

SECTION 260001 - ELECTRICAL WORK

(Filed Sub-Bid Required) - *

TABLE OF CONTENTS

PART 1 - GENERAL

1.01	GENERAL PROVISIONS.....	1
1.02	DESCRIPTION OF WORK	2
1.03	SUBMITTALS.....	2
1.04	REFERENCES.....	3
1.05	REGULATORY REQUIREMENTS	3
1.06	SURVEYS AND MEASUREMENTS	4
1.07	COORDINATION	4
1.08	MECHANICAL AND ELECTRICAL COORDINATION.....	5
1.09	INSTALLATION REQUIREMENTS.....	5
1.10	TYPICAL DETAILS	6
1.11	SLEEVES, INSERTS	6
1.12	CORING, DRILLING	6
1.13	ACCESSIBILITY	6
1.14	SUPPLEMENTARY SUPPORTING STEEL	6
1.15	TOOLS AND EQUIPMENT	7
1.16	RECORD DRAWINGS, PROJECT CLOSEOUT	7
1.17	GUARANTEE/WARRANTY	7
1.18	OPERATING, INSTRUCTION AND MAINTENANCE MANUALS	8
1.19	QUALITY ASSURANCE	9
1.20	DELIVERY, STORAGE AND HANDLING.....	10
1.21	TEMPORARY POWER AND LIGHTING	10
1.22	EXTRA MATERIALS.....	11
1.23	PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES.....	11

PART 2 - PRODUCTS

2.01	MANUFACTURERS.....	12
2.02	RACEWAYS AND FITTINGS.....	12
2.03	WIRING MATERIALS	14
2.04	OUTLET, JUNCTION, AND PULL BOXES.....	15
2.05	WIRING DEVICES	16
2.06	GROUNDING REQUIREMENTS.....	17
2.07	PHASING AND COLOR CODING	18
2.08	LIGHTING FIXTURES	19
2.09	HORIZONTAL DATA CABLING.....	21
2.10	FIRE ALARM SYSTEM.....	23

ELECTRICAL WORK

PART 3 - EXECUTION

3.01	BASIC REQUIREMENTS	29
3.02	TESTING REQUIREMENTS & INSTRUCTIONS	29
3.03	BRANCH CIRCUITRY	32
3.04	IDENTIFICATION AND TAGGING.....	33
3.05	LIMITING NOISE PRODUCED BY ELECTRICAL INSTALLATION	35
3.06	SUPPORTS AND FASTENINGS.....	35
3.07	SPLICING AND TERMINATING WIRES AND CABLES.....	37
3.08	PULLING WIRES INTO CONDUITS AND RACEWAYS.....	37
3.09	REQUIREMENTS FOR THE INSTALLATION OF JUNCTION BOXES, OUTLET BOXES AND PULL BOXES.....	38
3.10	LOCATING AND ROUTING OF CIRCUITRY	41
3.11	INSTALLING CIRCUITRY	42
3.12	HORIZONTAL DATA CABLING EXECUTION.....	42
3.13	FIRE ALARM SYSTEM EXECUTION.....	45

END OF TABLE OF CONTENTS

SECTION 260001 - ELECTRICAL WORK

(Filed Sub-Bid Required)

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Time, Manner and Requirements for Submitting Sub-Bids:
 - 1. Sub-bids for work under this Section shall be for the complete work and shall be filed in a sealed envelope with the Division of Capital Asset Management at a time and place as stipulated in the "NOTICE TO CONTRACTORS".

The following should appear on the upper left hand corner of the envelope:

NAME OF SUB-BIDDER: _____

MASS. STATE PROJECT: _____

SUB-BID FOR SECTION: 260001 – ELECTRICAL WORK

- 2. Each sub-bid submitted for work under this Section shall be on forms furnished by the Division of Capital Asset Management as required by Section 44F of Chapter 149 of the General Laws, as amended. Sub-bid forms may be obtained at Purchasing Office, University of Massachusetts at Amherst, Goodell Hall, 4th Floor, or may be obtained by written or telephone request [phone (413-545-0361)].
 - 3. Sub-bids filed with the University shall be accompanied by BID BOND or CASH or CERTIFIED CHECK or TREASURER'S CHECK or CASHIER'S CHECK issued by a responsible bank or trust company payable to the "Commonwealth of Massachusetts" in the amount of five percent of the sub-bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.
- C. Sub Sub-Bid Requirements: None under this Section.
 - D. Reference Drawings: The Work of this Filed Sub-Bid is shown on the following Contract Drawings: E-1

ELECTRICAL WORK

1.02 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
1. Electrical wiring, systems, equipment, and accessories in accordance with the specifications and drawings. Capacities and ratings of motors, transformers, cable, switchboards, switchgear, panelboards, motor control centers, and other items and arrangements for the specified items are shown on drawings.
 2. The Electrical Contractor shall carry the costs for all permits and fees in his/her bid.
 3. The Electrical Contractor shall contact the Amherst Fire Department and obtain a list of all items required for a permit. This information shall be submitted to the UMASS Project Manager for review before applying for the permit.
 4. All lighting systems (indoor and outdoor, normal, night, emergency and exit) including all fixtures, lamps, mounting accessories, switches, controls, outlets, wiring, raceways, and all other components and fittings required for a complete lighting system.
 5. Grounding and bonding of all electrical systems and equipment.
 6. Wiring devices (switches and receptacles) complete with associated wall plates.
 7. Power wiring to HVAC, plumbing and fire alarm equipment.
 8. Telephone and data system.
 9. Testing of all electrical systems.
 10. Coordination between electrical and other trades.
 11. All other systems hereinafter specified or indicated on the Contract Drawings, complete, leaving ready an electrical system in perfect operating condition.
- B. Items To Be wired Only: Install power wiring to the following items as furnished by the designated Sections:
1. Section 230001 - HEATING, VENTILATING AND AIR CONDITIONING:
- C. The Electrical Sub-Contractor shall be responsible for filing all documents, payment of all fees, and securing of all inspections and approvals necessary for the electrical work.

1.03 SUBMITTALS

- A. Comply with requirements specified in Section 013300 – SUBMITTAL REQUIREMENTS.
- B. Material and equipment requiring Shop Drawing Submittals shall include but not be limited to:
1. Light fixtures.

ELECTRICAL WORK

2. Overcurrent and switching devices.
3. Wiring devices and wall plates.
4. Telephone and data communications system including wiring diagram.
5. Wiring and cables.
6. Conduit.
7. Boxes and fittings.
8. Safety switches.

1.04 REFERENCES

- A. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any electrical item in the drawings or specifications for electrical work carries with it the instruction to furnish, install and connect the item as part of the electrical work, regardless of whether or not this instruction is explicitly stated.
- B. It shall be understood that the specifications and drawings for electrical work are complimentary and are to be taken together for a complete interpretation of the electrical work except that indications on the drawings, which refer to an individual element of work, take precedence over the specifications where they conflict with same.

1.05 REGULATORY REQUIREMENTS

- A. Comply with all applicable federal and state laws, and all local codes, by-laws and ordinances.
- B. Where provisions of the Contract Documents conflict with any codes, rules or regulations, the latter shall govern. Where the contract requirements are in excess of applicable codes, rules or regulations, the contract provisions shall govern unless the Project Manager rules otherwise.
- C. Request inspections from authorities having jurisdiction, obtain all permits and pay for all fees and inspection certificates as applicable and/or required. All permits and certificates shall be turned over to the UMA - AMHERST's Project Manager at the completion of the work. Copies of permits shall be given to the Project Manager prior to the start of work.
- D. Unless otherwise specified or indicated, materials and workmanship and equipment performance shall conform with the latest edition of the following standards, codes, specifications, requirements and regulations:
 1. State Building Code
 2. Massachusetts Electrical Code
 3. National Fire Protection Association (NFPA)
 4. Local Town Regulations and By-laws
 5. Underwriter's Laboratories, Inc. (UL)
 6. National Electrical Manufacturer's Association (NEMA)
 7. American National Standards Institute (ANSI)

ELECTRICAL WORK

- E. All electrical work shall meet or exceed any other state and local codes and/or authorities having jurisdiction including all other standards indicated herein.
- F. References to the Massachusetts Electrical Code (MEC), Underwriters Laboratories, Inc. (UL) and National Fire Protection Association (NFPA) are minimum installation requirement standards.

1.06 SURVEYS AND MEASUREMENTS

- A. Base all required measurements, both horizontal and vertical, on reference points established by the General Contractor and be responsible for the correct laying out of the electrical work. In the event of a discrepancy between actual measurements and those indicated, notify the General Contractor in writing, and do not proceed with the work required until written instructions have been issued by the General Contractor.

