

SECTION 260001

ELECTRICAL WORK

(Filed Sub-Bid Required)

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PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 1 - 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 and Maintenance 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: (Insert name of sub-bidder)

MASS. STATE PROJECT: ((Insert project number from top of page))

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 and Maintenance as required by Section 44F of Chapter 149 of the General Laws, as amended. Sub-bid forms may be obtained at the office of the Division of Capital Asset Management and Maintenance, or may be obtained by written or telephone request; telephone (617) 727-4003.
- 3. Sub-bids filed with the Division of Capital Asset Management and Maintenance 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:

1. Sub bidder's attention is directed to Massachusetts G.L. Chapter 149 Section 44F, as amended, which provides in part as follows.
2. Each sub-bidder shall list in Paragraph E of the "Form for Sub-bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which the Section of the Specifications for that sub trade requires such listing, provided that, in the absence of a contrary provision in the Specifications, any sub-bidder may, without listing any bid price, list his own name or part thereof and perform that work with persons on his own payroll, if such sub-bidders, after sub-bid openings, shows to the satisfaction of the Awarding Authority that he does customarily perform such class of work with persons on his own payroll and is qualified to do so. This Section of the Specifications requires that the following classes of work shall be listed in Paragraph E under the conditions indicated herein.

CLASSES OF WORK

REFERENCE PARAGRAPH OR SECTION

Fire Alarm System

- D. Reference Drawings: The Work of this Filed Sub-Bid is shown on the following Contract Drawings: ((always insert accurate list of sheet numbers of applicable Drawings)).

1.2 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. Interior secondary branch circuit installation, motor controls, overcurrent and switching devices, raceways, cables, wiring, junction and pull boxes, wireways, and all other components required to support electrical installation as shown.
  2. 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.
  3. Telephone system wiring, conduit, and outlet locations as required to facilitate installation of devices, patch panels, termination blocks, and outlets, by others.
  4. Data system wiring, conduit and outlet locations as required to facilitate installation of devices, patch panels, termination blocks, and outlets, by others.
  5. Grounding and bonding of new electrical systems and equipment in accordance with code.
  6. Fire alarm system components, interface and zone expansion modules as required to extend existing system. Includes wiring and conduit to support system expansion. Provide for Fire Department permitting, coordination, pretesting, acceptance testing and, paperwork submittals, including record of completion form.
  7. Wiring devices (switches and receptacles) complete with associated wall plates.

8. Power wiring to HVAC, plumbing and fire protection equipment where required.
9. Control wiring, conduit, and head end controls and annunciation associated with toilet flusher system. Flushers provided by others.
10. Provide wiring and conduit pathways as required to support installation of additional Security System Cameras & new head end equipment by others.
11. DSX Door Access System, including power and control wiring, DSX card readers, power transformers, & door strike. Head end equipment provided by others.
12. Cell Door Position Switches & Door position panel, including power and control wiring, power transformers, & and contacts. Head end equipment provided by others.
13. Remote security Monitor Station, Tele/Data interconnectivity and power at courtroom, Monitor provided by others.
14. Testing and demonstration of complete and functional electrical systems.
15. Coordination between electrical and other trades.
16. Certified seismic restraints to meet the Commonwealth of Massachusetts Building Code applicable at the time the building permit is issued
17. All other systems hereinafter specified or indicated on the Contract Drawings, complete, leaving ready an electrical system in perfect operating condition.
18. Core drilling up to 4" for the Work of this Section, where required.
19. Coordination drawings and record drawings and similar requirements.
20. Coordination with building occupants. Schedule work areas in consultation with the general contractor and building occupants, to allow for the continued use of the building during the construction.
21. All Work of Division 27 Sections - COMMUNICATIONS.
22. All Work of Division 28 Sections - ELECTRONIC SAFETY AND SECURITY.

- B. 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.
- C. The Electrical Sub-Contractor shall be responsible for coordination and final selection of wiring type, required to be installed to support ancillary electrical systems, where head end components and devices are furnished by others.

### 1.3 SUBMITTALS

- A. Comply with requirements specified in Section 013300 – SUBMITTAL REQUIREMENTS.
- B. Shop Drawing: Submittals shall include but not be limited to:
1. Light fixtures & Controls
  2. Overcurrent and switching devices.
  3. Wiring devices and wall plates.
  4. Security system components with wiring diagram.
  5. Fire alarm system with detail drawings, layout, wiring diagram, mass code required documentation, and schedule.
  6. Sound systems with wiring diagrams.
  7. Cable trays.
  8. Wiring and cables for line voltage and power limited systems.
  9. Conduit.
  10. Boxes and fittings.

