled parts:

1. Power Only: Equip above floor service fitting with a duplex receptacle on one side and a blank plate on the other side.
 2. Power / Telecom: Equip above floor service fitting with a duplex receptacle on one side and a voice data plate on other side.
 3. Power / Telecom (Furniture Feed): Equip above floor service fitting with a dual grommetted opening leading to an empty compartment for telephone/signal cables on the other side for combination units. Provide furniture feed connections as shown on drawings.
- B. A fire rated center coupling with separate raceways for power and communication, factory equipped with inorganic chemical panels that will expand on exposure to high heat to form a flame, smoke, and air seal within the entire assembly.
- C. An adjustable, divided extension channel complete with a box and special receptacle at the lower end for connection to the flexible wiring system.
- D. Unit shall be secured in a 3-inch diameter core drilled hole for insertion from above for combination units and 2-inch diameter core drilled for power only units.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Devices and finish plates to be installed plumb with building lines. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings. Unless otherwise noted on the drawings or shown/specified in the architectural drawings, details, and elevations the centerline of all receptacles shall be 18 inches above finished floor and the centerline of all light switches shall be 48 inches above finished floor per ADA. For all above counter devices, verify exact mounting heights with architectural drawings, details, and elevations.
- B. Finish plates and devices are not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.
- C. Provide weatherproof device covers on devices at all exterior locations and damp or wet label areas.
- D. Locations of all occupancy sensors shall be per manufacturer's recommendations and installation requirements for optimal coverage. Reference to Architectural drawings and interior design drawing is required. Coordination of device placement with furnishings is required to assure desired operation.

3.2 CORD CAPS:

- A. All special plugs provided with the receptacles shall be given to the Owner in their cartons with a letter stating the date and the Owner's representative that received the materials.

3.3 COORDINATION:

- A. The Electrical Drawings indicate the approximate location of all devices. Refer to Architectural elevations, sections and details for exact locations.
- B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals and similar equipment.

3.4 TESTING:

- A. Receptacles shall be tested for line to neutral, line to ground and neutral to ground faults. Correct any defective wiring.
- B. Test all GFI receptacles and replace defective units.
- C. Occupancy sensors shall be tested for correct operation and coverage with an individual positioned at various locations within room.

END OF SECTION

SECTION 16195
IDENTIFICATION

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Clearly and properly identify the complete electrical system to indicate the loads served or the function of each item of equipment connected under this work.

PART 2 - PRODUCTS

2.1 LABELS:

- A. Pre-printed: Permanent material pre-printed with black on white, with adhesive backing, Brady, 3M or equal.
- B. Laminated Plastic: 3-ply laminated plastic, black with white letters, for 208/120V equipment and red with white letters for 480/277V equipment. Lamicoid or equal.
- C. Clear Plastic Tape: Black 12 point Helvetica medium characters machine imprinted on clear tape, Merlin, Kroy or equal.
- D. Plastic Tape: Black or red with white letters, adhesive backing, field printed with proper tool, Dymo-tape or equal.
- E. Wire Markers: White with black numbers, adhesive backed tape on dispenser roll, Brady, 3M or equal.

PART 3 - EXECUTION

3.1 SWITCHGEAR:

- A. Label the new feeder protective devices in all distribution panels with laminated plastic labels indicating the function or the load served.

3.2 BRANCH CIRCUIT PANELBOARDS:

- A. Indicate panel number with laminated plastic labels. Indicate voltage phase and feeder source, feeder wire size, and feeder breaker or fuse size with plastic tape labels on the inside of the panel door.
- B. Provide typewritten panel directories, with protective, clear transparent covers, accurately accounting for every breaker installed including spares. Schedules shall use the actual room designations assigned by name or number near completion of the work and not the space designation on the Construction Drawings.

3.3 EQUIPMENT:

- A. Label all disconnect switches, motor starters, relays, contactors, and time switches indicating equipment served with plastic tape labels.
- B. Where the controlling device is remote mounted from the serving panel, include the serving panel designation and circuit number with additional plastic tape labels.

3.4 DEVICES:

- A. Label each receptacle plate with preprinted clear plastic press on labels with 3/16" minimum black letters indicating serving panel and circuit number. Clean all oils, dirt and any foreign materials from plate prior to label application.
- B. Receptacles connected to a GFCI protected circuit downstream from the protecting device shall be so labeled.

3.5 RACEWAYS AND BOXES:

- A. Label all pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover. Covers shall be color labeled as follows: 480Y/277V wiring - orange; 208Y/120V wiring - black; fire alarm - red; communications - green; security - blue.
- B. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

3.6 SYSTEMS:

- A. Complex control circuits may utilize any combination of colors with each conductor identified throughout, using wraparound numbers or letters. Use the number or letters shown where the Drawings or operation and maintenance data indicate wiring identification.
- B. Label the fire alarm and communication equipment zones, controls, indicators, etc., with machine printed labels or indicators appropriate for the equipment installed as supplied or recommended by the equipment manufacturer.

3.7 EXISTING EQUIPMENT:

- A. Provide new labels for existing switchgear and panels in accordance with panel descriptions shown on the Drawings. Provide new labels for feeder devices where labels are non-existent, incorrect or confusing on existing distribution panels affected by this work.
- B. Equip existing branch circuit panelboards scheduled to remain with new, accurate circuit directories where circuiting changes are made.

END OF SECTION

SECTION 16420
SECONDARY DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install the materials for the secondary service and distribution system as specified herein and shown on the Drawings. Overload and short circuit protection of the secondary distribution system shall be fully rated. Series rating shall not be acceptable.
- B. Paint all recess panels to match wall finish.

1.3 SUBMITTALS:

- A. Shop drawings.
- B. Product data.
- C. Ground Fault Protection System Test Report.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. General Electric, Square D, Eaton/Cutler Hammer, Siemens.

2.2 SUB-DISTRIBUTION PANELS:

- A. Circuit Breakers: Molded case, bolt-in thermal magnetic type. Breakers shall have short circuit capacity rating to withstand the maximum short circuit duty which can be expected at the breaker location in the electrical system. Minimum short circuit rating for any circuit breaker shall be 10,000 A.I.C. for 120V and 208V breakers.

2.3 BRANCH PANELBOARDS:

- A. Branch Circuit Panels: Bolt-in circuit breaker type with aluminum or copper bussing. Panels shall be fitted with flush lift latches and locks keyed alike. Deliver all panel keys to the Owner at completion of the project.
- B. Main Circuit Breakers: Equip panels indicated with main circuit breakers sized as scheduled and mounted behind door at top of panel. Back feeding of branch circuit breakers is not acceptable.
- C. Branch Circuit Breakers: Molded case, thermal magnetic type. Breakers shall have short circuit capacity rating to withstand the maximum short circuit duty which can be expected at the breaker location in the electrical system. Breakers mounted in branch panelboards shall

be of the bolt-in type. Circuit breakers used for switching duty shall be UL listed for that purpose and marked "SWD". Minimum short circuit rating for any circuit breaker: 10,000 A.I.C. for 120V and 208V breakers.

- D. Wiring Gutters: A minimum of 4 inches wide except where feeder conductors enter where a minimum of 6 inches clear shall be provided. Feeder conductors to enter directly in line with lug terminals wherever practicable. Provide separate feeder studs for each feeder conductor compression lug.
- E. Cabinets: Flush doors with concealed hinges and mounting clamps equal to Square D Mono Flat, or ITE Decor trim. Surface panels shall have metal face trims with no sharp edges or corners. Finish surface panel tubs to match face trim.
- F. Ground Bus: Provide a grounding bus with termination capacity for the grounding conductor sized for the branch circuit equipment grounding conductors in isolated ground 208Y/120V panels identified by suffix IG. Grounding bus shall be bonded to the panel cabinet.