1.07 COORDINATION

- A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.
- B. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow speedy and efficient completion of the work.
- C. Furnish to other trades advance information on locations and sizes of all frames, boxes, sleeves and openings needed for their work, and also furnish information and shop drawings necessary to permit trades affected by the work to install same properly and without delay.
- D. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Project Manager. Where the electrical work shall interfere with the work of other trades, assist in working out the space conditions to make satisfactory adjustments before installation. Without extra cost to UMA - Amherst, make reasonable modifications to the work as required by normal structural interferences. Pay the General Contractor for additional openings, or relocating and/or enlarging existing openings through concrete floors, walls, beams and roof required for any work which was not properly coordinated. Maintain maximum headroom at all locations. All piping, duct, conduit, and associated components to be as tight to underside of structure as possible.
- E. If any electrical work has been installed before coordination with other trades so as to cause interference with the work of such trades, all necessary adjustments and corrections shall be made by the electrical trades involved without extra cost to UMA - Amherst.

ELECTRICAL WORK

- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to the Project Manager for review and approval.
- G. Protect all materials and work of other trades from damage which may be caused by the electrical work, and repair all damages without extra cost to UMA - Amherst.

1.08 MECHANICAL AND ELECTRICAL COORDINATION

- A. Heating and Ventilating Subcontractor shall furnish and install various electrical items relating to the heating and ventilating equipment and control apparatus. The Electrical Subcontractor shall be required to connect power wiring to this equipment unless noted otherwise.
- B. The Heating and Ventilating and Electrical Subcontractors shall coordinate their respective portions of the work, as well as the electrical characteristics of the heating and ventilating equipment.
- C. All power wiring and local disconnect switches will be provided by the Electrical Subcontractor for the line voltage power. All control and interlocking wiring shall be the responsibility of the Heating and Ventilating Subcontractor.
- D. 120V and above power wiring sources extended and connected to heating and ventilating control panels, transformers and switches shall be the responsibility of the Electrical Subcontractor. All low voltage thermostats, zone valves and any switch wiring shall be the responsibility of the Heating and Ventilating Subcontractor.
- E. Temperature control and equipment wiring shall be installed by the Heating and Ventilating Subcontractor.
- F. Pipe Tracing shall be furnished and installed by the specified subcontractor. Power connections shall be by the Electrical Subcontractor.
- G. The Electrical Subcontractor will provide all magnetic starters except those furnished as an integral part of packaged equipment. VFD's shall be provided by the HVAC contractor and power wired by the Electrical Contractor.

1.09 INSTALLATION REQUIREMENTS

- A. The arrangement of all electrical work shown on the drawings is diagrammatic only and indicates the minimum requirements of the work. Conditions at the building including actual measurements shall determine the details of the installation. All work shall be laid out and installed so as to require the least amount of cutting and patching.
- B. Check the Architectural plans and specifications before ordering any material and equipment. Any discrepancies shall be brought to the attention of the Project Manager for his determination prior to proceeding with the work.

ELECTRICAL WORK

1.10 TYPICAL DETAILS

- A. Typical details where shown on the drawings shall apply to each and every item of the project where such items are applicable. They are not repeated in full on the drawings, which in many cases are diagrammatic only, but with the intention that such details shall be incorporated in full. Any alternate method proposed for use by the Contractor shall have the prior approval of the Project Manager.

1.11 SLEEVES, INSERTS

- A. Furnish and install all sleeves, inserts, anchor bolts and similar items to be set into masonry or concrete, as required for mechanical and electrical work. Internal diameter of sleeve shall be 2" larger than the outside diameter of the pipe or insulation covered line passing through it.

1.12 CORING, DRILLING

- A. Core, cut and/or drill all small holes 4.5" diameter or less in walls and floors required for the installation of sleeves and supports for the electrical work.

1.13 ACCESSIBILITY

- A. Install all work such that parts requiring periodic inspection, operation, maintenance and repair are readily accessible.
- B. Furnish all access panels appropriate to particular conditions, to be installed by trades having responsibility for the construction of actual walls, floors or ceilings at required locations.

1.14 SUPPLEMENTARY SUPPORTING STEEL

- A. Provide all supplementary steelwork required for mounting or supporting equipment and materials.
- B. Steelwork shall be firmly connected to building construction as required.
- C. Steelwork shall be of sufficient strength to allow only minimum deflection in conformity with manufacturer's published requirements.
- D. All supplementary steelwork shall be installed in a neat and workmanlike manner parallel to floor, wall and ceiling construction; all turns shall be made at forty-five and ninety degrees, and/or as dictated by construction and installation conditions.
- E. All manufactured steel parts and fittings shall be galvanized.

1.15 TOOLS AND EQUIPMENT

- A. Provide all tools and equipment required for the fabrication and installation of the mechanical and electrical equipment at the site.

1.16 RECORD DRAWINGS, PROJECT CLOSEOUT

- A. Comply with requirements specified in Section 017700 – CONTRACT CLOSEOUT.
- B. This trade shall submit the record set for approval by the fire and building departments in a form acceptable to the departments, when required by the jurisdiction.
- C. Drawings shall show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation.

1.17 GUARANTEE/WARRANTY

- A. Guarantee Work of this Section in writing for one year following the date of beneficial occupancy by the University. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Project Manager's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.
- B. In addition to guarantee requirements of Division 01 and of Subparagraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in User Agency's name.
 - 1. Upon receipt of notice from the Project Manager of failure of any part of the systems or equipment during the warranty period, the affected part or parts shall be replaced by this Contractor without any reimbursement.
 - 2. Replace material and equipment that require excessive service during guarantee period as defined and as directed by Designer.
 - 3. Submit copies of equipment and material warranties to Designer before final payment.
 - 4. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to UMA.
 - 5. This Paragraph shall not be interpreted to limit UMA's rights under applicable codes and laws and under this Contract.
 - 6. Part 2 Paragraphs of this Specification may specify warranty requirements that exceed those of this Paragraph. Those paragraphs will govern.

ELECTRICAL WORK

7. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work by DCAM's Project Manager, and shall not initiate the guarantee period.
8. Non-durable items, such as electric lamps, shall be replaced up to the date of acceptance, such that they shall have had no more than 100 hours use prior to this date.
9. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately to the Project Manager's satisfaction, advise Project Manager in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Project Manager will direct course of action.

1.18 OPERATING, INSTRUCTION AND MAINTENANCE MANUALS

- A. Refer to SECTION 017700 - CONTRACT CLOSEOUT for submittal procedures pertaining to operating and maintenance manuals.
- B. Each copy of the approved operating and maintenance manual shall contain copies of approved shop drawings, equipment literature, cuts, bulletins, details, equipment and engineering data sheets and typewritten instructions relative to the care and maintenance for the operation of the equipment, all properly indexed. Each manual shall have the following minimum contents:
 1. Table Of Contents
 2. Introduction
 - a. Explanation of manual and its purpose and use.
 - b. Description of the electrical systems.
 - c. Safety precautions necessary for equipment.
 - d. Illustrations, schematics and diagrams.
 - e. Installation drawing.
 3. Maintenance
 - a. Maintenance and lubricating instructions.
 - b. Replacement charts.
 - c. Trouble shooting charts for equipment components.
 - d. Testing instructions for each typical component.
 - e. Two typed sets of instructions for ordering spare parts. Each set shall include name, price, telephone number and address of where they may be obtained.
 4. Manufacturer's Literature

- a. The equipment for which shop drawings have been submitted and approved.

1.19 QUALITY ASSURANCE

- A. The requirements of the State Building Code and local regulations establish the minimum acceptable quality of workmanship and materials, and all work shall conform thereto unless more stringent requirements are indicated or specified herein.
- B. All work shall comply with the latest editions of the codes as referenced herein.
- C. Follow manufacturer's directions for articles furnished, in addition to directions shown on drawings or specified herein.
- D. Protect all work, materials, and equipment from damage during process of work. Replace all damaged or defective work, materials and equipment without additional cost to UMA.
- E. All equipment and materials for permanent installation shall be the products of recognized manufacturers and shall be new.
- F. Equipment and materials shall:
 1. Where normally subject to Underwriters Laboratory Inc. listing or labeling services, be so listed or labeled.
 2. Be without blemish or defect.
 3. Not be used for temporary light and power purposes.
 4. Be in accordance with the latest applicable NEMA standards.
 5. Be products which will meet with the acceptance of all authorities having jurisdiction over the work. Where such acceptance is contingent upon having the products examined, tested and certified by Underwriters or other recognized testing laboratory, the product shall be so examined, tested and certified.
- G. Except for conduit, conduit fittings, outlet boxes, wire and cable, all items of equipment or material of one generic type shall be the product of one manufacturer throughout.
- H. For items which are to be installed but not purchased as part of the electrical work, the electrical work shall include:
 1. The coordination of their delivery.

ELECTRICAL WORK

2. Their unloading from delivery trucks driven into any point on the property line at grade level.
 3. Their safe handling and field storage up to the time of permanent placement in the project.
 4. The correction of any damage, defacement or corrosion to which they may have been subjected. Replacement if necessary shall be coordinated with Contractor who originally purchased the item.
 5. Their field make-up and internal wiring as may be necessary for their proper operation.
 6. Their mounting in place including the purchase and installation of all dunnage, supporting members, and fastenings necessary to adapt them to architectural and structural conditions.
 7. Their connection to building wiring including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring. Included also shall be the purchase and installation of any substitute lugs or other wiring terminations as may be necessary to adapt their terminals to the building wiring as called for and to the connection methods set forth in these specifications.
- I. Items which are to be installed but not purchased as part of the electric work shall be carefully examined upon delivery to the project. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of the electric work will be considered only if presented in writing within one week of the date of delivery to the project of the items in question. The electric work includes all procedures, regardless of how extensive, necessary to put into satisfactory operation, all items for which no claims have been submitted as outlined above.