11. Safety switches.

#### 1.4 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.

#### 1.5 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 Designer 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 DCAMM's Project Manager s at the completion of the work. Copies of permits shall be given to the resident engineer 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. State 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)
- 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.

#### 1.6 SURVEYS AND MEASUREMENTS

- A. Base all required measurements, both horizontal and vertical, on reference points established by the Construction Manager 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

Construction Manager in writing, and do not proceed with the work required until written instructions have been issued by the Construction Manager.

#### 1.7 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 Designer. 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 DCAMM, make reasonable modifications to the work as required by normal structural interferences. Pay the Construction Manager 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 DCAMM.
- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer 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 DCAMM.

#### 1.8 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 thermostat, zone valve 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. The Electrical Subcontractor will provide all magnetic starters except those furnished as an integral part of packaged equipment.

#### 1.9 MECHANICAL AND ELECTRICAL COORDINATION DRAWINGS

- A. Refer to Section 013100 – PROJECT MANAGEMENT AND COORDINATION for coordination drawing requirements

#### 1.10 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 Designer for his determination prior to proceeding with the work.

#### 1.11 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 Designer.

#### 1.12 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 1" larger than the outside diameter of the pipe or insulation covered line passing through it.

1.13 CORING, DRILLING

- A. Core, cut and/or drill all small holes 4" diameter or less in walls and floors required for the installation of sleeves and supports for the electrical work.

1.14 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.

1.15 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 PORTABLE AND DETACHABLE PARTS

- A. Contractors shall retain in their possession all portable and/or detachable parts and portions of materials, devices, equipment etc. necessary for the proper operation and maintenance of the mechanical and electrical systems until final completion of the work, at which time they shall be handed over to DCAMM's Project Manager.

1.17 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 compliant with the building code, and 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.

1.18 GUARANTEE/WARRANTY

- A. Guarantee Work of this Section in writing for one year following the date of Substantial Completion. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Designer'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 DCAMM's 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. Provide 24 hour service contact information, beginning on the date the project is accepted by DCAMM, whether or not fully occupied, and lasting until the termination of the guarantee period. Service shall be at no cost to DCAMM. Service can be provided by this contractor or a separate service organization. Choice of service organization shall be subject to Designer and DCAMM's Project Manager's approval.
  4. Submit copies of equipment and material warranties to Designer before final payment.
  5. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to User Agency.
  6. This Paragraph shall not be interpreted to limit DCAMM's rights under applicable codes and laws and under this Contract.
  7. Part 2 Paragraphs of this Specification may specify warranty requirements that exceed those of this Paragraph. Those paragraphs will govern.
  8. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work by DCAMM's Project Manager, and shall not initiate the guarantee period.
  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 DCAMM's Project Manager's satisfaction, advise Designer in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Designer will direct course of action.

1.19 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.

#### 1.20 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 DCAMM.
- 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.
  - 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.

#### 1.21 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.

#### 1.22 TEMPORARY POWER AND LIGHTING

- A. The Electrical Subcontractor shall furnish and install Temporary lighting shall be based on a minimum of one watt per square foot covering each and every square foot of floor areas where existing lighting is to be removed, as directed by the general contractor. Sufficient wiring, lamps, and outlets shall be installed to insure proper lighting in all areas required. Minimum sized lamp used shall be 1000 lumen.
- B. All necessary branch circuiting, GFCI protected receptacles, temporary lamp replacements and accessories required for the temporary light and power installation shall be provided by the Electrical Subcontractor.
- C. All temporary wiring and accessories thereto installed by the Electrical Subcontractor shall be removed after their purposes have been served.
- D. Provide all temporary lighting and power required above during the normal working hours of the project or a total of ten (10) hours per normal working day; Saturdays, Sundays and legal holidays are excluded. In addition to the above, provide and maintain, to the satisfaction of the

local authorities having jurisdiction, all temporary lighting and power that may be required for safety purposes.

1.23 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.

1.24 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 Designer 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 User Agency's designated representative, 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 User Agency's working schedule, as many times as required until all work is completed. Any outages of service shall be approved by DCAMM's Project Manager, prior to commencing the work. No outages or shutdowns of service shall occur without the written authorization of the DCAMM's Project Manager prior to commencing the work. Give notice of any scheduled shutdowns, a minimum of weeks in advance. User Agency shall make their best efforts to meet this request without adversely affecting the electric service to the existing building.
- B. Prior to any deactivation and relocation or demolition work, consult the drawings and arrange a conference with the Designer and the DCAMM's Project Manager in the field to 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 tie ins 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 Construction Managers provided dumpster. All hazardous electrical materials shall be legally disposed by the electrical subcontractor.
- D. DCAMM's Project Manger reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
- E. Phasing

1. The Electrical Subcontractor shall construct the subject project in phases as directed by the Designer 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

### 2.1 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. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.
- B. For purpose of establishing a standard of quality and not for purpose of limiting competition, 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 "approved equal" by Designer, other manufacturers equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Designer.
- E. All materials shall be new and shall be UL listed.