2.4 FUSES:

- A. Fuse each active fusible switch with non-renewable type, dual element, current-limiting fuses of such characteristics as shown on the Drawings. Fuses shall be Bussmann, Cefco, Littelfuse or approved equal.
- B. Fuses shall be capable of holding 500% of rated current for a minimum of 10 seconds, and carry a UL listed interrupting rating of 200,000 amperes rms symmetrical.
- C. Provide fuses as follows:
 - 1. Up to 600A: UL Class RK-1, time delay.
 - 2. Above 600A: UL Class L, time delay.
 - 3. Motor loads: UL Class RK-5, time delay.
- D. Fuses shall have the ampere rating permanently stamped or etched into the metal cap.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Install the secondary distribution system assemblies and equipment as shown on the Drawings, parallel and square with the building lines.
- B. Neatly lace and secure the conductors of the feeder circuits individually at maximum 2 foot intervals. The cable lugs shall not support the weight of the cables.

3.2 BRANCH PANELBOARDS:

- A. Install panelboards plumb and level, located as shown on the Drawings up 6'-0" to top unless noted otherwise.

- B. Equip selected breakers with mechanical locking devices such that they may be locked in the “on” position. Selected breakers shall include those serving alarm systems, fire suppression systems, communications systems and other critical loads directed.
- C. Install a spare 3/4-inch conduit from flush panels for each three single pole breakers or spaces provided. Terminate conduits above accessible ceiling or as directed.

END OF SECTION

SECTION 16440
DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide switches of proper characteristics as disconnecting means.

1.2 SUBMITTALS:

- A. Shop Drawings: Indicate field dimensions, description of materials and finishes, component connections, anchorage methods, hardware, and installation procedures.
- B. Product Data.
- C. Operating and Maintenance Data.

1.3 WORK IN RELATED SECTIONS

- A. 16195 Identification.
- B. 16420 Secondary Distribution System.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. General Electric, Square D, Eaton/Cutler Hammer, Siemens.

2.2 DISCONNECTS:

- A. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock and indicating handle that will accept a minimum of three padlocks.
- B. Enclosures shall be NEMA 1 for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript "WP".
- C. Disconnects shall be fusible or non-fusible as designated on Drawings.
- D. Rejection Fuse Clips: Provide for fusible switches (30 to 600A) to prevent the installation of Class H and Class K non-current-limiting fuses.

PART 3 - EXECUTION

3.1 DISCONNECT SWITCHES:

- A. Provide all code required disconnect switches under this work, whether specifically shown or not.
- B. Provide one manufacturer for all disconnect switches on the project.
- C. Disconnect switches shall be installed as recommended by the manufacturer and shall be square with the building structural lines.
- D. Install fuses in all fused switches.
- E. Provide identification as specified in Section 16195.

END OF SECTION

SECTION 16450
GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide complete ground systems as specified herein and shown on the Drawings. Include conduit system, transformer housings, panel enclosure, motors, and miscellaneous grounds as required.

PART 2 - PRODUCTS

2.1 GROUND CONDUCTORS:

- A. Bare or green insulated copper for interior systems.
- B. Bare copper for underground or exterior systems.

2.2 CONNECTORS:

- A. Cast, set screw or bolted type.
- B. Form poured, exothermic welds.
- C. Grounding lugs where provided as standard manufacturer's items on equipment.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Grounding Conductors: Sized in accordance with Article 250, Tables 250-122 and 250-66 of the National Electrical Code.
- B. Grounding Conductor Connectors: Made up tight and located for future servicing and to insure low impedance.
- C. All Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.
- D. Provide equipment grounding conductor in all PVC conduit runs.
- E. Provide circuit ground conductor in all feeder and branch circuiting. Bond circuit ground conductor to each splice, device and equipment box or enclosure. Terminate circuit ground conductor on panel ground bus.

3.3 EQUIPMENT:

- A. Provide separate green insulated equipment ground conductor in all non-metallic and flexible electrical raceways. Effectively ground all luminaires, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.
- B. Provide grounding bushings on all feeder conduit entrances to panels and equipment enclosures and bond bushings to enclosures with minimum No. 10 AWG conductor. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through No. 10 AWG.

END OF SECTION

SECTION 16480
MOTOR CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide manual or magnetic motor starters of the proper characteristics for equipment as listed on the Drawings.
- B. Provide switches of proper characteristics as disconnecting means.

1.2 SUBMITTALS:

- A. Shop drawings.
- B. Product data.
- C. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

- A. Motor Starters and Visible Blade Disconnects: Same manufacture as the distribution equipment specified in Section 16420, Allen Bradley or approved equal.
- B. Horsepower Rated Toggle Switches: Arrow Hart, General Electric, Hubbell, Pass & Seymour.

2.2 MOTOR STARTERS:

- A. Manual starters, toggle type, quick-make, quick-break, with thermal overload protection and suitable enclosures.
- B. Magnetic starters, full voltage across the line non-reversing type, 120 volt coils, overload relays in each leg, red running pilot lights, one normally closed and one normally open auxiliary contacts, 120V control transformers and suitable enclosures. The starters shall be combination type with fusible switches where shown adjacent to the disconnect switch.
- C. Provide multiple starters for proper operation of 2-speed motors as scheduled on the Drawings.
- D. Equip starters with H-O-A selector switches, start-stop stations, or other auxiliary control device listed. Where no auxiliary devices are listed, equip each starter with an H-O-A switch.

2.3 DISCONNECTS:

- A. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock.
- B. Enclosures shall be NEMA 1 for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript "WP".
- C. Disconnects shall be fusible or non-fusible as designated on Drawings.

2.4 FUSES:

- A. Fuses shall be UL Class RK-5 dual element, time delay, current limiting type. The overload thermal time delay element shall be a spring actuated soldered copper assembly in a separate sand free compartment. The short circuit current limiting section shall be copper alloy links encased in quartz sand.
- B. Fuses shall be capable of holding 500% of rated current for a minimum of 10 seconds, and carry a UL listed minimum interrupting rating of 100,000 amperes rms symmetrical.

PART 3 - EXECUTION

3.1 MOTOR STARTERS:

- A. Provide the motor starting equipment as shown on the Drawings and coordinate all motor "overload" starter relays.
- B. Install the starters at the respective equipment unless shown otherwise.

3.2 DISCONNECT SWITCHES:

- A. Provide all code required disconnect switches under this work, whether specifically shown or not.
- B. Non-fusible disconnect switches required when equipment is not in sight of the branch circuit panel or starter may be horsepower rated, toggle type in suitable enclosure, mounted at or on the equipment.

3.3 FUSES:

- A. Install fuses for motor protection to best protect the motor without nuisance tripping. Should fuse sizes require changing from what is shown due to variance between the original design information and actual equipment installed, fuses shall be sized in accordance with NEC. In no case shall fuses be sized smaller than the starter heaters on motor circuits.
- B. Provide one complete set of spare fuses of each amperage used on this project. Store spare fuses in the spare fuse cabinet.

END OF SECTION

SECTION 16500
LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Provide all lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location. Outlet symbols on the Drawings without a type designation shall have a luminaire the same as those used in similar or like locations.
- B. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Engineer and provide a suitable luminaire type as directed.
- C. Coordinate installation of luminaires with the ceiling installation and all other trades to provide a total system that is neat and orderly in appearance.
- D. Install all remote ballasts in enclosures as required by luminaire specified. Remote mounted ballasts shall be located within the distance limitations specified by the ballast manufacturer.