1.20 DELIVERY, STORAGE AND HANDLING

- A. All materials for the work of this section shall be delivered, stored and handled so as to preclude damage of any nature. Manufactured materials shall be delivered and stored in their original containers, plainly marked with the products' and manufacturer's name. Materials in broken containers or in packages showing watermarks or other evidence of damage, shall not be used and shall be removed from the site.

1.21 TEMPORARY POWER AND LIGHTING

- A. All temporary electrical work shall meet the requirements of the Massachusetts Electrical Code and all Federal Standards and local laws.
- B. All temporary wiring and accessories thereto installed by the Electrical Subcontractor shall be removed after their purposes have been served.

ELECTRICAL WORK

- C. The General Contractor will pay for the cost of electric energy consumed by himself and by all of his Subcontractors, unless otherwise indicated.
- D. All lamps installed in permanent lighting fixtures and used for lighting during construction shall be replaced by the Electrical Subcontractor just prior to date of Use and Occupancy or Final Acceptance.

1.22 EXTRA MATERIALS

- A. Furnish extra materials described in following product specification sections that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.

1.23 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

- A. During the execution of the work, required relocation, etc., of existing equipment and systems in the existing building areas where new work is to be installed or new connections are scheduled to be made, shall be performed by the Electrical Subcontractor, as required by job conditions and as determined by the Project Manager in the field, to facilitate the installation of the new system, while demolition, relocation work or new tie ins will be performed. Outages required for construction purposes shall be scheduled for the shortest practical periods of time, in coordination with the Project Manager for specified, mutually agreeable periods of time, after each of which the interruption shall cease and the service shall be restored. This procedure shall be repeated to suit the building occupants' working schedule, as many times as required until all work is completed. Any outages of service shall be approved by the Project Manager at least 14 days prior to commencing the work. No outages or shutdowns of service shall occur without the written authorization of the Project Manager prior to commencing the work.
- B. Prior to any deactivation and relocation or demolition work, inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
- C. All deactivation, relocation and temporary connections of electrical systems and equipment shall be provided by the Electrical Subcontractor. All demolition and removal of electrical systems and equipment designed to be demolished shall be provided by the Electrical Subcontractor. Place all demolished electrical materials except hazardous materials (PCB lighting ballasts, fluorescent lamps, etc.) As determined by the Authority having jurisdiction in general contractors provided dumpster. All hazardous electrical materials shall be legally disposed by the electrical subcontractor.
- D. UMA Project Manger reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
- E. Phasing

ELECTRICAL WORK

1. The Electrical Subcontractor shall construct the subject project in phases as directed by the Project Manager to suit the project progress schedule, as well as the completion date of the project.
2. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architectural drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application.
- B. For purpose of establishing a standard of quality and not for purpose of limiting completion, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.
- C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers products will be unacceptable.
- D. Where Specifications list manufacturer's names and/or "as approved" or "Equal approved by Project Manager, other manufacturers equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Project Manager.
- E. All materials shall be new and shall be UL listed.

2.02 RACEWAYS AND FITTINGS

- A. Raceways - General:
 1. No raceway shall be used smaller than 3/4" diameter. No conduit shall have more than three (3) 90° bends in any one run, and where necessary, pull boxes shall be provided.
 2. Rigid metal conduit conforming to, and installed in accordance with, Article 346 of NFPA 70 shall be heavy wall zinc coated steel conforming to American Standard Specifications C80-1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, and in

ELECTRICAL WORK

mechanical rooms and where raceway may be subject to mechanical damage, i.e., loading docks, work shops, etc.

3. Thin wall conduit (EMT), conforming to, and installed in accordance with, Article 346 of NFPA 70 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings where exposed but not subject to mechanical damage, and shall be used for fire alarm work.
4. Flexible metal conduit shall be used for connections to recessed lighting fixtures and motors. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include a grounding conductor.
5. Acceptable manufacturers:
 - a. Allied Tube & Conduit Company
 - b. AFC Cable Systems, Inc.
 - c. Alflex Inc.
 - d. O-Z Gedney; a unit of General Signal.
6. Fittings:
 - a. Provide insulated bushings on all raceways 1 inch diameter or larger.
 - b. Manufacturer's standard fittings shall be used for raceway supports.
 - c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap.
 - d. Couplings for rigid metal conduit shall be threaded type.
 - e. Threadless fittings for EMT shall be watertight compression type. Set-screw type fittings are not acceptable. All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1 inch diameter.
 - f. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
 - g. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
 - h. Acceptable manufacturers:
 1. O.Z. Gedney; a unit of General Signal
 2. Crouse Hinds
 3. Appleton
 4. EFCOR
 5. Steel City

ELECTRICAL WORK

2.03 WIRING MATERIALS

- A. Building Wire and Cable shall be copper with 600V insulation, THWN for branch circuitry and XHHW for feeders.
- B. Conductors shall be of soft drawn 98% minimum conductivity properly refined copper, stranded construction where No. 12 AWG and larger.
- C. Exterior of wires shall bear repetitive markings along their entire length indicating conductor size, insulation type and voltage rating.
- D. Exterior of wires shall be color coded, so as to indicate a clear differentiation between each phase and between each phase and neutral. In all cases, grounded neutral wires and cables shall be identified by the colors white or gray. In sizes and insulation types where factory applied colors are not available, wires and cables shall be color coded by the application of colored plastic tapes in overlapping turns at all terminal points, and in all boxes in which splices are made. Colored tape shall be applied for a distance of 6 inches along the wires and cables, or along their entire extensions beyond raceway ends, whichever is less.
- E. Final connections to motors shall be made with 18" of neoprene sheathed flexible conduit.
- F. Minimum branch circuit conductor size shall be No. 12 AWG installed in conduit. Motor control circuit wiring shall be minimum No. 12 AWG installed in conduit.
- G. Branch and motor circuit lengths shall be kept to a minimum in the approximate areas diagrammatically shown on the drawings. Conductor and raceway sizes shall be increased to maintain 3% voltage drop as determined by proposed circuit length. The contractor shall report all circuit lengths greater than 100 feet to the Engineer of Record. Voltage measurements for all circuit lengths over 100 feet shall be recorded and submitted to the project manager after installation.
- H. Other wires and cables required for the various systems described elsewhere in this section of the Specifications shall be as specified herein, as shown on the Contract Drawings, or as recommended by the manufacturer of the specific equipment for which they are used, all installed in conduit.
- I. Steel Metal Clad sheathed cable NFPA 70, type MC may be used for branch circuitry where shown and where run concealed and not subject to physical damage. All branch circuits shall be run in conduit from the panelboard to the first outlet. All type MC cable used shall contain a full size insulated ground conductor. All conductors shall be copper. All type MC cable insulation used shall have voltage rating of 600 volts, shall have a temperature rating of 75 degrees C. and shall be thermoplastic material. Armor material shall be steel and armor design shall be interlocked metal tape. Fire alarm rated MC cable may be used for fire alarm work where concealed.
- J. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or equal:

ELECTRICAL WORK

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Southwire Company.

2.04 OUTLET, JUNCTION, AND PULL BOXES

A. Outlets:

1. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations shall be of cast-metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction.
2. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of NFPA 70. Boxes shall not be less than 1-1/2" deep unless shallower boxes are required by structural conditions and are specifically approved by Project Manager. Ceiling and bracket outlet boxes shall not be less than 4" octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4" square or of comparable volume.
3. Acceptable manufacturers:
 - a. Appleton
 - b. Crouse Hinds
 - c. Steel City
 - d. RACO

- B. Pull and Junction Boxes: Where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be as required by Code. Where intermediate cable supports are necessary because of box dimensions, provide insulated removable core brackets to support conductors. Junction boxes are to be equipped with barriers to separate circuits. Where splices are to be made, boxes shall be large enough to provide ample work space. All conductors in boxes are to be clearly tagged to indicate characteristics. Boxes shall be supported independently of raceways. Junction boxes in moist or wet areas shall be galvanized type. Boxes larger than 4 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.