### 2.2 RACEWAYS AND FITTINGS

- A. Raceways - General:
  1. Except for floor boxes, no conduit shall be allowed in elevated floor slabs. When connecting to a floor box, that conduit raceway shall take the shortest run in the floor slab.
  2. No raceway shall be used smaller than 3/4" diameter. No conduit shall have more than three (3) 90o bends in any one run, and where necessary, pull boxes shall be provided. Intermediate metal conduit is not allowed.
  3. 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 mechanical rooms and where raceway may be subject to mechanical damage, i.e., loading docks, work shops, etc.

4. 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. EMT shall utilize compression type fittings.
5. 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. FMC/LTFMC shall be run concealed or in mechanical spaces only.
6. Surface Raceway shall be Steel type limited capacity where concealed work installation is impactable. Provide surface raceway equal to Wiremold 700 series, with ivory finish. Where higher capacity raceway is required, Steel type 2-piece Surface raceway w/ ivory finish, equal to Wiremold 2000 series may be utilized. Surface Raceway shall be allowed in all areas where concealed methods, and existing embedded conduit pathways are inadequate to serve new electrical / communication outlet locations.
7. Rigid non-metallic conduit may be used at the contractors option for underground electric and telephone services outside the foundation wall and shall be polyvinyl chloride (PVC) schedule 40, 90oC. If option of rigid non-metallic conduit is exercised, underground runs outside the foundation wall shall be concrete encased at contractor's expense.
8. PVC Schedule 40 may also be used for below slab circuits within building confines. Below slab rigid non-metallic conduits do not require concrete encasement. Rigid non metallic conduits shall not be used in slabs. Rigid steel elbows or stubs shall be used for penetrations from below slab or through exterior walls into building. PVC shall not be installed within building. Raceways and fittings shall be produced by same manufacturer.
9. 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. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
  - h. Couplings, elbows and other fittings used with rigid nonmetallic raceways shall be of the solvent cemented type to secure a waterproof installation.
  - i. Acceptable Manufacturers:
    - 1) O.Z.
    - 2) Crouse Hinds
    - 3) Appleton
    - 4) EFCOR
    - 5) Steel City

## 2.3 WIRING MATERIALS

- A. Conductors 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, solid construction where No. 10 AWG and smaller, stranded construction where No. 8 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 approved 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 metal conduit.
- F. Minimum conductor size shall be No. 12 AWG installed in conduit. Motor control circuit wiring shall be minimum No. 14 AWG installed in conduit.
- G. For fire alarm and other specialty systems wiring, refer to manufacturers shop drawings and wiring diagrams for conductor size, electrical characteristics, and approved wire manufacturers.
- 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. Except for homeruns from the first device, junction point, or lighting fixture, Type "MC" cable may be used for all concealed 20 AMP 120V receptacle and lighting branch circuits where allowed by code if installed and terminated as specified under Execution Section.
- J. Wiring materials shall be manufactured by Triangle, Republic, Anaconda, General Cable, or equal.

## 2.4 OUTLET, JUNCTION, PULL BOXES, AND WIRING TROUGHS FOR ALL SYSTEMS

- 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 Designer. 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.

## 2.5 WIRING DEVICES

- A. Provide wiring device type plates for all wall mounted devices. All wall plates shall be smooth high impact nylon for all public areas, offices, classrooms, etc color as directed by the Designer. Provide galvanized steel for all Utility, Electric and Mechanical Rooms.
- 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 Designer for all public areas, offices, classrooms etc. Provide brown devices for all Utility, Electrical and Mechanical Rooms.
  2. Exclude compact or "despard" type devices.
- 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. Single pole switch shall be equal to Hubbell No. HBL1221.
  2. Double pole switch shall be equal to Hubbell No. HBL1222.
  3. Three-way switch shall be equal to Hubbell No. HBL1223.
  4. Four-way switch shall be equal to Hubbell No. HBL1224.
  5. Single pole pilot light switch shall be equal to Hubbell No. HBL1221PL.
  6. Equivalent 277 volt 20 amp switches shall be used where required.



- 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. Equal to Hubbell No. HBL5362.
  - 2. Where indicated on plans provide receptacles with ground fault current interrupters, UL class A, 20A, 125V to be equal to Hubbell No. GF5352.
- E. Nonstandard convenience receptacles and special purpose power supply receptacles shall be as listed on plans.
- F. Devices and device plates for flush wall devices which are not integrally equipped with same, shall be as directed by the Designer.
- G. For unfinished spaces, plates for surface mounted wall devices which are not integrally equipped with same, shall be galvanized sheet steel, formed raised type which does not overlap box. Where for switches, such plates shall have toggle guards.
- 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.
- J. Wiring devices and associated hardware shall be manufactured by Arrow Hart, Leviton, or Pass and Seymour.