1.2 RELATED WORK IN OTHER SECTIONS:

- A. The provisions of Section 16050 - Basic Electrical Materials and Methods, apply to work specified in this section.
- B. Section 16140, Wiring Devices.

1.3 QUALITY ASSURANCE:

- A. The lighting design for this project was based on luminaire types and manufacturers as specified.
- B. Other "Or Equal" Manufacturers and Products: Submit Substitution Request, complying with requirements of Section 01630 Product Options and Substitutions.
- C. Equality shall be determined by the following luminaire characteristics.
Lack of data on any characteristic shall constitute justification for rejection of the submittal.
 - 1. Performance
 - a. Distribution.
 - b. Utilization.
 - c. Average brightness/maximum brightness.
 - d. Spacing to mounting height ratio.
 - e. Visual comfort probability.
 - 2. Construction
 - a. Engineering.
 - b. Workmanship.

- c. Rigidity.
- d. Permanence of materials and finishes.
- 3. Installation Ease
 - a. Captive parts and captive hardware.
 - b. Provision for leveling.
 - c. Through-wiring ease.
- 4. Maintenance
 - a. Relamping ease.
 - b. Replacement of ballast and lamp sockets.
- 5. Appearance
 - a. Light tightness.
 - b. Neat, trim styling.
 - c. Conformance with design intent

1.4 SUBMITTALS:

- A. Submit the following in accordance with Section 16050:
 - 1. Shop Drawings.
 - 2. Product Data.
 - 3. Photometric Reports consist of a minimum of:
 - a. Candlepower Distribution Curves.
 - b. Coefficient of Utilization Table.
 - c. Zonal Lumen Summary.
 - 4. Certification of lamp ballast compatibility.
 - 5. Operation and Maintenance Data.
 - 6. Operational Sample upon request.

1.5 REFERENCE STANDARDS

- A. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts - Supplements; 2011.
- B. IEEE C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits; 2002 (Cor 1, 2012).
- C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- D. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; Illuminating Engineering Society; 2008.
- E. IES LM-80 - Approved Method: Measuring Lumen Maintenance of LED Light Sources; Illuminating Engineering Society; 2008.
- F. NECA 1 - Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
- G. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.
- H. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

- I. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; National Electrical Manufacturers Association; 2011.
- J. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; National Electrical Manufacturers Association; 2012.
- K. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L. NFPA 101 - Life Safety Code; National Fire Protection Association; 2012.
- M. UL 924 - Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- N. UL 935 - Fluorescent-Lamp Ballasts; Current Edition, Including All Revisions.
- O. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- P. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Recessed luminaires shall have trims which fit neatly and tightly to the surfaces in which they are installed without leaks or gaps. Where necessary, install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.
- B. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover shall be thermally protected for this application and shall carry a fire rated listing.
- C. Luminaires installed under canopies, roofs or open areas and similar damp or wet locations shall be UL listed and labeled as suitable for damp or wet locations.
- D. Aligners: Ball type with nominally 45 degree movement either side of center. Provide white stem aligner canopies where installed in finished areas.

2.2 FLUORESCENT LUMINAIRES:

- A. Doors 12" X 48" and larger: Flat metal equipped with mitered corners, rotary cam or spring assisted latches to hinge from either side.
- B. Diffusers 12" x 48" and larger: Injection molded of clear acrylic plastic, 0.188" overall thickness with 0.125 minimum unpenetrated thickness square cone base, similar to Pattern 12 configuration. Holophane 6251 Series.

- C. Finish: Baked white dry polyester powder, unless otherwise specified with a minimum average reflectance of 85% on all exposed and light reflecting surfaces. Steel components shall be prepared for finishing with a 5-step zinc phosphating process.
- D. Ballasts shall operate a maximum of two lamps in each luminaire. Three and four lamp ballasts shall not be provided.

2.3 LINEAR FLUORESCENT LUMINAIRES:

- A. Housing: One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness in one uninterrupted section of 1 ft to 24 ft with the cross sectional dimensions as indicated in the Luminaire Schedule. Section lengths shall be as shown on the drawings, and shall be such that the luminaire shall be able to be transported into and out of the installation location after final construction without any building demolition being required. Where housing sections are joined together to form a continuous row, an internal alignment spline shall be provided.
- B. End Plates: Die cast end plates shall be mechanically attached without any exposed fasteners. End caps shall be minimum 0.125" thick.
- C. Finish:
 - 1. All exposed aluminum surfaces shall be satin etched and clear anodized.
 - 2. All exposed aluminum surfaces shall be satin etched and anodized in the color as indicated in the Luminaire Schedule.
 - 3. All exposed aluminum surfaces shall be satin etched and clear anodized. Finish shall be treated with an acid wash and clear water rinse. The luminaire shall then be electrostatically painted and oven baked in the color indicated in the Luminaire Schedule.
- D. Lens: Linear prismatic 100% virgin acrylic optical lens, mechanically secured from within the housing. Lens shall have 0.125" minimum unpenetrated thickness. Lens shall have smooth exterior and interior longitudinal prisms.
- E. Reflectors: Reflectors shall be steel, minimum 22 ga, with hard baked white enamel finish with minimum 85% reflectance.
- F. Suspension:
 - 1. Luminaires shall be suspended from pendants with swivel stem aligners and be suspended with stems. A canopy shall be provided at the ceiling to conceal all suspension hardware.
 - 2. At the electrified connection provide cord feed. Where emergency feed is required, a separate feed point shall be provided.
 - 3. Suspension method shall allow adjustment to be made in hanging length to allow for variance in ceiling height.
 - 4. Verify finish and color of all exposed suspension components with Architect.

2.4 EXIT SIGNS

- A. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
 - 1. Number of Faces: Single or double as indicated or as required for the installed location.
 - 2. Directional Arrows: As indicated or as required for the installed location.

2.5 BALLASTS & DRIVERS:

- A. Fluorescent Electronic: Electronic ballasts shall meet the requirements of UL 935 and shall bear the appropriate UL label and have the same physical dimensions and mounting arrangement as those of their core and coil counterparts. Tandem wiring between luminaires may be used to minimize the number of ballasts while accomplishing the switching requirements shown on the drawings. Advance Mark V and Mark VII, or equal. Ballasts shall have the following electrical characteristics.
 - 1. Withstand input power line transients as defined in ANSI C62.41. The ballasts shall tolerate a line voltage variation of $\pm 10\%$. The power factor shall be 90% or higher. The lamp crest factor shall measure 1.7 or less. The average Ballast Factor (BF) shall be a minimum of 92.5% under ANSI C82.2 conditions unless otherwise noted on drawings.
 - 2. Total harmonic distortion of the input current to the electronic ballast shall not exceed 10% of the input current and comply with FCC rules and regulations Part 18 concerning the generation of both EMF (electromagnetic interference) and RFI (radio frequency interference).
 - 3. The electronic ballasts shall be Class "A" sound rated and UL Class "P" thermally protected. The ballast shall be provided with an internal fuse to protect the electrical power supply from internal component failure. The ballast shall also be short-circuit protected in the event of miswiring.
 - 4. Ballasts shall be warranted against defects in materials and workmanship for five years. The warranty shall include either a \$10 replacement labor allowance or complete replacement including labor by an agent of the manufacturer.
- B. Where dimming control is specified, the control and ballasts shall be compatible and designed to operate together.
- C. Ballasts used in enclosed and gasketed luminaires listed for use in wet locations shall be of Type I construction.
- D. Ballasts shall be rated for the expected ambient temperature in which they are installed. All exterior installed ballasts shall be rated to start the lamps at 00 F.
- E. Systems using tandem wired luminaires shall be labeled accordingly. Label shall be in the lamp compartment of each luminaire and identify the function of that luminaire.
- F. Dimmable LED Drivers:

1. Dimming Range: Continuous dimming from 100 percent to five percent relative light output unless dimming capability to lower level is indicated, without flicker.
2. Control Compatibility: Fully compatible with the dimming controls to be installed.