2.05 WIRING DEVICES

- A. Provide wiring device type plates for all wall mounted devices. All wall plates shall be Type 302 stainless steel. Receptacle plate shall be labeled with source panel designation and circuit number.
- B. Wiring devices standard for the project (i.e., with no specific type indicated) shall conform to the following:
 - 1. Visible part colors of wiring devices shall be as directed by the Architect.
- C. Wiring device switches shall be toggle type, A.C. specification grade, 20 amps on 120 volt circuits. Switches shall be mounted 48" to center line above finished floor unless noted otherwise.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 2221 (single pole), 2222 (two pole), 2223 (three way).
 - b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way).
 - c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way).
 - d. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way).
- D. Standard duplex convenience receptacles shall be 125 volt, 20 amps, three wire (two circuit wires plus ground), "U-bar" ground NEMA slot configuration 5-20R, specification grade with a one-piece ground assembly. Receptacles shall be mounted 18" to center line above finished floor unless noted otherwise.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; 5351 (single), 5352 (duplex).
 - b. Hubbell; HBL5351 (single), CR5352 (duplex).
 - c. Leviton; 5891 (single), 5352 (duplex).
 - d. Pass & Seymour; 5381 (single), 5352 (duplex).
- E. GFCI Receptacles: General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

ELECTRICAL WORK

- a. Cooper; GF20.
 - b. Pass & Seymour; 2084.
 - c. Leviton, 8898
- F. Non-standard convenience receptacles and special purpose power supply receptacles shall be as listed on plans.
- G. Devices and device plates for flush wall devices which are not integrally equipped with same, shall be as directed by the Project Manager.
- H. Where more than one wiring device is indicated in the same location, the devices shall be mounted in gangs under a common wall plate.
- I. Mount duplex convenience and power receptacles vertically with grounding posts at top of device unless otherwise indicated. Locate grounding post to left when horizontal mounting is indicated.

2.06 GROUNDING REQUIREMENTS

- A. Ground all systems and equipment in accordance with best industry practice and the requirements of Massachusetts Electrical Code.
- B. Provide grounding bonds between all metallic conduits of the light and power system which enter and leave cable chambers or other non-metallic cable pulling and splicing boxes. Accomplish this by equipping the conduits with bushings of the grounding type individually cross connected.
- C. Bond metallic conduits containing grounding electrode conductors and main bonding conductors to the ground bus service enclosure and/or grounding electrode at both ends of each run utilizing grounding bushings and jumpers.
- D. Provide grounding bonds for all metallic conduits of the light and power system which terminate in pits below equipment for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually to the ground bus.
- E. Provide supplementary ground bonding where metallic conduits terminate at metal clad equipment (or at the metal pull box of equipment) for which a ground bus is specified. Accomplish this by equipping the conduits with bushings of the grounding type connected individually by means of jumpers to the ground bus. Exclude the jumpers where directed. This exclusion will be required where an isolated ground for electronic equipment is to be maintained.
- F. Each grounding type bushing shall have the maximum ground wire accommodation available in standard manufacture for the particular conduit size. Connection to bushing shall be with wire of this maximum size.

ELECTRICAL WORK

- G. Bonding conductors on the load side of the service device and equipment grounding conductors shall be sized in relation to the fuses or trip size of the overcurrent device supplying the circuit.
- H. The central equipment for the fire protective alarm system and telephone system shall have its grounding terminal connected to the grounding electrode by means of a No. 6 green coded insulated conductor, run in 3/4" conduit. Utilize a ground clamp of a type specifically manufactured for the purpose.
- I. Connectors shall be listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- J. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
- K. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.07 PHASING AND COLOR CODING

- A. The insulation or covering of each wire or cable shall be color coded so as to provide for circuit identification as specified below.

1.	<u>120/208 V Circuits</u>	<u>277/480V</u>	<u>Phase Circuits</u>
2.	Black	Brown	A
3.	Red	Orange	B
4.	Blue	Yellow	C
5.	White	Grey	Neutral
6.	Green	Green w/yellow tracer	Equipment Ground

- B. Color coding shall be achieved by one of the following methods:
 - 1. The insulation or covering shall be coded during manufacture by use of one of the following methods:
 - a. Colored compounds.
 - b. Colored coatings.
 - 2. In sizes and insulation types where factory applied colors are not available, wires and cables shall be color coded by the application of colored plastic tapes in overlapping turns at all terminal points, and in all boxes in which splices are made.
- C. The same colored cable shall be connected to the same phase throughout the project.

- D. In general, building load centers and panelboards shall be phased "A", "B", "C", left to right. The neutral, although it may be in different locations for different equipment, shall be identified.

2.08 LIGHTING FIXTURES

- A. Lighting fixtures shall be in accordance with identifications on the drawings and the following.
- B. Finishes shall be as selected by the Architect or as indicated on the plans.
- C. Any additional appurtenances required for installation and operation, where same are not covered by the identification used on the drawings, shall be included.
- D. Recessed fixtures shall be coordinated with ceiling construction.
- E. Exact location of all fixtures shall be confirmed with the Architect prior to rough-in.
- F. Recessed fixtures throughout shall have their components, wiring and external connections coordinated for use in ceilings utilized as air handling plenums.
- G. Fixtures for use outdoors or in areas designated as damp locations shall be suitably gasketed and U.L. listed for such applications.
- H. All ballasts or transformers for discharge type lamps shall be for 60 cycles operation.
- I. All ballasts or transformers for discharge or fluorescent type lamps shall be high power factor type.
- J. In-line fuses shall be provided for all ballast and transformers.
- K. Ballasts for fluorescent lamps shall be electronic high frequency electronic type (20 KHZ or greater) type "P", class "A" sound rated, instant start and parallel wired such that if one lamp burns out the remaining lamps stay lit. Electronic ballasts shall comply with UL 935, ANSI C82.1, CBM certified and meet FCC standards for EMI/RFI (FCC 47 CFR Part 18 non consumer) with a total harmonic distribution of less than 20%. Ballasts shall carry a manufacturer's warranty of five years and be manufactured by Osram Sylvania, Magnetek, Advance or approved equal.
- L. All fixtures shall be UL approved with labels attesting thereto.
- M. All lamps shall be included. Except where specifically noted otherwise all fluorescent lamps shall be as follows:
 - 1. Fluorescent lamps of the proper wattage and voltage rating shall be provided in each fixture as indicated on the fixture schedule. All fluorescent lamps shall be manufactured to appropriate specifications given in ANSI C78.

ELECTRICAL WORK

Unless noted otherwise, fluorescent lamps shall be 3500K and have a minimum CRI of 82.

2. Unless otherwise noted, all compact fluorescent lamps shall be 3500K and have a minimum CRI of 82. The contractor shall verify that the proper lamp type for the specified ballast type is furnished with the compact fluorescent fixture.
 - a. Compact fluorescent ballasts shall be UL listed, Class P, Type 1 and CBM Certified.
 - b. Where 4-pin electronic ballast compatible compact fluorescent lamps are specified, electronic ballasts shall include circuitry capable of sensing when lamp is approaching end of life and shut down the lamp circuit. This end of life sensing must be impervious to low/high line voltage conditions and result in no false tripping or overheating of lamp bases.
- N. All lamps shall be of the type specified in the light fixture schedule.
- O. The contractor shall obtain all information relative to the exact type of hung ceilings and suspension systems to be installed before ordering any recessed fixtures. This Contractor shall furnish the proper type fixtures applicable to the ceiling framing system. If, other than the type of fixtures specified are required for installation due to the type of ceiling construction, this Contractor shall furnish and install the proper type fixtures and mounting appurtenances required at no extra charge.
- P. The Contractor shall coordinate the exact locations of all lighting fixtures with the ceiling pattern during the Construction Period and before installation of the fixtures. Interferences between lighting fixtures, and other equipment, shall be brought to the attention of the General Contractor.
- Q. Include the aiming and/or adjustments of all lighting fixtures requiring same in accordance with instructions issued by the Project Manager in the field.
- R. All lamp sockets in lighting fixtures shall be suitable for the indicated lamps and shall be set so that the lamps are positioned in optically correct relation to all lighting fixtures components.
- S. Lighting fixtures shall be supported from building structure only, not from hung or suspended ceiling, by means of chains or threaded rods. The use of tie wire will not be allowed.
- T. All fixtures shall include seismic clips and shall be supported to comply with seismic regulations.
- U. Lamps shall be manufactured by General Electric, Phillips, OSRAM, or Sylvania.

ELECTRICAL WORK

2.09 HORIZONTAL DATA CABLING

A. Related Documents

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. See Section 3.12 for Horizontal Data Cabling Execution.

B. Summary

1. Section Includes:
 - a. UTP cabling.
 - b. Pathways
 - c. Cable connecting hardware, Ethernet switch, and related components.
 - d. Telecommunications outlet/connectors.
 - e. Cabling system identification products.
 - f. Cable management system.

C. Definitions:

1. BICSI: Building Industry Consulting Service International.
2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
3. EMI: Electromagnetic interference.
4. IDC: Insulation displacement connector.
5. LAN: Local area network.
6. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
7. UTP: Unshielded twisted pair.

D. Quality Assurance

1. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
2. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician
3. Testing Supervision: Currently certified by BICSI as an RCDD to supervise on-site testing.

E. Delivery, Storage, and Handling

1. Test cables upon receipt at Project site.
 - a. Test each pair of UTP cable for open and short circuits.

F. Horizontal Cabling Description

ELECTRICAL WORK

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - a. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - b. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - c. Bridged taps and splices shall not be installed in the horizontal cabling.
 - d. Splitters shall not be installed as part of the optical fiber cabling.

G. Performance Requirements

1. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Grounding: Comply with J-STD-607-A.