## 2.6 GROUNDING REQUIREMENTS

- A. Ground all systems and equipment in accordance with best industry practice, the requirements of NFPA 70

## 2.7 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 (only 120/208V power is available at this building).

<u>120/208 V Circuits</u>	<u>277/480V</u>	<u>Phase Circuits</u>
Black	Brown	A
Red	Orange	B
Blue	Yellow	C
White	Grey	Neutral
Green	Green with 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.
- 2.8 ENCLOSURES FOR INDIVIDUALLY MOUNTED OVERCURRENT AND SWITCHING DEVICES
- A. Construction shall be NEMA Class I, where installed indoors.
- B. Construction shall be NEMA Class IV, where installed outdoors, in mechanical rooms, in locations defined as damp or wet by NFPA 70 or where indicated as weatherproof.
- C. Operating handles shall be front or side type to accommodate hand access space and flush or surface mounting requirements.
- D. Each shall be equipped with padlock for locking operating handle in the open position.
- 2.9 MOLDED CASE CIRCUIT BREAKERS
- A. Molded case type circuit breakers shall consist of manually operated quick make quick break mechanically trip free operating mechanisms for simultaneous operation of all poles, with contacts, arc interrupters and trip elements for each pole, all enclosed in molded phenolic plastic cases.
1. Their tripping units shall be of the "thermal magnetic" type having bimetallic elements for time delay overload protection and magnetic elements for short circuit protection.
  2. They shall be manually operable by means of toggle type operating handles having "tripped" position midway between the "on off" position.
  3. They shall each be contained in an individual case enclosing only the number of poles required for the particular breaker.
  4. All panels and individually mounted circuit breakers shall have short circuit ratings exceeding the available short circuit or the values indicated in the Power System Studies in this section by a factor of 1.2 with a minimum as follows:
    - a. 240V class panels/breakers
      - 1) 110 kAIC where shown fed by a 150 kVA or less transformer
      - 2) 222 kAIC where shown fed by a 300 kVA or less transformer
  5. They shall be of the "bolted in" type except where required for installation into a 'plug-in' type panelboard or load center.

6. Where necessary, to accommodate other requirements, their frame sizes shall be increased to conform to such requirements, frame sizes being indicated only as a reference to the minimum acceptable interrupting ratings noted above.
7. Where single pole in trip sizes 20 amps or less, they shall be rated for switching duty.
8. They shall be equipped with 5 milliamp sensitivity ground fault interrupting features where so indicated.

- B. They shall be manufactured by Square D, Cutler Hammer, or General Electric, and should match the manufacturer and type of the corresponding panelboard or load center.

## 2.10 MOTOR CONTROLS

### A. Motor Controls - Manual and Magnetic:

1. Individually mounted magnetic starters shall be across-the-line type with thermal overload on each phase, single-speed, two-speed, or reduced voltage start as indicated. Check exact type of two-speed or part-winding motors to be furnished by other contractors, and provide proper starter.
2. Starters shall be of the replaceable contact double break type, of size and type required for particular motor horsepower and voltage. Minimum size starter to be size 1.
  - a. Starters shall have OL reset button, green pilot light to indicate "ON", and "HAND-OFF-AUTO" switch in cover. Pilot lights shall be push-to-test type.
  - b. Starters to have 120 volt control transformers with fused output being provided for those units operating on 277/480 volt system.
  - c. Provide proper rating of thermal overloads. Replace any overloads found to be of an incorrect rating. Provide a spare set of three thermal overloads for each starter.
  - d. Provide four (4) sets of auxiliary contacts of convertible type N.O. to N.C. for each starter.
  - e. Motor starters installed in dry locations shall have NEMA I enclosures. Those in wet locations shall have NEMA IV enclosures.
  - f. Acceptable Manufacturers:
    - 1) 1Allan Bradley
    - 2) 2General Electric
    - 3) 3Cutler Hammer
    - 4) 4Square D
3. Manual motor starters shall have pilot lights and shall be furnished with thermal overloads on each phase.

- B. Motors: Each motor shall have disconnect switch and starter provided under this section. Starters which are a part of "factory assembled" control panel will be provided under section supplying equipment to be controlled but connected under this section.