2.7 LAMPS:

- A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated as manufactured by General Electric, Phillips, Osram/Sylvania, Venture or approved equal. All fluorescent lamps shall be of the same manufacturer.
- B. Incandescent lamps: Inside frosted, 130 volt rated except where otherwise specified. Provide reflector lamp for fixtures designed and cataloged for such lamps unless specified otherwise, 120 volt rated. Lamps with diodes are not acceptable.
- C. Fluorescent lamps: T-8 lamps shall be 48" 32 watt, inside tri-phosphor coated, 4100 degrees K color temperature or as required by luminaire specified in the luminaire schedule. Provide low mercury content and extra life lamps, 24,000 average hours. GE F32T8/XL/SPX41 or equal.
- D. Compact Fluorescent Lamps: Of wattage and configuration indicated in Luminaire Schedule, Tri-Phosphor, 3500°K color temperature. Lamps shall be single ended dual pin plug-in base, except those used with dimming ballasts, which shall utilize the 4-pin configuration.
- E. Metal halide lamps: Of wattage, base style, color and type indicated in Luminaire Schedule. Provide pulse start lamps.
- F. Low voltage lamps: Of wattage, beam spread, base style and type indicated in Luminaire Schedule.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.
- B. The Architectural Reflected Ceiling Plans shall take preference as to the exact placement of the luminaires in the ceiling.
- C. Leave luminaires clean at the time of acceptance of the work with every lamp in operation. If luminaires are deemed dirty by the Architect at completion of the work, the Contractor shall clean them at no additional cost.

- D. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan. The final decision as to adequacy of support and alignment, will be given by the Architect. The fixtures shall be supported by separate means from the building structure and not from the ceiling system, ductwork, piping or other systems.
- E. Aim luminaires to provide the lighting pattern for which the luminaire is designed and as directed by Engineer.
- F. Manufacturer's labels or monograms shall not be visible after luminaire is installed, but must be included for future reference.
- G. When lamping tungsten halogen luminaires use silk gloves to insert lamps.
- H. Where incandescent lamps are used for construction lighting, the lamps shall be replaced with new lamps just prior to occupancy by the owner.

3.2 WIRING:

- A. Recessed luminaires served from a junction box above the ceiling may be connected with 3/8" flex, 2 No. 18. Provide 3 No. 18 wires where dual circuiting is called for. Provide ground continuity.

END OF SECTION

SECTION 16720
FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section specifies a Fire Alarm System (FAS) including initiation, notification, control and power equipment, cable, connectors, and associated equipment and material. Provide Notification Appliance Circuit (NAC) Panel as required to accommodate new ADA horn/strobe and strobe devices. Provide new smoke detectors, fire smoke dampers, duct smoke detectors, control modules (AOM), manual pull stations, magnetic door holders, and other fire alarm devices/equipment. Provide new head end/main fire alarm control panel.
- B. Related sections:
 - 1. Division 15 - Section 15820
 - 2. Division 16 - Section 16050, 16140, 16110, 16195, 16120, 16450
 - 3. Division 17 - Section 17130, 17900

1.2 DEFINITIONS

- A. Alarm Signal: Signifies state of emergency requiring immediate action. Pertains to signals such as operation of manual station and operation of sprinkler system water flow switch.
- B. Authority Having Jurisdiction (AHJ): The "AHJ" is the organization, office, or individual responsible for approving equipment, installation, or procedure.
- C. Class A Wiring: Circuits arranged and electrically supervised such that a single break or a single non-simultaneous ground fault condition on a circuit conductor indicates a trouble signal at the fire alarm control panel (FACP), and the circuit continues to be capable of operation for its intended service in the faulted condition no matter where the break or ground fault condition occurs.
- D. Class B Wiring: Circuits electrically supervised such that a single break or a single non-simultaneous ground fault condition on a circuit conductor indicates a trouble signal at the FACP no matter where the break or ground fault condition occurs. Circuits are not capable of transmitting an alarm signal beyond the fault location.
- E. Initiating Device: An FAS component that originates transmission of a change of state condition, such as manual stations, smoke detectors, heat detectors, or sprinkler system water-flow and tamper switches.
- F. "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
- G. Multiplex System: A system using a signaling method characterized by the simultaneous or sequential transmission, or both, and the reception of multiple signals in a communication channel, including means for positively identifying each signal.

- H. Notification Appliance: An FAS component such as a bell, horn, speaker, strobe light, etc. that provides an audible or visible output or both.
- I. Style: Initiating device, notification appliance, or signaling line circuit designation by the circuits' ability to transmit alarm and trouble signals during specified simultaneous multiple circuit fault conditions, in addition to the single circuit fault conditions considered in the designations of the circuits by class.
- J. Supervisory Signal: Indicates abnormal status or need for action regarding fire suppression or other protective systems.
- K. Trouble Signal: Indicates that a fault, such as an open circuit, ground, power supply, communications, or other trouble has occurred on the system.
- L. Zone: Initiating device or combination of devices connected to a single alarm-initiating device circuit or programmed to report (addressable devices) as a single circuit.

1.3 SYSTEM DESCRIPTION

- A. General: Provide complete, addressable, non-coded, multiplex, microprocessor-based fire detection and alarm system.
- B. Alarm Initiation: By individually addressable, automatically or manually operated devices.
- C. Local Alarm Notification - Audible: Automatic by sounding of notification appliances (horns) throughout the building(s).
- D. Local Alarm Notification - Visible: Automatic by lighting of notification appliances (Xenon type strobe lights) throughout the building(s).
- E. Remote Alarm Notification: Provisions for alarm signal transmission to a local remote display/annunciator.
- F. Central Station Notification: Utilize existing provisions for alarm signal transmission to a UL Listed alarm monitoring service.
- G. Functional Description: Include following system functions and operating features plus additional functions and features required by the Local Authority Having Jurisdiction:
 1. Fully field configurable and programmable system. (The use of batteries or battery backup for the programming function is not acceptable).
 2. Priority of Signals: Accomplish automatic response functions by first zone and/or device initiated. Alarm functions resulting from initiation by first zone are not altered by subsequent alarms. Highest priority is alarm signal. Supervisory and trouble signals have second and third level priority. Higher-priority signals take precedence over signals of lower priority, even though lower-priority condition occurred first. Annunciate all alarm signals regardless of priority or order received.