H. UTP Cable

1. Manufacturers: Subject to compliance with requirements, provide Berk-Tek CMP-00424-BKTE-5-06, or equal plenum rated products by one of the following:
 - a. Belden Inc.
 - b. CommScope, Inc.
 - c. Mohawk; a division of Belden Networking, Inc.
2. Description: 100-ohm, four-pair UTP, with blue jacket.
 - a. Comply with ICEA S-90-661 for mechanical properties.
 - b. Comply with TIA/EIA-568-B.1 for performance specifications.
 - c. Comply with TIA/EIA-568-B.2, Category 5e.
 - d. Cable shall be pre-printed with cumulative foot markings at a minimum of 2 foot intervals.

I. UTP Cable Hardware

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Belden Inc.
 - b. Hubbell Premise Wiring.
 - c. Leviton Commercial Networks Division.
 - d. Panduit Corp.
2. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
3. Provide 48 position patch panel, loaded with 24 jacks (leaving 24 open positions for future use). Jacks shall be Siemon MX5-F01 (Black) or equal. The contractor may also terminate the cables directly using RJ45 plugs as per existing work in data room 227.
4. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
 - a. Flush wall mounted jacks/couplers
 - i. Faceplate: Siemon CT4-FP-20 (ivory)
 - ii Jack Insert: Siemon CT-C5-20 (ivory, angled double jack coupler)
 - iii Blanks: Siemon CT-BLNK-20

J. Grounding

1. Comply with requirements in Section 16060 "Grounding and Bonding" for grounding conductors and connectors.
2. Comply with J-STD-607-A.

2.10 FIRE ALARM SYSTEM

A. Related Documents

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. See Section 3.13 for Fire Alarm System Execution.

B. Scope

ELECTRICAL WORK

1. Provide components to the existing addressable fire alarm and control system in compliance with all specifications and drawings. The equipment shall interface to other building systems to conduct monitoring and control functions as described herein.
2. All new equipment shall be compatible and UL listed for use with the existing Simplex fire alarm system.
3. Evacuation notification shall consist of audio evacuation tone and visual (strobe) signaling.
4. Final connections, testing, and adjusting of the system shall be done under the direct supervision of the system manufacturer's representative. Provide NICET certified and factory trained technicians to make final connections, demonstrate the system to the satisfaction of the Engineer of Record, and make all additional adjustments to the system operation as required by the DCAM's Project Manager.
5. The system design and installation shall conform to the following standards:
 - a. All equipment shall be UL listed for its intended purpose.
 - b. NFPA standards 70, 72, 90A, 92A, and 101.
 - c. Current State Building Code.
 - d. The Americans with Disabilities Act (ADA).
 - e. All requirements of all local authorities having jurisdiction.
6. Submit 6 complete sets of shop drawings to include:
 - a. Complete point-to-point riser diagram showing all equipment and size, type and number of all conductors and devices.
 - b. Large scale drawings of each panel showing module placement and spare capacity allowances.
 - c. Address listing of all field devices shown on floor plans for coordination of LCD message text assignments.
 - d. Original catalog data sheets for all items to assure compliance with these specifications. This equipment shall be subject to approval, and no equipment shall be ordered without prior approval.
 - e. Provide calculations to support the size of standby batteries notification circuits and power supplies submitted. Calculations shall

ELECTRICAL WORK

demonstrate proper current draw, voltage drop, wire size considerations and spare capacity allowances.

- f. Confirmation that the equipment supplier will provide on-site project management and supervision during system installation, and perform system testing and instruction.
7. Conform to all UL standards for testing (and provide certification) of the completed installation by a UL approved testing company.
8. The equipment supplier shall conduct the programming of the system and a complete rack/test of hardware panels prior to delivery to the installing contractor.
9. Provide verification that all room names and numbers on the construction drawings will be coordinated with final room names and numbers as designated by UMA. Update all risers and drawings accordingly for Operating & Maintenance manuals at the completion of the project. Addresses shall be programmed using final room names and numbers.
10. Provide copies of Operating & Maintenance manuals with the request for final inspection. O & M Manuals shall include the following:
 - a. All of the information submitted in the shop drawings.
 - b. As-built documentation which incorporates all modifications to the system, whether made as a field change or by a change order.
 - c. Include a copy of the final test report, [UL certificate] and test contract.

C. Sequence of Operation

1. The operation of a manual station or activation of any automatic alarm initiating device, except duct smoke detectors, shall automatically:
 - a. Initiate the transmission of the alarm to the Campus Police via Radio Masterbox.
 - b. Sound evacuation signal over all audio circuits.
 - c. Flash all visual signals throughout the building in a synchronized manner.
 - d. Flash an alarm LED and sound an audible signal at the FACP. Upon Acknowledgment, the alarm LED shall light steadily and the audible shall silence. Subsequent alarms shall re-initiate this sequence.

ELECTRICAL WORK

- e. Visually indicate the alarm initiating device type and location via the LCD display located at the FACP and at any remote annunciators.
2. Duct smoke detectors shall automatically shut down HVAC equipment to initiate a supervisory alarm transmission only. Audio and visual building alarms shall not be activated.
- D. General Requirements
1. All equipment shall be new and unused. All components and systems shall be designed for uninterrupted duty. All equipment, materials and accessories covered by these requirements shall be provided by a single manufacturer, or if provided by different manufacturers recognized and listed as compatible by both manufacturers.
 2. Circuiting Guidelines. Each initiating device and indicating circuit shall be electronically supervised and individually addressable. All wiring shall be as follows:
 - a. Individual addressable modules shall be used to monitor status conditions from any related systems or conventional devices.
 - b. Addressable control modules or relays shall provide auxiliary control functions.
 - c. Addressable loop wiring shall support all devices shown and allow for a minimum of 25% spare capacity and be wired in existing building NFPA Class and Style.
 - d. As a minimum, power supplies, amplifiers and notification appliance circuits shall operate all devices shown plus 25% spare capacity
 - e. Audio and visual signals shall be circuited separately to allow continued operation of the visual signal in the event of a silencing of the audible signal.
- E. System Components:
1. System Power Supplies:
 - a. Provide integral system power supplies as required for new devices. Each supply shall contain brownout, low battery detection, system ground fault, and LED indicators for loss of AC or CPU failure.
 2. Intelligent System Devices: Provide intelligent analog devices where shown and required. Each device shall retain operating characteristics in non-volatile memory and conduct algorithms to distinguish real fire conditions from unwanted nuisance alarms. All analog devices shall provide dual LED indicators, a green LED shall flash to denote active communication, and a

ELECTRICAL WORK

red LED shall flash to denote an alarm condition. Devices shall be interchangeable with twist-lock bases which may include a supervised remote LED output, fault isolation circuitry, or an auxiliary relay contact. In the event of an addressable loop communications failure, devices shall remain capable of initiating an alarm sequence.

- a. Photoelectric Smoke Detector: Provide analog photoelectric smoke detectors where shown and required.
 - b. Analog Heat Detectors: Provide Analog Heat Detectors for fixed temperature operation. Each conventional heat detector shall be individually addressable via an intelligent input module.
 - c. Analog Duct Smoke Detector: Provide analog photoelectric duct smoke detectors to be mounted in air ducts by HVAC where shown and required. Each detector shall be supplied with duct mounting plate, remote test station/indicator and sampling tubes sized according to duct width. Provide the required auxiliary relay outputs or addressable relay control modules with each detector in order to accomplish the required HVAC control and override functions to be wired by HVAC controls contractor.
 - d. Monitor Module: Provide addressable input monitor as required to monitor related systems or integrate conventional initiating devices onto the addressable loop.
 - e. Control Module: Provide addressable output control modules as required to supervise and control conventional devices (indicating circuits, AHUs, door holders, etc.) over the addressable loop. Control modules shall provide a supervised output rated for 1 or 2 amps @ 24VDC, as required.
3. Primary Notification Appliances: Flush mounted combination horn/strobe Audio/Visual signaling appliances as follows:
 - a. Visual Signals: Furnish and install synchronizing xenon strobes in compliance with NFPA 72 chapter 6. Strobes shall have an effective intensity rating of 75 candela unless otherwise shown on the drawings.
 - b. Audible Signals: Electric-vibrating-polarized type horn, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns shall produce a sound-pressure level of 90 dBA, measured 10 from the horn.

B. Wire and Cable

1. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

ELECTRICAL WORK

2. Signaling Line Circuits: Type FPLR, twisted, shielded pair, No. 18 AWG.
 - a. Circuit Integrity Cable: Twisted shielded pair, NFPA 70 Article 760, Classification CI, for power-limited fire alarm signal service. UL listed as Type FPLR, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
 3. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - a. Low-Voltage Circuits: No. 14 AWG, minimum.
 - b. Line-Voltage Circuits: No. 12 AWG, minimum.
 - c. Multiconductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, UL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.
 4. Provide complete wiring and conduit between all equipment. All devices shall be mounted upon and splices made in UL listed boxes. Wiring splices and transposing or changing of colors will not be permitted.
 5. All junction boxes shall be painted red.
 6. Fire Alarm control systems and equipment shall be connected to separate dedicated branch circuits, sized as required for proper service. Circuits shall be labeled 'FIRE ALARM'. The circuit breaker shall be red in color and provided with a breaker lock.
- C. Final Tests / Warranty
1. See Section 3.13 Fire Alarm System Execution
- D. Training
1. The contractor shall provide the services of the manufacturer's representative for a period of 4 hours, during normal business hours, to instruct the User Agency's designated personnel and fire department response teams on the operation of the system.