1. Provide motor terminal boxes for each motor not furnished with same.

### C. Disconnect Switches:

1. Disconnect (safety) switches shall conform to industrial standards of NEMA, be UL listed and shall be heavy duty type, quick-make, quick-break type with interlocking cover

- mechanism and provisions for padlocking switch handle in "OFF" position. Three pole toggle switches are not acceptable as substitute for disconnect switches.
2. Disconnect switches shall be of fused or unfused type as indicated with number of disconnecting poles indicated. The grounded conductor shall not be switched. Switches shall be for use with current limiting fuses with rejection type fuse clips and those shall be horsepower rated.
  3. Enclosures shall be of proper NEMA type for the intended location and shall be phosphate coated or equivalent code gauge galvanized sheet steel with gray baked enamel finish.
  4. Acceptable Manufacturers:
    - a. General Electric
    - b. Cutler Hammer
    - c. Square D
- D. Combination Starter
1. Provide combination starters where indicated on the plans.
- E. Motor Control Circuitry
1. Except as noted below, select materials exactly as specified for feeders. Utilize No. 12 A.W.G. THWN conductors throughout minimum.
  2. Motor control circuit wires may be run in the same conduit as the wires of motor power circuits; however, exclude motor control wires from enclosures (other than motor starter enclosures) which contain power circuit overcurrent protection and switching devices; also from pull boxes and junction boxes containing the wires of main and submain feeders. Utilize auxiliary pull boxes to separate motor control wires from motor power circuit wires before the power circuit wires enter the items from which motor control wires are excluded.
  3. Prior to installing any motor control circuitry for a particular motor, notify the Designer of any deviations between the control circuitry requirements of the trade supplying the motor and the indicated electric work.

## 2.11 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 Designer 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 Designer 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 T8 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. Remote ballasts shall be standard core and coil type "P", sound rating "A".
- M. All ballasts or transformers for discharge type lamps intended for use outdoors shall be of the low temperature type having the lowest temperature rating available in standard manufacture.
- N. Ballasts and transformers shall be of the "low energy full light output" type where available. Each shall not exceed industry minimum rated input wattage by more than 8%.
- O. All fixtures shall be UL approved with labels attesting thereto.
- P. 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. Unless noted otherwise, fluorescent lamps shall be T8 3500EK 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.
  - 3. All metal halide lamps of the proper wattage and voltage rating shall be provided in each fixture as indicated on the fixture schedule and the ANSI designation of the ballast. Unless otherwise noted metal halide lamps shall be universal burn type with a clear outer glass jacket.

4. All HPS lamps of the proper wattage and voltage rating shall be provided in each fixture as indicated on the fixture schedule and the ANSI designation of the ballast.
5. All incandescent lamps shall be rated for 130 volt operation.

- Q. All lamps shall be of the type specified in the light fixture schedule.
- R. 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.
- S. 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 Construction Manager.
- T. Include the aiming and/or adjustments of all lighting fixtures requiring same in accordance with instructions issued by the Designer in the field.
- U. 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.
- V. 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.
- W. All fixtures shall include seismic clips and shall be supported to comply with seismic regulations.
- X. Lamps shall be manufactured by General Electric, Phillips, OSRAM, or Sylvania.
- Y. Exit Signs: Code compliant, including the International Symbol of Accessibility at accessible exit doors. Provide Telesis Universal Mount Edgelit LED Exit Signs by Evenlite or approved equal, fabricated with 6 inch exit letters and 6 inch accessibility symbol; aluminum housing, .

## 2.12 FIRE ALARM SYSTEM

### A. Scope and Related Documents

1. The work covered by this section of the specifications includes the furnishing of all labor, equipment, materials, and performance of all operations in connection with the expansion of the existing Simplex 4005 Fire Alarm System existing at the Courthouse.
2. The complete installation is to conform to the applicable sections of NFPA-72, NFPA-71, Local Code Requirements and Massachusetts Electrical Code (MEC) with particular attention to Article 760.
3. The work covered by this section of the specifications is to be coordinated with the related work as specified elsewhere under the project specifications.

4. The existing fire alarm control panel is a microprocessor based fire alarm system. New notification appliances shall be added to existing loops. Existing Notification loops shall be load tested and verified to have available capacity for additional devices.
5. New fire notification devices shall be installed where shown, and installed in compliance with the specifications and drawings. Devices shall be of the same manufacturer as the existing fire alarm system.
6. Provide Notification Appliance Circuit Expansion Panel to support new devices installed in the areas of renovation.

B. Quality Assurance

1. Each and all items of the Fire Alarm System shall be listed as a product of a SINGLE fire alarm system manufacturer, equal to the existing fire alarm system manufacturer. Each shall be listed under the appropriate category by Underwriters' Laboratories, Inc. (UL), and shall bear the "U.L." label. All control equipment is to be listed under UL category UOJZ as a single control unit. Partial listing is not acceptable.
2. The equipment and installation supervision furnished under this specification is to be provided by a manufacturer, independent dealer, or distributors who has been engaged in production and installation of this type (software driven) of equipment for at least ten (10) years, and has a fully-equipped service organization within fifty (50) miles of the installation.