3. Non-interfering: Zone, power, wire, and supervise the system so a signal on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable after the initiating device or devices are restored to normal.
 4. Silencing Alarm, Supervisory and Trouble Conditions: Switches provide capability for acknowledgment of alarm, supervisory, trouble, and other specified signals at FACP and capability to silence local audible signal and light a light-emitting diode (LED). Acknowledge pending alarms prior to silencing the audible signal. Silencing the audible notification appliances must not automatically turn off the visible appliances. Subsequent zone alarms cause audible signal to sound again until silenced by switch operation. Restoring alarm, supervisory, and trouble conditions to normal extinguishes associated LED and causes audible signal to sound again until restoration is acknowledged by switch operation.
 5. Loss of primary power sounds trouble signal at FACP and remote display/annunciator. Indicate when fire alarm system is operating on alternate power supply.
 6. Annunciation: Manual and automatic operation of alarm and supervisory-initiating devices annunciates the following:
 - a. FACP LCD:
 - b. 32-character custom message
 - c. Identify device type
 - d. Devices Status (i.e. Alarm, Supervisory, Trouble)
 - e. Time and Date
 7. FACP Annunciator: Display plain-English-language descriptions and addresses of initiating devices, alarms, trouble signals, supervisory signals, monitoring actions, system and component status, and system commands.
 8. See the fire alarm system matrices for required system functions:
 9. Trouble-Shooting, Maintenance, and Diagnostics:
 - a. Automatic identification at the FACP and at the remote display/annunciator of any analog sensor, which becomes dirty prior to false alarming.
 - b. Automatic and manual adjustment of analog sensor sensitivity (up or down). Adjustable by time of day.
 10. FACP Primary Power Supply: Primary power to be supplied in accordance with NFPA 70.
- H. Recording of Events: Record alarm, supervisory, and trouble events to FACP history buffer. Recordings are by zone, device, and function. When FACP receives a signal, alarm, supervisory, and trouble conditions are recorded. The recording includes the type of signal, zone identification, date, and the time of occurrence. The recording differentiates alarm signals from all other recorded indications. When system is reset, this event is also recorded, including same information for device, location, date, and time. A menu command initiates a printout of a list of existing alarm, supervisory, and trouble conditions in system when a printer is attached.
1. Provide a total of 500 event capacity, allowing, “first in, first out” memory.
 2. Provide RS-232 port on each FACP suitable for a printer attachment.
- I. Permissible Signal Time Elapse: Maximum permissible elapsed time between actuation of alarm or fire-detection system alarm-initiating device and indication at FACP is 5 seconds.

- J. Independent System Monitoring: Supervise each independent smoke or heat detection system, duct detector, and elevator smoke-detection system for both normal operation and trouble.
- K. Circuit Supervision: Indicate circuit faults by both zone and trouble signal at the FACP. Provide distinctive indicating audible zone and LED-indicating light. Maximum permissible elapsed time between occurrence of trouble condition and indication at FACP is 200 seconds.
- L. Communications: Provide equipment suitable for transmission of signals over copper cable.
- M. Provide and install conduit, cable, raceways, and accessories to power and interconnect FAS equipment. Meet requirements specified in Division 16 - Electrical. Meet local code requirements and established industry standards for installation of conduit and raceways.

1.4 SUBMITTALS

- A. Initial submittal shall consist of:
 - 1. Product data for system components. Include dimensioned plans and elevations showing minimum clearances and installed devices and configuration. Include list of materials and Nationally Registered Testing Laboratory (NRTL) listing data.
 - 2. Wiring diagrams from manufacturer differentiating between factory- and field-installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring.
 - 3. System cable types including sizes, dimensions and characteristics based on voltage drop and signal loss calculations.
 - 4. System operation description covering this specific project including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 - 5. Voltage drop calculations for Notification Appliance Circuits and other low voltage control circuits.
 - 6. Battery calculations for all power supplies requiring battery backup.
 - 7. Complete and expanded functional matrix noting input/output addresses, and "custom messages". Provide in Microsoft Excel format. Make available in hard copy and 3.5" disk copy.
 - 8. Complete single-line riser diagram noting all devices with circuit/device address and associated room number.
 - 9. Floor plans with all necessary notations, clarifications, and noting all devices with circuit/device address and associated room number and description.
 - a. Include ceiling type and height.
 - b. Include raceway type being utilized as approved in Section 16110.
 - 10. Circuit labeling scheme differentiating between circuit types.
 - 11. All shop drawings shall be prepared utilizing Auto CAD 2002. Engineer shall not be responsible for providing fire alarm drawings and shall charge a fee of \$100/sheet for electronic fire alarm drawings.
- B. Provide Operations and Maintenance manuals for all devices and/or products

- C. Submission to Authority Having Jurisdiction: Fire Marshal shall approve and stamp fire alarm shop drawings prior to submitting shop drawings to engineer. Include copies of annotated Contract Drawings as required to depict component locations to facilitate review. Upon receipt of comments from the AHJ, submit them to the Owner for review. Resubmit if required to make clarifications or revisions to obtain approval.
- D. Test Procedures: Submit test procedures for system acceptance test.
 - 1. Develop test procedures to confirm that each specification requirement is met or exceeded.
 - 2. Provide Alarm Test Procedure (ATP) based upon complete functional matrix. Provide space for AHJ and Owner's (or their designated representative) to "sign off" per each device.
- E. Certifications: Provide evidence of personnel qualifications and certifications. Provide personnel licensed as required by state law.
 - 1. Requirements:
 - a. Installation foreman shall be Oregon licensed low voltage journeyman.
 - b. Installation crew shall be minimum Oregon licensed low voltage apprentices.
 - c. Vendor project manager shall be certified NICET Level III.
 - d. Vendor technician performing system programming, start-up, and testing shall be NICET Level II, and factory certified on system being supplied.
 - e. Organization chart for project.
- F. Record Drawings: Provide drawings showing equipment installed, cable identifiers, and schedules. Record drawings shall be "CAD" version of "redlined" drawings maintained on project site".
 - 1. Include NFPA 72 Certificate of Completion for each site.
- G. Sequence and Scheduling Plan: Provide Gantt chart schedule for design and installation within 30 days of award.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Factory-authorized. Minimum of five years experience in the design, installation, and maintenance of industrial fire alarm systems.
- B. Compliance With Local Requirements: Comply with the current and applicable building code, local ordinances and regulations, and the requirements of the AHJ.
 - 1. Oregon Structural Specialty Code
 - 2. Uniform Fire Code w/Oregon Amendments
 - 3. Oregon Mechanical Code
- C. Comply with requirements of the Americans With Disabilities Act (ADA).
- D. NRTL Listing: Provide systems and equipment that are "Listed and Labeled."
- E. Single-Source Responsibility: Each item of Fire Alarm System is listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters'

Laboratories, Inc. (UL), and bears the UL label. Control equipment is listed under UL category UOJZ.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturers' requirements. Coordinate storage location(s) with Owner's on site personnel.

1.7 FIELD INVESTIGATION

- A. Survey property where Work is to be performed to identify utilities and services where Work is to be coordinated prior to bid. Final equipment locations to be coordinated with and approved by Owner and AHJ prior to installation.
- B. Lack of survey by the awarded contractor/vendor team shall not relieve them of the responsibility to provide a complete and operational system.

1.8 SCHEDULING

- A. Schedule and coordinate installation with General Contractor's personnel. Minimize downtime and schedule sequence of all work with owner and General Contractor.

1.9 POST-CONTRACT INSPECTION

- A. Conduct post-contract inspection with Owner-designated representative(s) to ensure that punch list items have been remedied and that systems are functioning as designed.

1.10 WARRANTY

- A. Labor:
 - 1. Warrant all labor associated with each system installation for one –(1) year after owner's acceptance of the system.
 - 2. Should the system or system components fail to perform, during the one –(1) year warranty period, and according to terms of warranty, the contractor/vendor shall repair or replace system or components at no charge to the Owner and with a minimum delay.
- B. Equipment and Components:
 - 1. Warrant all hardware and software against faulty or inadequate design, improper assembly, defective workmanship or materials, breakage, or other failure for one -(1) year after owner's acceptance of the system.
 - 2. The minimum warranty period shall be one –(1) year, however; each contractor/vendor should clearly indicate the maximum equipment and device warranty which is available at no additional charge.
 - 3. Provide software upgrades and revisions for all components at no charge to the Owner during the initial on (1) year warranty.