PART 3 - EXECUTION

3.01 BASIC REQUIREMENTS

- A. Adhere to best industry practice and the following.
- B. All work shall be concealed.
- C. Route circuitry runs embedded in concrete to coordinate with structural requirements.
- D. Equip each raceway intended for the future installation of wire or cable with a nylon pulling cord 3/16 inch in diameter and clearly identify both ends of the raceway.
- E. Provide all outlet boxes, junction boxes, and pull boxes for proper wire pulling and device installation. Include those omitted from the drawings due to symbolic methods of notation.
- F. Provide all sleeves through fireproof and waterproof slabs, walls, etc. required for electric work.
 - 1. Provide waterproof sealing for the sleeves through waterproof slabs, walls, etc.
 - 2. Provide fireproof sealing for the sleeves through fireproof walls, slabs, etc.
 - 3. Provide fireproof sealing for the openings in fireproof walls, slabs, etc., resulting from removal of existing electrical sleeves, conduits, poke-thru's, etc.
- G. Bundle wiring passing through pull boxes and panel boards in a neat and orderly manner with plastic cable ties. Cable ties shall be Ty-Raps as manufactured by Thomas & Betts, Holub Industries Inc., Quick Wrap, Bundy Unirap or equal.
- H. Turn branch circuits and auxiliary system wiring out of wiring gutters at 90 degrees to circuit breakers and terminal lugs.

3.02 TESTING REQUIREMENTS AND INSTRUCTIONS

- A. The Electrical Subcontractor shall provide supervision, labor, materials, tools, test instruments and all other equipment or services and expenses required to test, adjust, set, calibrate, and operationally check work and components of the electrical systems and circuitry throughout the work.

The Electrical Subcontractor shall pay for all tests specified in this Section, including expenses incident to retests occasioned by defects and failures of equipment to meet specifications, at no additional cost to UMA - AMHERST. Any defects or deficiencies discovered in any of the electrical work shall be corrected.

ELECTRICAL WORK

The Electrical Subcontractor shall:

1. Replace wiring and equipment found defective (defined as failing to meet specified requirements) at no additional cost to UMA - AMHERST.
 2. Submit three copies of test results to the engineer.
- B. Do not void equipment warranties or guarantees by testing and checkout work. Checks and tests shall be supplemental to and compatible with the manufacturer's installation instructions. Where deviations are apparent, obtain the manufacturer's approved review of procedure prior to testing. Where any repairs, modifications, adjustments, tests or checks are to be made, the Contractor shall contact the engineer to determine if the work should be performed by or with the manufacturer's representative.

All checks and tests specified for proper operating and safety of equipment and personnel are to be performed concurrent with progression of the work, prior to Final Acceptance by DCAM.

- C. Test are to:
1. Provide initial equipment/system acceptance.
 2. Provide recorded data for future routine maintenance and trouble shooting.
 3. Provide assurance that each system component is installed satisfactorily and can be expected to perform, and continue to perform, its specified function with reasonable reliability throughout the life of the facility.
- D. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, or faulty, is to be reported to the engineer. Corrective action by the Contractor requires prior engineer approval, retesting, and inspection.
- E. Prior to testing and start-up, equipment and wiring shall be properly and permanently identified with nameplates, and other identification as specified in this Section. Check and tighten terminals and connection points, remove shipping blocks and thoroughly clean equipment, repair damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions for delivery to the engineer. Make routine checks and tests as the job progresses to ensure that wiring and equipment is properly installed.
- F. After each electrical system installation is complete, perform the tests to determine that the entire system is in proper working order and in accordance with applicable codes, manufacturer's instructions, drawings, and specifications. Tests are in addition to shop tests of individual items at the manufacturer's plant. Perform insulation and ground resistance tests before operating tests.

ELECTRICAL WORK

- G. Perform insulation tests on electrical equipment, apparatus, cables, motors, generators, transformers, circuit breakers and switches, switchgear, motor control centers, and similar electrical equipment, at the following times and conditions:
1. Prior to energization and/or placing into service.
 2. When damage to the insulation is suspected or known to exist.
 3. After repairs or modifications to the equipment affecting the insulation.
 4. Where lightning or other surge conditions are known to have existed on the circuit.
- H. Make openings in circuits for test instruments and place and connect instruments, equipment, and devices, required for the tests. Upon completion of tests, remove instruments and instrument connections and restore circuits to permanent condition.
- I. List each circuit and measured resistance as test data. Maintain record of insulation resistance values. Identify conductor, or equipment, date that value was taken and resistance value. Arrange information in tabular form and submit to Engineer.
- J. Report inspections, tests, and calibrations in writing on engineer-approved reports/forms. The recorded data form shall have the signatures of the persons conducting the tests, authorized witnesses, and the engineer. The forms shall serve as the test and inspection checklist.
- K. Specific Tests:
1. Wire and Cable: (All conductors originating from main switchboard and distribution panels).
 - a. Before energizing any cable or wire, megger the insulation resistance of every external circuit wire to each other and to ground. Tests shall be conducted at voltages of 500 volts or lower. Continuity test each wire and cable to verify the field applied tag per conductor. Minimum insulation resistance values shall not be less than two megohms.
 - b. Take insulation resistance measurements for motor feeders. With motors disconnected, measure insulation resistance from load side of contactors or circuit breakers.
 - c. Check cables and wires for the proper identification numbering and/or color coding.
 - d. Inspect cables for physical damage and proper connection in accordance with single line diagram.
 - e. Panelboards
 1. Inspect for physical damage and proper grounding.

2. Compare nameplate information with schedules and report any discrepancies.
3. Inspect all panelboards for cleanliness, workmanship, etc. 4. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - i. Measure as directed during period of normal system loading.
 - ii. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - iii. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - iv. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.03 BRANCH CIRCUITRY

- A. For all lighting and appliance branch circuitry, raceway sizes shall conform to industry standard maximum permissible occupancy requirements except where these are exceeded by other requirements specified elsewhere.
- B. Circuits shall be balanced on phases at their supply as evenly as possible.
- C. Feeder connections shall be in the phase rotation which establishes proper operation for all equipment supplied.
- D. Reduced size conductors indicated for any feeders shall be taken as their grounding conductors.
- E. Feeders consisting of multiple cables and raceways shall be arranged such that each raceway of the feeder contains one cable for each leg and one neutral cable, if any.
- F. For circuitry indicated as being protected at 20 Amps or less, abide by the following:
 1. All combined branch circuit homeruns shall be provided with separate neutral conductors.
 2. Minimum conductor size shall be No. 12 A.W.G. copper.
 3. Conductors operating at 120 volts extending in excess of 100 Ft., or at 277 volts extending in excess of 200 ft., to the last outlet or fixture tap shall be

ELECTRICAL WORK

increased to allow for a maximum 3% voltage drop. Raceway sizes shall be increased as required by MEC.

4. Lighting fixtures and receptacles shall not be connected to the same circuit.
 5. Circuits shall be balanced on phases at their supply point as evenly as possible.
- G. Install insulated equipment grounding conductors with all feeders and branch circuits.
- H. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
 2. Lighting circuits.
 3. Receptacle circuits.
 4. Single-phase motor and appliance branch circuits.
 5. Three-phase motor and appliance branch circuits.
 6. Flexible raceway runs.
 7. Armored and metal-clad cable runs.
 8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

3.04 IDENTIFICATION AND TAGGING

- A. Identify individually:
1. Each panelboard and circuit breaker.
 2. Each wiring device, receptacle and switch.
 3. Each feeder, wire or cable of all systems.
 4. Each switchboard.
 5. Each end of nylon pullwire in empty conduit.
- B. Each wire or cable in a feeder shall be identified at its terminal points of connection and in each pullbox, junction box and panel gutter through which it passes.

- C. The nomenclature used to identify panelboards or load center shall designate the numbers assigned to them.
- D. The nomenclature used to identify switches or circuit breakers shall:
 - 1. Where they disconnect mains or services designate this fact.
 - 2. Where they control feeders, designate the feeder number and the name of the load supplied.
 - 3. Where they control lighting and appliance branch circuitry, designate the name of the space and the load supplied.
- E. The nomenclature used to identify feeder wires and cables shall designate the feeder number.
- F. Identification for panelboards or load centers shall be by means of engraved lamacoid nameplates showing 1/4" high white lettering on a black background fastened to the outside face of the front.
- G. Identification for switches or circuit breakers shall be by means of the following:
 - 1. Where individually enclosed -- engraved lamacoid nameplates showing 1/8" high white lettering on a black background fastened on the outside front face of the enclosure.
 - 2. Where in panelboards or load centers without doors -- same as for individually enclosed.
 - 3. Where in panelboards or load centers with doors -- typewritten directories mounted behind transparent plastic covers, in metal frames fastened on the inside face of the doors. Directory shall indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable
- H. Identification for wires and cables shall be by means of wrap around "brady" type labels.
- I. Device plates for local toggle switches, toggle switch type motor starters, pilot lights and the like, whose function is not readily apparent shall be engraved with 1/8" high letters suitably describing the equipment controlled or indicated.
- J. Phase identification letters shall be stamped into the metal of the bus bars of each phase of the main busses of each switchboard and each panelboard. The letters shall be visible from at least one "normal posture" location without having to demount any current carrying or supporting elements.