C. General

1. Furnish and install Fire Alarm System components as described herein and as shown on the plans; to be wired, connected, and left in first class operating condition. The system expansion shall utilize the existing fire alarm system notification loops to support new equipment as shown.
2. To accommodate and facilitate job site changes, notification appliance circuits shall be individually configurable on-site to provide, upon activation, a fast march time, slow march time, temporal code, PNIS code or a master code until deactivated or reset upon any output circuit. .
3. To accommodate and facilitate job site changes, notification circuit loop shall be tested for load, and expanded upon only if capacity exists to support additional devices.
4. New Notification appliances shall be synchronized throughout each area.

D. Operation

1. The existing Fire Alarm Control Panel operation and performance shall not be inadvertently modified or negatively affected with the additional devices installed. Continue the existing operation as required.

E. Alarm Sequence

1. The system alarm operation and performance shall not be inadvertently modified or negatively affected with the expansion of the notification appliance loops required to be installed in support of the renovated space.

F. Power Requirements

1. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of sixty (24) hours with 10 minutes of alarm operation at the end of this period. The system shall automatically transfer to the standby batteries upon power failure. All battery charging and recharging operations shall be automatic.
2. The Electrical Contractor shall submit, along with Shop Drawings, complete battery calculations of the proposed system.
3. All circuits requiring system operating power shall be 24VDC and shall be individually fused at the notification appliance circuit expansion panel or main control panel.

G. Notification Appliances

1. Alarm horns shall be polarized and shall be operated by 24 VDC. Each horn assembly shall include separate wire leads for in/out wiring for each leg of the associated signal circuit. T-tapping of signal device conductors to signal circuit conductors shall NOT be accepted. The alarm horns shall be suitable for rear mounting.
2. Visual indicating appliances shall be comprised of a Xenon flashtube and be entirely solid state. These devices shall be UL listed and be capable of either ceiling or wall mounting. The LEXAN lens shall be pyramidal in shape to allow better visibility. Visual units shall be of the stand alone type or be incorporated as part of the (horn, bell) unit.
3. Audio/Visual units shall provide a common enclosure for the fire alarm audible and visual alarm devices. The housing shall be designed to accommodate either horns, bells, or chimes. The unit shall be complete with a tamper resistant, Pyramidal shaped lexan lens with "Fire" lettering visible from a 180° field of view. The front panel or bezel, which is constructed of UL Listed Noryl, may be inverted so that the lens is below the audible device. Integral Xenon strobe shall provide a minimum light output of 7.5 candela/seconds at 24VDC at a 45 flashes per minute rate. Xenon strobes shall provide a 4 wire connection to insure properly supervised in/out system connection. Unit shall be complete with all mounting hardware including backbox. Audio/visual unit shall be UL Listed for its intended purpose.

H. Installation

1. Provide and install the system in accordance with the plans and specifications, all applicable codes and the manufacturer's recommendations. All wiring shall be installed in strict compliance with all the provisions of NEC - Article 760 A and C, Power Limited Fire Protective Signaling Circuits or if required may be reclassified as non-power limited and wired in accordance with NEC-Article 760 A and B. Upon completion, the contractor shall so certify in writing to the Owner and General Contractor.
2. Provide Fire Alarm System Type MC cable run concealed in all areas. Conduit and thermoplastic jacketed cable shall be installed where run exposed.
3. All junction boxes shall be sprayed red and labeled "Fire Alarm". Wiring color code shall be maintained throughout the installation.
4. Installation of equipment and devices that pertain to other work in the contract shall be closely coordinated with the appropriate Contractors.
5. The contractor shall clean all dirt and debris from the inside and the outside of the fire alarm equipment after completion of the installation.



6. The manufacturer's authorized representative shall provide on-site supervision of installation at time of startup and testing.
7. Each Initiation Device shall be provided with an identification label coordinated with fire alarm system programming, to include the individual device address.
8. Each Notification Device shall be provided with an identification label, coordinated with the SLC loop supporting the device.

I. Testing

1. The completed fire alarm system shall be fully tested in accordance with NFPA-72 by the Electrical Contractor in the presence of the Owner's representative and the Local Fire Marshal. Upon completion of a successful test, the contractor shall so certify in writing to the Owner and General Contractor.

J. Warranty

1. The contractor shall warrant the modified fire alarm system wiring and equipment to be free from inherent mechanical and electrical defects for a period of one (1) year from the date of the completed and certified test or from the date of first beneficial use.

K. Final connections between control equipment and wiring system shall be made under direct supervision of a representative of the manufacturer.