1.11 SCOPE OF WORK

- A. The scope of work for this project consists of a remodel of the whole second floor and a partial of the third floor of an existing building with five floors. It shall be the contractor's responsibility to familiarize themselves with the specific nature of each site.
- B. Appropriate cabling in cable tray or conduit shall be permitted above ceiling and in conduit in walls as shown on drawings. Provide with insulated bushings on all conduit stub-outs to cable tray.
- C. All exposed fire alarm wiring shall be installed in EMT, minimum ¾" in size. All horn/strobes, strobes and manual pull stations shall be mounted, on the manufacturer's supplied box, to create a neat and workmanlike appearance.

PART 2 – PRODUCTS

2.1 VENDORS

- A. Manufacturer: Match University of Oregon Standard fire alarm system
- B. The following are the minimum requirements for installation of the fire alarm system.
 - 1. Signal Line Circuit: Provide 20% spare device capacity when installation is complete.
 - 2. Notification Appliance Circuit: Provide 20% additional capacity for current consumption and length of circuit (per NAC) when installation is complete.
 - 3. Power Supply: Provide 20% spare power.
 - a. Batteries: Provide 20% spare battery power.

2.2 EQUIPMENT/COMPONENTS

- A. Provide equipment, conduit, and wire as required to provide a complete and operational fire alarm system. Equipment is to be standard, unmodified, "off-the-shelf" products designed for uninterrupted duty. Where types are not indicated, provide products complying with established industry standards. Wire and cable has applicable National Electrical Code (NEC) rating for area in which it is to be installed (e.g., FLP for plenum areas).

2.3 FIRE ALARM CONTROL PANEL

- A. General: Comply with UL 864, 9th Edition.
- B. Cabinet: Lockable steel enclosure. Arrange panel so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control panel, provide exactly matching modular unit enclosures. Accommodate all components and allow ample gutter space for interconnection of panels and field wiring. Identify each enclosure by an engraved, red, laminated, phenolic-resin nameplate. Lettering on the enclosure's nameplate shall not be less than 1 inch (25 mm) high. Identify individual components and modules within the cabinets with permanent labels.

- C. Systems: The module circuit boards in the FACP consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.
- D. Control Modules: Provide types and capacities required to perform all functions of the fire alarm systems. Local, visible, and audible signals announce alarm, supervisory, and trouble conditions.
- E. Zones/Addresses: Provide for sufficient alarm and supervisory zones/addresses as indicated by devices noted on the drawings.
- F. Resetting: Provide necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm or trouble condition still exists.
- G. Alphanumeric Display and System Controls: Arrange to provide the basic interface between human operator at the FACP and addressable system components, including annunciation and supervision. A display with a minimum of 32 characters show alarm, supervisory, and component status messages. Arrange keypad for use in entering and executing control commands.
- H. Instructions: Printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install frame in a location observable from the FACP. Include interpretation and appropriate response for displays and signals, and briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 EMERGENCY POWER SUPPLY

- A. General: Components include sealed lead acid-type battery, charger, and an automatic transfer switch. Battery nominal life expectancy is 5 years, minimum.
- B. Battery capacity is adequate to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24-hours. At the end of this period, the battery has sufficient capacity to operate the system, including alarm-indicating devices in either alarm or supervisory mode, for a period of 5 minutes. (Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.) Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining the batteries at full charge. In the event batteries are fully discharged, the charger recharges them to 75% capacity within 12 hours. Charger output is supervised as part of system power supply supervision.
- C. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.5 ADDRESSABLE DEVICES

- A. Alarm-Initiating Devices: Classified as addressable devices according to NFPA 72.

1. Communication Transmitter and Receiver: Integral to device. Provides each device with a unique identification and capability for status reporting to the FACP.
2. External Addressable Interface Unit: May be used where specified devices are not manufactured and labeled with integral multiplex transmitter and receiver. Arrange to monitor status of each device individually.

2.6 MANUAL PULL STATIONS

- A. Description: Single-action type, fabricated of metal or plastic, and finished in red with molded, raised letter operating instructions in white.
 1. Station Reset: Key (same as FACP) reset. Station to have integral addressable module. Stations have screw terminals for connections.
 2. Where indicated on the drawings, provide with Plexiglas cover. Cover by STI or equal.

2.7 INTERFACE MODULES

- A. Provide interface module for monitoring dry contact inputs such as flow and tamper switches, hood systems, and other related devices. Class "B" initiating device circuits.
- B. Device may be single or dual input as necessary.

2.8 CONTROL MODULE

- A. Provide control module for control of circuits as indicated on drawings. Provide Form "C", 4 ampere rated @ 120VAC or 24VDC. Provide interposing relay as indicated on the drawings.

2.9 SMOKE DETECTORS

- A. General: Comply with UL 268. Include the following features:
 1. Factory Nameplate: Serial number and type identification.
 2. Operating Voltage: 24-VDC, nominal.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 4. Plug-in Arrangement: Detector and associated encapsulated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. The plug connection requires no springs for secure mounting and contact maintenance. Terminals in the fixed base accept building wiring.
 5. Integral Visual Indicating Light: Connect to indicate detector has operated.
 6. Remote Controllability: Individually monitor detectors at the FACP for calibration, sensitivity, and alarm condition, and individually adjust for sensitivity from the FACP.
- B. Photo-electronic Smoke Detectors: Include the following features:
 1. Detector Sensitivity: Between 2.5 and 3.5 percent-per-foot (0.008-0.011-percent-per-mm) smoke obscuration when tested according to UL 268.
 2. Sensor: An infrared detector light source with matching silicon-cell receiver. Provide integral thermistor set for 135 degrees Fahrenheit, rate compensated.
 3. Provide audible base as indicated on drawings. Base shall provide 85dBA @ 10 feet. Provide operation as indicated in functional matrix.

4. Provide the following devices in the indicated locations:
 - a. Resident Rooms: Smoke detector with integral thermal element. Must comply with requirements of functional matrix.
 - b. All other areas: Standard addressable photoelectric detector.

2.10 ALARM-INDICATING DEVICES

- A. Provide audio/visual devices with temporal (Code 3) audible signal and synchronized strobes.
- B. The notification appliances shall be Wheelock Series AS Multi-Candela Audible Strobe appliances and Series AH Audible appliances or equal.
 1. The Series AS Multi-Candela shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service.
 2. The Series AH Audible shall be UL Listed under Standard 464 (Fire Protective Signaling).
 3. Device characteristics:
 - a. All inputs shall be compatible with standard reverse polarity supervision of circuit wiring by a Fire Alarm Control Panel (FACP).
 - b. The audible portion of the appliance shall have a minimum of three (3) field selectable settings for dBA levels and shall have a choice of continuous or temporal (Code 3) audible outputs.
 - c. The strobe portion of the appliance shall produce a flash rate of one (1) flash per second over the listed Regulated Input Voltage Range of 16 to 33 VDC for 24-VDC models and shall incorporate a Xenon flashtube enclosed in a rugged Lexan(r) lens.
 - d. The Series AS Multi-Candela(r) shall be of low current design and shall have Zero Inrush.
 - e. The strobe intensity shall have a minimum of four (4) field selectable settings and shall be rated per UL 1971 for: 15, 30, 75 or 110 candela (wall mount versions).
 - f. The audible and audible strobe shall be designed for 24 VDC, 2-Wire operation and, when synchronization is required, shall be compatible with Wheelock's SM, DSM Sync Modules or Wheelock's PS-12/24-8 Power Supply with built-in Patented Sync Protocol.
 - g. The strobes shall not drift out of synchronization at any time during operation.
 - h. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash-rate.
 - i. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation (when used with the Wheelock Sync Module, Dual Sync Module or Wheelock Power Supply).
 4. Mounting:
 - a. The Series AS Multi-Candela(r) Audible Strobe and Series AH Audible shall incorporate a Patented Universal Mounting Plate that shall allow mounting to a single-gang, double-gang, 4-inch square, 100mm European type back boxes, or the SHBB Surface Back box.
 - b) If required, an NATP (Notification Appliance Trim plate) shall be provided. All notification appliances shall be backward compatible.