- K. Equip the front face of all switchboard pull boxes junction boxes and the like containing cables, busing or devices operating in excess of 600 volts with enameled sheet metal "red on white" signs reading "DANGER--HIGH VOLTAGE."
- L. Equip all electric closets and the like with enameled sheet metal "red on white" signs reading "Electrical Equipment Room -- No Storage Permitted." Signs shall be mounted at clearly visible locations within the rooms.
- M. Provide a sign at the service entrance equipment room indicating the type and location of all on site emergency or standby power sources.
- N. Identify each outlet box, junction box, and cabinet used in conjunction with empty raceway for wires of a future system by means of indelible markings on the inside denoting the system.
- O. Prior to installing identifying tags and nameplates, submit their nomenclature for approval. Conform to all revisions issued by the Project Manager.

3.05 LIMITING NOISE PRODUCED BY ELECTRICAL INSTALLATION

- A. Perform the following work, in accordance with field instructions issued by the Project Manager to assure that minimal noise is produced by electrical installations due to equipment furnished as part of the electrical work.
- B. Check and tighten the fastenings of sheet metal plates, covers, doors and trims used in the enclosures of electrical equipment.
- C. Remove and replace any individual device containing one or more magnetic flux path metallic cores (e.g., discharge lamp ballast, transformer, reactor, dimmer, solenoid) which is found to have a noise output exceeding that of other identical devices installed at the project.

3.06 SUPPORTS AND FASTENINGS

- A. Support work in accordance with best industry standards, Mass. Electric Code and the following:
- B. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.
- C. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members. They shall be rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- D. No work intended for exposed installation shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4" air space between the building surfaces and the work. Provide 3/4"

ELECTRICAL WORK

thick exterior grade plywood painted with two coats of fire-retardant grey paint for mounting of panelboards.

- E. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric conduits, raceways or cables for support.
- F. Nothing shall rest on, or depend for support on, suspended ceiling media.
- G. Support less than 2" trade size, vertically run, conduits at intervals no greater than 8 Ft. Support such conduits, 2-1/2" trade size or larger, at intervals no greater than the story height, or 15 Ft, whichever is smaller.
- H. Where they are not embedded in concrete, support less than 1" trade size, horizontally run, conduits at intervals no greater than 7 ft.. Support such conduits, 1" trade size or larger, at intervals no greater than 10 ft.
- I. Support all lighting fixtures directly from structural slab, deck or framing member.
- J. Where fixtures and ceilings are such as to require fixture support from ceiling openings frames, include in the electric work the members necessary to tie back the ceiling opening frames to ceiling suspension members or slabs so as to provide actual support for the fixtures noted above.
- K. As a minimum procedure, in suspended ceilings support small runs of circuitry (e.g., conduit not in excess of 1 inch trade size) from ceiling suspension members as defined above. Support larger runs of circuitry directly from structural slabs, decks or framing members.
- L. Fasten electric work to building structure in accordance with the best industry practice.
- M. Floor mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastenings in all cases.
- N. For items which are shown as being ceiling mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to building structural elements.
- O. As a minimum procedure, where weight applied to the attachment points is 100 lbs. or less, fasten to concrete and solid masonry with bolts and expansion shields.
- P. As a minimum procedure, where weight applied to building attachment points exceeds 100 lbs., but is 300 lbs. or less, conform to the following:
 - 1. At field poured concrete slabs, utilize inserts with 20' minimum length slip-through steel rods, set transverse to reinforcing steel.

ELECTRICAL WORK

3.07 SPLICING AND TERMINATING WIRES AND CABLES

- A. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.
- B. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it, so that it is accessible from the removal cover side of the box.
- C. Join solid conductors No. 8 AWG and smaller by securely twisting them together and soldering, or by using insulated coiled steel spring "wire nut" type connectors. Exclude "wire nuts" employing non-expandable springs. Terminate conductors No. 8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected.
- D. Join, tap and terminate stranded conductors No. 6 AWG and larger by means of solder sleeves, taps; and lugs with applied solder or by means of bolted saddle type or pressure indent type connectors, taps and lugs. Exclude connectors and lugs of the types which apply set screws directly to conductors. Where equipment or devices are equipped with set screw type terminals which are impossible to change, replace the factory supplied set screws with a type having a ball bearing tip. Apply pressure indent type connectors, taps and lugs utilizing tools manufactured specifically for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector.
- E. Except where wire nuts are used, build up insulation over conductor joints to a value, equal both in thickness and dielectric strength, to that of the factory applied conductor insulation. Insulation of conductor taps and joints shall be by means of half-lapped layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.
- F. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.
- G. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.
- H. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.
- I. Lugs for conductors used to make phase leg connections on the line side of the main service overcurrent and switching device shall be of the limiter type.

3.08 PULLING WIRES INTO CONDUITS AND RACEWAYS

- A. Delay pulling wires or cables in until the project has progressed to a point when general construction procedures are not liable to injure wires and cables, and when moisture is excluded from raceways.
- B. Utilize nylon snakes or metallic fish tapes with ball type heads to set up for pulling. In raceways 2" trade size and larger, utilize a pulling assembly ahead of wires consisting of a suitable brush followed by an 3-1/2" diameter ball mandrel.
- C. Leave sufficient slack on all runs of wire and cable to permit the secure connection of devices and equipment.
- D. Include circular wedge-type cable supports for wires and cables at the top of any vertical raceway longer than 20 feet. Also include additional supports spaced at intervals which are no greater than 10'. Supports shall be located in accessible pull boxes. Supports shall be of a nondeteriorating insulating material manufactured specifically for the purpose.
- E. Pulling lubricants shall be used. They shall be products manufactured specifically for the purpose.
- F. Slack on wires and cables located in cabinets and pull boxes shall be formed and set in place in groupings corresponding to their occupancy of raceways. They shall also be arranged, with insulators and supports provided where necessary, such that cable shims or other such temporary expedients do not have to be left permanently in place to prevent the wires and cables from shifting when covers or trims are removed.

3.09 REQUIREMENTS FOR THE INSTALLATION OF JUNCTION BOXES, OUTLET BOXES AND PULL BOXES

- A. Flush wall mounted outlet boxes shall not be set back to back but shall be offset at least 12" horizontally regardless of any indication on the drawings.
- B. Locate all boxes so that their removable covers are accessible without necessitating the removal of parts of permanent building structure, including piping, ductwork, and other permanent mechanical elements.
- C. In conjunction with concealed circuitry, abide by one of the following instructions (as may be applicable to the conditions) in order to assure the aforementioned accessibility. (Not required for circuitry concealed by removable suspended ceiling tiles.)
 - 1. For a small (outlet size) box on circuitry concealed in a partition or wall, locate box or fitting so that its removable cover side (or the face of any applied raised cover) penetrates through to within 1/8" a of the exposed surface of the building materials concealing the circuitry and apply a blank or device plate to suit the functional requirements.

ELECTRICAL WORK

2. For a large box on circuitry concealed in a partition, suspended ceiling, or wall, locate box totally hidden but with its removable cover directly behind an architectural access door or panel (included for the purpose, separate from the electric work) in the building construction which conceals the circuitry.
 3. For a small (outlet size) box on circuitry concealed above and intended as an outlet for a surface mounted lighting fixture or other such electrical item, locate box so that its removable cover side penetrates through to the exposed surface of the building materials concealing the circuitry. Arrange the mounting of the lighting fixture or other item so that it completely covers the opening in the building construction caused by the box.
 4. For a small (outlet size) box on circuitry concealed in a suspended ceiling, and intended as an outlet for a non-demountable type of recessed lighting fixtures or other such electrical items, locate box totally hidden but with its removable cover not more than one foot away from the building construction opening occupied by the demountable items.
- D. Apply junction and pull boxes in accordance with the following:
1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.
 2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.
 3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.
 4. Include all required junction and pull boxes regardless of indications on the drawings (which, due to symbolic methods of notation, may omit to show some of them).
- E. Apply outlet boxes in accordance with the following:
1. Unless noted below or otherwise specifically indicated, include a separate outlet box for each individual wiring device, lighting fixture and signal or communication system outlet component. Outlet boxes supplied attached to lighting fixtures shall not be used as replacements for the boxes specified herein.
 2. A continuous row of fixtures of the end-to-end channel type, designed for "through wiring," and wired in accordance with the specification hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