L. The manufacturer's representative shall demonstrate the operation of the alarm system to the Architect and Owner, and upon completion, to a representative of the Northampton Fire Department.

M. The Electrical Contractor shall co-ordinate the system installation with the Fitchburg Fire Department and shall file application for fire alarm service, shall arrange for inspections and supervision by the Fire Department, and shall pay all fees in connection with the installation of the system.

2.13 COMMUNICATION – TELEPHONE & DATA SYSTEMS

A. General Requirements

1. The contractor shall Furnish and Install conduit pathways, communication wiring, termination boxes and material required to facilitate the final installation of telephone and data outlets and patch panel connections by others, and as detailed in these specifications and applicable contract drawings.

B. Data Outlet locations, as shown on Drawings, shall consist of standard size outlet box, and cover plates (smooth phenolic brown), with 2 ports for data jack installation.

C. The work in this Section shall be performed by Electrical Contractor.

D. Both Telephone and Data cabling shall be Category 6, unshielded twisted pair, (UTP), with a blue sheath as described in ANSI/TIA/EIA-606-A

1. Solid copper, 24 AWG, 100 ohm balanced twisted-pair (UTP) Category 6 cables with four individually twisted-pairs, which meet or exceed the mechanical and transmission performance specifications in ANSI/TIA/EIA-568-B.2-1 up to 250 MHz.
2. Wall Plates and Connectors
  - a. Single-gang faceplate with two openings containing the following devices:
    1. Data Outlet - 8-pin modular, category 6, unkeyed, black, pinned to either T568 (A or B) standards.
    2. Voice Outlet - 8-pin modular, category 6, unkeyed, ivory, pinned to either T568 (A or B) standards.
3. Data Jack Modules
  - a. Eight position modules shall be used in all work areas and modular patch panels and shall meet the TIA/EIA-568-B.2-1 Category 6 standard. Modules shall be tested and approved for Category 6 ETL component compliance. The module termination to 4 pair 24 – 22 AWG 100 ohm solid unshielded twisted pair cable shall be accomplished by use of a forward motion termination cap and shall not require the use of a punchdown tool. All modules shall be 100% tested for NEXT performance. The termination cap shall be color coded for T568A and T568B wiring schemes.

E. Installation of Data and Telephone Cabling

1. Install materials and equipment in accordance with manufacturer's printed instructions to comply with governing regulations and industry standards applicable to the work and as shown on approved Shop Drawings.
  - a. Contractor shall rigidly adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing all cables.
2. Arrange and mount all equipment and materials in a manner acceptable to the Architect/Engineer and Owner.
3. Installation shall conform to the following basic guidelines:
  - a. Use of approved wire, cable, and wiring devices.
  - b. Neat and uncluttered wire termination.
4. Provide fire stopping for electrical penetrations through fire rated floors, walls, and other partitions of building construction as required by other sections of the specifications.

F. General Co-ordination (Data and Telephone Wiring)

1. Entire system shall conform completely with pertinent codes, laws, ordinances, regulations, standards, criteria, or other requirements, including, but not limited to,

structural support, fire rating and health/safety requirements regarding all items. Such conformity shall have precedence over this Specification.

2. Secure equipment firmly in place, including boxes, conduit, and cables. Provide fastenings and supports adequate to support loads.
3. Install work neatly, with boxes, equipment, etc., plumb and square. Adjust layout as necessary to preserve symmetry and aesthetics. Install equipment to provide maximum safety to future operators.
4. Clearly, logically, and permanently mark connectors, jacks, cables, and cable terminations.

G. Wiring

1. Provide wire, conduits, and raceways according to standard broadcast practices. Do not exceed 30% fill in conduit (see section J for details).
2. Exercise care in wiring to avoid damage to cables and equipment.
3. Wiring shall not rest on ceiling material nor touch any heat sources. Conduits exposed to physical abuse shall be run in RSC, 3/4" minimum.
4. Install all data wire and cable. Ensure proper.
  - a. Pulling tensions.
  - b. Quantities.
  - c. Types.
  - d. Lengths.
  - e. Routing.
  - f. Wire group separation.
  - g. Identification.
  - h. Bend radius
5. Splicing of cables is not permitted between terminations at specified equipment.
6. Form, in a neat and orderly manner, all conductors in enclosures and boxes, wireways and wiring troughs, providing circuit and conductor identification. Tie as required using T&B "Ty-Raps" of appropriate size and type. Limit spacing between ties to 6", and provide circuit and conductor identification at least once in each enclosure.
7. Provide ample service loops at each termination so that plates, panels, and equipment can be unmounted for service and inspection.

2.14 EQUIPMENT GROUNDING REQUIREMENTS

- A. Equipment ground all systems and equipment in accordance with best industry practice.
- B. All separately derived sources (i.e., transformers) shall be grounded per code.
- C. 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.
- D. 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.