- C. Strobes: The visual notification appliances shall be Wheelock Series RSS Multi-Candela Strobe Appliances or approved equals.
1. The Series RSS Multi-Candela shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service
 2. The strobe shall be listed for indoor use and shall meet the requirements of FCC Part 15 Class B.
 3. Device characteristics:
 - a. All inputs shall be compatible with standard reverse polarity supervision of circuit wiring by a Fire Alarm Control Panel (FACP).
 - b. The strobe portion of the appliance shall produce a flash rate of one (1) flash per second over the listed Regulated Input Voltage Range of 16 to 33 VDC for 24-VDC models and shall incorporate a Xenon flashtube enclosed in a rugged Lexan(r) lens.
 - c. The Series RSS Multi-Candela(r) shall be of low current design and shall have Zero Inrush.
 - d. The strobe intensity shall have a minimum of four (4) field selectable settings and shall be rated per UL 1971 for: 15, 30, 75 or 110 candela (wall mount versions).
 - e. The strobe shall be designed for 24 VDC, 2-Wire operation and, when synchronization is required, shall be compatible with Wheelock's SM, DSM Sync Modules or Wheelock's PS-12/24-8 Power Supply with built-in Patented Sync Protocol.
 - f. The strobes shall not drift out of synchronization at any time during operation.
 - g. If the sync module or Power Supply fails to operate, (i.e., contacts remain closed), the strobe shall revert to a non-synchronized flash-rate.
 - h. The appliance shall also be designed so that audible signals on the NAC may be silenced while maintaining strobe activation (when used with the Wheelock Sync Module, Dual Sync Module or Wheelock Power Supply).
 4. Mounting:
 - a. The strobes shall be designed for indoor surface of flush mounting
 - b. The Series RSS Multi-Candela(r) Strobe and Series AH Audible shall incorporate a Patented Universal Mounting Plate that shall allow mounting to a single-gang, double-gang, 4-inch square, 100mm European type back boxes, or the SHBB Surface Back box.
 - c. If required, an NATP (Notification Appliance Trim plate) shall be provided. An attaching cover plate shall be provided to give the Appliance and attractive appearance. The Appliance shall not have any mounting holes or screw heads visible when the installation is completed.
 3. Weather Proof Horn and Strobe:
 - a. Provide Wheelock model W3MT-24R weatherproof strobe or equal.
 - b. Provide Wheelock model AH-24WP weatherproof horn or equal.
 - c. Mount both devices to manufacturer's weatherproof box (WBB-R).
- E. Synchronization Modules:
1. The sync modules shall be Wheelock Series SM or DSM Sync Modules.
 2. Series SM or DSM Sync Modules shall be the master controllers for Wheelock Series AS/AH, NS/NS4/NH, RSS, RSP, SL, SLM appliances where a synchronized audible/visual audible or visual only appliance is specified.
 3. All modules shall be UL listed under Standard 464. Series SM and DSM modules shall be designed to interface with Series AS Audible Strobe Appliances and NS Horn Strobe

- Appliances to produce a synchronized temporal (Code 3) horn as well as synchronized strobe flash on a two-wire alarm circuit.
4. Other synchronized products are the Wheelock Series RSS, RSSP, SL, SLM visual only appliances and Series AH and NH Horn Appliances.
 5. SM Sync Module shall incorporate two input NAC circuits for power connection from the Fire Alarm Control Panel: one for the strobe NAC circuit and one for the audible NAC circuit.
 6. DSM modules shall provide an additional strobe circuit input/output for control of either two Class "B" NAC circuits or a single Class "A" NAC circuit.
 7. Operation:
 - a. Upon activation of the audible silence function at the Fire Alarm Control Panel, the audible signal component of Series AS Audible Strobe and/or the Series NS Horn Strobe may be silenced while maintaining strobe activation.
 - b. The DSM dual circuit version shall provide the additional capability of "daisy-chaining", that is, the ability to interconnect multiple DSM's for synchronous horn and strobe operation on multiple NAC circuits.
 - c. Interconnection capability shall be for a maximum of 40 NAC circuits.
 8. Voltages:
 - a. All modules shall operate on either 12 or 24 VDC.
 - b. Rated average current requirement for the SM 12/24 shall be .014 amperes @ 12 VDC and .025 amperes @ 24 VDC.
 - c. The DSM 12/24 shall be .020 amperes @ 12 VDC and .038 amperes @ 24 VDC.
 - d. A single circuit SM Sync Module shall be capable of handling a 3-ampere load at 12 or 24 VDC and the dual circuit DSM Sync Module shall be capable of handling a load of 3 amperes per NAC circuit at 12 or 24 VDC.
 - e. All versions shall be polarized for DC supervision and shall incorporate screw terminals for in/out field wiring of #18 to #12 AWG wire size.
 9. Mounting:
 - a. SM module shall mount to a standard 4" x 2-1/8" deep back box.
 - b. DSM module shall mount to a 4-11/16" x 2-1/8" deep back box. (Wheelock DSM)

2.13 MISCELLANEOUS

- A. Line-Voltage and Low-Voltage Wire and Cable: Provide copper cable in sizes and types as recommended by equipment manufacturer for indicated applications. Use solid copper conductors. Sizes and types based on load voltage drop and line loss calculations provided by manufacturer. Provide cable that meets or exceeds the appropriate requirement for the areas in which it is installed. Outer jacket to be continuous, free from holes, splits, and inclusions.
- B. AC Surge Protection: Provide lightning/surge protection devices for all AC powered components. Comply with UL 96, 96A, 497, 497A, 497B, and 1449. Transtector or equal as approved manufacturer.
- C. Low Voltage Surge Protection: Provide lightning/surge protection devices for all "low voltage" powered circuits as they "leave" and "enter" a building. Comply with NEC and applicable UL Listings. Transtector or equal as approved manufacturer.

- D. Tags For Identifying Tested Components: Comply with NFPA 72.
- F. Wire Labeling: Provide Panduit laser tags or equal. Each panel connection and device connection to indicate either its preceding origination point, or its destination point. Provide labeling scheme with submittals.

2.14 ACCESSORIES

- A. Provide hardware, software, cables, adapters, terminators, and other products as needed for a fully functional Fire Alarm System.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system according to UFC 10-2 Standard, NEC, and other applicable standards.
- B. Ensure that:
 1. Applicable statutes, ordinances, regulations, license requirements and codes are fully complied with.
 2. Required permits are obtained.
 3. Required inspections are conducted.
 4. Necessary certificates are issued, obtained, and delivered to Owner.
- C. Arrange components to be mounted to provide a neat appearance and accessibility for servicing equipment.
- D. Program system per the requirements of this specification, the functional matrices, and local code requirements.