ELECTRICAL WORK

3. A series of separate fixtures, designed for "through wiring," spaced not more than 4' apart, and inter-connected with conduit or raceway and circuitry which is in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.
 4. Connection to recessed ceiling fixtures supplied with pigtails may be arranged so that more than one, but not more than four, such fixtures are connected into a single outlet box. When adopting this procedure:
 - a. Utilize an outlet box no smaller than 5" square by 2-1/2" deep.
 - b. Allow no fixture to be supplied from an outlet box in another room.
 5. Multiple local switches indicated at a single location shall be gang mounted in a single outlet box.
 6. Include all required outlet boxes regardless of indications on the drawings (which due to symbolic methods of notation, may omit to show some of them).
- F. Install junction boxes, pull boxes and outlet boxes in accordance with the following:
1. Exclude surface mounted outlet boxes in conjunction with concealed circuitry.
 2. Exclude unused circuitry openings in junction and pull boxes. In larger boxes each such opening shall be closed with a galvanized sheet steel plate fastened with a continuous weld all around. In small outlet type boxes, utilize plugs as specified for such boxes.
 3. Close up all unused circuitry openings in outlet boxes. Unused openings in cast boxes shall be closed with approved cast metal threaded plugs. Unused openings in sheet metal boxes shall be closed with sheet metal knock-out plugs.
 4. Outlet boxes for switches shall be located at the strike side of doors. Indicated door swings are subject to field change. Outlet boxes shall be located on the basis of final door swing arrangements.
 5. Boxes and plaster covers for duplex receptacles shall be arranged for vertical mounting of the receptacle.
 6. Equip outlet boxes used for devices which are connected to wires of systems supplied by more than one set of voltage characteristics with barriers to separate the different systems.
- G. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

ELECTRICAL WORK

- H. Barriers in junction and pull boxes which are larger than outlet size shall be of the polyester resin fiberglass of adequate thickness for mechanical strength, but in no case less than 1/4" thick. Each barrier shall be mounted, without fastenings, between angle iron guides so that they may be readily removed.

3.10 LOCATING AND ROUTING OF CIRCUITRY

- A. In general, all circuitry shall be run concealed except that it shall be run exposed where the following conditions occur:
 - 1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.
 - 2. Horizontally and vertically in mechanical equipment spaces.
 - 3. Horizontally and vertically in electric equipment rooms.
- B. Concealed circuitry shall be so located that building construction materials can be applied over its thickest elements without being subject to spalling or cracking.
- C. All circuitry and raceways shall not be run within slabs.
- D. Circuitry run exposed shall be routed parallel to building walls and column lines.
- E. Exposed circuitry located overhead shall be run in a completely accessible manner on the underside of all piping and ductwork.
- F. Circuitry run in suspended ceilings shall be routed parallel to building walls, column lines, etc.
- G. Circuitry shall be routed so as to prevent electric conductors from being subject to high ambient temperature. Minimum clearances from heated lines or surfaces shall be maintained as follows:
 - 1. Crossing where uninsulated 3"
 - 2. Crossing where insulated 1"
 - 3. Running parallel where uninsulated 36"
 - 4. Running parallel where insulated 6"
- H. Circuitry shall not be run in elevator shafts, hoistways, and the like. Where outlets for trail cables, pit lights, run be level lights, and the like, are involved, only the "final connection" outlet boxes themselves shall be located within or open into, the confines of the shaft.

- I. Circuitry for miscellaneous systems indicated without notation as to location and routing shall be run as per the requirements and notations governing the adjacent light and power circuitry.

3.11 INSTALLING CIRCUITRY

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated
- B. In runs of conduit or raceway including flexible limit the number of bends between cable access points to a total which does not exceed the maximum specified for the particular system. Where no such maximum is specified, limit the number to four right angle bends or the equivalent thereof.
- C. In each conduit or raceway assigned for the future pulling in of wires, include a nylon drag cord. In raceways 2" trade size and larger, the cord shall be pulled in utilizing a suitable brush, followed by an 85% diameter ball mandrel ahead of the cord in the pulling assembly. In the event that obstructions are encountered, which will not permit the drag cord to be installed, the blocked section of raceway shall be replaced and any cutting and patching of the structure involved in such replacement shall be included as part of the electric work.
- D. Circuitry shall be arranged such that conductors of one feeder or circuitry carrying "going" current are not separated from conductors of the same feeder or circuitry carrying "return" current by any ferrous or other metal. Where not within raceways, all "going" and "return" current conductors of one feeder or circuit shall be laced together so as to minimize induction heating of adjacent metal components.
- E. Sleeves used where circuitry is to penetrate waterproof slabs, decks and walls, shall be of a type selected to suite the water condition encountered in the field.

3.12 HORIZONTAL DATA CABLING EXECUTION

- A. Wiring Methods
 1. Install plenum cable in raceways except within consoles, cabinets, desks and counters. In accessible ceiling spaces, J-hooks may be used rather than raceways.
 2. All raceways shall be concealed except as shown on the contract drawings.
 3. Comply with manufacturers' bend radii limitations."
- B. Installation of Cables
 1. Comply with NECA 1.
 2. General Requirements for Cabling:

ELECTRICAL WORK

- a. Comply with TIA/EIA-568-B.1.
 - b. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices." Except as noted in 2.3C option to use RJ45 connectors instead of a patch panel.
 - c. Install 110-style IDC termination hardware unless otherwise indicated.
 - d. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - e. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 24 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - f. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter.
 - g. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - h. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.
 - i. In the communications equipment room, install a 10-foot long service loop on each end of cable.
 - j. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than 1/4 inch from the point of termination to maintain cable geometry.
- D. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as required by UMASS.:
- E. Firestopping
1. Comply with requirements in Division 7 Section - Penetration Firestopping.

ELECTRICAL WORK

F. Grounding

1. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
2. Comply with J-STD-607-A.

G. Identification

1. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with UMASS requirements.
2. Cable and Wire Identification:
 - a. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated. Arrange label so it can be read without pulling from raceway.

H. Field Quality Control

1. Perform the following tests and inspections:
 - a. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - b. Visually confirm Category 5e marking of outlets, cover plates, outlet/connectors, and patch panels.
 - c. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - d. Test cables after termination but not cross-connection.
 - e. UTP Performance Tests:
 - i. The contractor shall test each outlet. Each jack shall be tested from end-to-end of the completed assembly for correct wire sequence and continuity. Any defects shall be corrected.
 - f. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - i. Data Tests: These tests assume the Information Technology Staff has a network installed and is available

ELECTRICAL WORK

to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

2. End-to-end cabling will be considered defective if it does not pass tests and inspections.

3.13 FIRE ALARM SYSTEM EXECUTION

A. Equipment installation

1. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
 - a. Connect new equipment to the existing control panel in the existing part of the building.
 - b. Expand, modify, and supplement the existing Fire Alarm Control Panel as necessary to extend the existing control and monitoring functions to the new points. New components shall be capable of merging with the existing configuration without degrading the performance of either system.
2. Smoke or Heat Detector Spacing:
 - a. Smooth ceiling spacing shall not exceed 30 feet.
 - b. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
 - c. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
 - d. Refer to Fire Alarm drawings for approximate device locations.
3. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
4. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct. Install test switch near room entrance in a space pre-approved by EHS and AFD.
5. Audible Alarm-Indicating Devices: Install 80" above finished floor in locations shown. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

6. Visible Alarm-Indicating Devices: Install 80" above finished floor in locations shown.
7. Device Location-Indicating Lights: Locate in public space near the device they monitor.

B. Wiring Installation

1. Install wiring according to the following:
 - a. NECA 1.
 - b. TIA/EIA 568-A.
2. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
3. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train 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 system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
4. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
5. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Match existing building color coding for fire alarm system wiring. Paint all fire alarm system junction boxes, pullboxes and covers red.

G. IDENTIFICATION

1. Identify system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification."
2. Install instructions frame in a location visible from the FACP.

F. GROUNDING

1. Ground the FACP and associated circuits; comply with IEEE 1100. Provide a ground wire in each fire alarm conduit per the Amherst Wiring Inspector.

ELECTRICAL WORK

G. FIELD QUALITY CONTROL

1. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connection, and to assist in field testing. Report results in writing. **The manufacturers field representative, Simplex, shall be present for the pretest, Engineer's Test and the final test with Amherst Fire Department.**
2. Perform the following field tests and inspections and prepare test reports:
 - a. Before requesting final approval of the installation, submit a written affidavit stating the installation meets the plans and specifications. Also complete and submit the NFPA Record of Completion form and submit all fire alarm system as-built drawings.
 - b. Perform each electrical test and visual and mechanical inspection listed in NFPA 72 and as indicated on the Fire Alarm Matrix on the drawings. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
 - c. Include a test of 10% of the existing system, or as directed by AFD, in tests and inspections.
 - d. **Once system has been completely tested and verified to be in 100% correct operating condition, the Project Manager shall request a Final Test with the Electrical Contractor, Simplex, the Amherst Fire Department, the State Building Inspector and the University of Massachusetts Department of Environmental Health and Safety. The Electrical Contractor is responsible for submitting all documentation required to schedule the final test.**

* = Filed Sub-Bid Required

END OF SECTION 260001

ELECTRICAL WORK