3.2 EQUIPMENT INSTALLATION

- A. Fire Alarm Power Supply Disconnect: Paint red and label "FIRE ALARM CIRCUIT CONTROL." Provide with lockable handle or cover.
- B. Fire Alarm Control Panel and Annunciators: Label requirements of Division 16. Mount with top at 60 inches above the finished floor.
- C. Manual Pull Stations: Mount semi-flush in recessed back boxes with operating handles mounted 48 inches above the finished floor. Locate in accordance with ADA requirements.
- D. Smoke Detectors: Install ceiling-mounted detectors not less than four inches from a sidewall to the near edge. Install detectors located on the wall at least four inches but not more than 12 inches below the ceiling. On smooth ceilings, install detectors not over 30 feet apart in any direction. Install detectors no closer than five feet from air registers.

- E. Audible/Visible Alarm-Indicating Devices: Install 80-inches above the highest floor level within the space or 6 inches below the ceiling, whichever is lower. Combine audible and visible alarms at the same location into a single unit.
- F. Visible Alarm-Indicating Devices: Install 80-inches above the highest floor level within the space or six inches below the ceiling, whichever is lower.
- G. Monitor and Control Modules: Mount devices so that they will be accessible for maintenance. Provide junction box as appropriate for configuration. Interposing relays shall be in the same enclosure as the control module.

3.3 WIRING INSTALLATION

- A. Provide panel wiring required, including temporary wiring. Install wiring according to NEC and National Fire Protection Association regulations (as applicable), and local building codes and ordinances. Obtain and adhere to referenced regulations, codes, ordinances, and standards. Label conductors as noted in Part I of this section.
- B. Install wiring in metal raceway, except where plastic conduit is approved for underground applications. Conceal raceway except in unfinished spaces and as indicated. Utilize in/out-wiring method for initiating and notification circuits.
- C. Install cable continuous and unspliced from origination to destination. Ensure cable distance limitations are not exceeded and that cable is sized and rated for appropriate application.
- D. Wiring Within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the wiring diagrams of the system. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Connect distribution and connector panel ground terminals to grounding terminals on each piece of equipment by a separate ground wire. Run ground wire from panel ground terminal to nearest building or distribution ground system. Grounding shall be as indicated on the manufacturer's shop drawings.
- F. Cable Taps: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where any circuit tap is made. Terminal strip connection points shall not have more than two (2) conductors under each screw terminal.
 - 1. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Paint fire alarm system junction boxes and covers red. Label covers of junction boxes "FA".

3.4 FIELD QUALITY CONTROLS

- A. **Manufacturer's Field Services:** Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

- B. **Testing:**
 - 1. Assemble Alarm Test Procedure (ATP) for use in pre-testing.
 - 2. Base ATP on format of Functional Matrix, and the requirements of NFPA 72.

- C. **Pre-testing:**
 - 1. Upon completing installation of the system, align, adjust, and balance the system and perform complete pre-testing.
 - 2. Determine, through pretesting, the conformance of the system to the requirements of the Functional Matrix, Drawings and Specifications.
 - 3. Correct deficiencies observed in pre-testing.
 - 4. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 - 5. Minimum required tests:
 - a. Verify the absence of unwanted voltages between circuit conductors and ground.
 - b. Test all conductors for short circuits utilizing an insulation-testing device.
 - c. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the pretest report (see attached example).
 - d. Verify the control unit is in the normal condition as detailed in the manufacturer's operating and maintenance manual.
 - e. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than ten percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 - f. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - g. Test the system for all specified functions according to the manufacturer's operating and maintenance manual.
 - i. Systematically initiate specified functional performance items at each device including making all possible alarm and monitoring initiations and using all communications options.
 - ii. For each item, observe related performance at all devices, as they are required to be affected by the input item under all system sequences.
 - iii. Observe indicating lights, displays, signal tones, and annunciator indications.
 - h. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the period and in the manner specified.
 - 6. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

- D. **Report of Pre-testing:**
 - 1. After pre-testing is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the pre-testing.

2. Attach documentation of pretest results.
- E. Final Test Notice: Provide 10-day minimum notice to the Owner in writing when system is ready for final acceptance testing.
 - F. Final Test and Inspection:
 1. Test per requirements of AHJ.
 2. Owner and/or Owner's Representative shall conduct a 100% functional test of the system to ensure all conditions are in compliance with Functional Matrix, Specifications, and Drawings.
 - G. Retesting:
 1. Should the system not meet satisfactory approval of either the AHJ or the Owner (or the Owner's designated Representative), and retest be determined to be necessary, then the contractor/vendor shall bear all applicable cost such as transportation, lodging, and per diems.
 2. Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
 - H. Report of Final Test and Inspection:
 1. Provide the following within 30-days of Owner Acceptance.
 - a. Provide a written record of inspections, tests, and detailed test results in the form of the original ATP.
 - b. Submit completed NFPA 72 Certificate of Completion.
 - c. Provide record drawings
 - d. Provide Operation and Maintenance manuals.

3.5 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.
- B. Clean smoke detectors internally, as required, using methods and materials recommended by manufacturer.

3.6 SYSTEM SERVICING

- A. Provide Owner with pricing for a one -(1) year Inspection and Test Agreement for the facilities. Furnish pricing and a copy of agreement 30 days prior to Owner Acceptance Testing. Inspection and Test to be based upon standards published in the Oregon Uniform Fire Code, Article 10-2.
- B. Provide Owner with pricing for a one -(1) year U.L. Listed central station monitoring agreement. Furnish pricing and a copy of agreement 30 days prior to Owner Acceptance Testing.

3.7 TRAINING

- A. Provide services of a factory-authorized service representative to demonstrate system and train Owner's staff personnel as specified below
1. Train Owner's personnel in the procedures involved in operating the system within 48 hours of owner acceptance.
 2. Provide minimum of 2 hours training. Schedule training in conjunction with Owner Acceptance Testing.
 3. The object of training is the following:

Familiarization of System Operation for:

Alarm, and the definition of an alarm condition.

Provide an overview of what alarm initiating devices are furnished with the system

Supervisory, and the definition of a supervisory condition

Trouble, and the definition of a trouble condition

Provide an explanation as to the operation of the audio/visual devices

4. Provide a syllabus of training when submitting schedule for Final Acceptance Testing.
5. Provide a letter stating, within seven –(7) days following the training, indicating who attended, the time and date that the training occurred, and signed by the site manager.

END OF SECTION

SECTION 16740
TELEPHONE/DATA PROVISIONS

PART 1 - GENERAL

1.1 WORK INCLUDED:

- A. Furnish and install telephone/data raceway system as noted on the drawings.
- B. Comply with the latest versions of ANSI/TIA/EIA Standards 569, 606 and 607 and current University of Oregon Telecommunications Standards.

1.2 RELATED WORK:

- A. Section 16110 - Conduits, Raceways, Boxes, Fittings.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. Wall Outlet Boxes: Double-gang deep junction box with single-gang mud ring.
- B. Conduits: 1-inch minimum size with larger sizes indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Conduit bends shall be large radius field bends or factory ells. Cast type fittings or sharp bends shall not be installed unless specifically approved by the systems installer. No section of conduit shall be longer than 100 feet or contain more than two 90 degree bends between pull points or pull boxes.
- B. Where conduits are shown stubbed up into a terminal area, stub 6 inches above floor or 12 inches down from ceiling at the appropriate terminal board location, terminating in insulating bushings.
- C. Provide a pull wire in all conduits.
- D. Protect all existing telephone terminals and data equipment that will remain in service during construction from mechanical injury and dust entry.
- E. Coordinate with system supplier for phasing and work scheduling.

- F. The inside radius of a bend in conduit shall be at least 6 times the internal diameter. When the conduit size is greater than 2 inches, the inside radius shall be at least 10 times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least 10 times the internal diameter of the conduit.
- G. All low voltage conduit stub-outs shall be provided with insulated bushings.

END OF SECTION