- E. Each branch circuit and feeder shall have a dedicated equipment grounding conductor, minimum # 12 AWG. Shared or tapped equipment grounding conductor shall not be acceptable.

## 2.15 RACEWAYS AND WIRING TO SUPPORT VIDEO (TV) & OTHER SYSTEMS

- A. The Electrical Subcontractor shall furnish and install CCTV Video outlets including conduit, wiring, outlet box, outlet cover plate, fittings, and all other appurtenances required, leaving the entire installation ready for installation of camera system equipment by others.
- B. In general, each voice/data and each video outlets are shown on the Drawings. Each outlet location shall be a minimum 4"x 4" square outlet box with a single gang trim (walls) or round raised cover (ceilings) and blank coverplate. Depth of the outlet box shall be minimum 2-1/2" in wall or 1-1/2" on the ceiling.
- C. The Electrical Subcontractor shall coordinate with existing equipment manufacturer for camera wiring requirements & install said wiring from each camera location to head end equipment location to facilitate the camera installation by others.
- D. All blank wall plates shall be furnished by the Electrical Subcontractor and be of the same finish and by the manufacturer furnishing all other wiring device and switch plates installed.
- E. Provide a 1/2" conduit to serve a single camera outlet location. Calculate conduit fill where multiple conductors are routed in a single raceway, multi conductor conduit shall be minimum of 3/4" trade size.
- F. Firestop and seal all penetrations as required to maintain fire separations as indicated on the Architectural Drawings.
- G. Prison Cell Systems
  - 1. Door position monitor contacts & Head end equipment serving prison door position annunciation, shall be provided by others, and installed by the electrical contractor. Coordinate with equipment provider for final wire selection and routing, furnish and install wiring and raceway to provide a complete system installation.
  - 2. Toilet Flush equipment & Head end equipment shall be provided by others and installed by the electrical contractor. Coordinate with equipment provider for final wire selection and routing, furnish and install wiring and raceway to provide a complete system installation.
  - 3. Provide Raceway in compliance with specifications to support installation of communication & control wiring throughout the building where indicated.
  - 4. Reuse of existing wiremold raceway is at the discretion of the electrical contractor, and is subject to standard fill limitations.
  - 5. Coordinate with manufactures' wiring diagrams and required wiring specifications. Electrical contractor to furnish and install wiring and connections to devices & equipment.
- H. Other Systems

1. Door Access System shall be compatible and integrated with the existing proprietary DSX system.
  - a. Door Strike to be furnished and installed by others, wiring and connections to support door strike to be provided by electrical contractor.
  - b. Door Strike Transformer to be furnished by others, installation, power and control wiring and connections to be provided by electrical contractor.
  - c. DSX Controller to be furnished by others, installation, power and control wiring and connections to be provided by electrical contractor.
  - d. DSX Card Reader to be furnished by others, installation, power and control wiring and connections to be provided by electrical contractor.
  - e. Coordinate with manufactures' wiring diagrams and required wiring specifications. Electrical contractor to furnish and install conduit, wiring and connections to devices & equipment.

## 2.16 SEISMIC RESTRAINT AND VIBRATION ISOLATION DEVICES

### A. Devices

1. All seismic devices described in this section shall be the product of a single manufacturer. Mason Industries is the base manufacturer of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with intent, structural design, performance and deflections of the Base Manufacturer. The devices shall be identified by the manufacturer to be suitable for the particular seismic application(s) and also be listed with California OSHPD to ensure product seismic capability
2. The manufacturer of the seismic restraint devices shall certify that the devices are capable of accepting, without failure, the seismic forces as determined by the Part 2 "SEISMIC RESTRAINT STUDIES" section of these specifications. The manufacturer shall select the appropriate seismic restraint device type, quantities, locations, installation instructions, drawings and field supervision to insure proper installation and performance of system, consistent with the "SEISMIC RESTRAINT STUDIES".
3. Corrosion protection for outdoor applications shall be as follows:
  - a. Springs cadmium plated, zinc electroplated, or powder coat
  - b. Hardware cadmium plated
  - c. All other metal parts hot spray or hot dipped galvanized
4. All seismic restraint devices:
  - a. shall maintain the equipment in a captive position and not short circuit isolation devices during normal operating conditions.
  - b. shall have provisions for bolting and/or welding to the structure.
5. Welding of springs to isolator housing, base plates, etc., is strictly prohibited.
6. Contractor shall provide restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the Part 2 "Seismic Restraint Studies".
7. The same manufacturer shall provide vibration isolation devices for transformers suitable to maintain minimum deflection as stated in the Part 2 "SEISMIC RESTRAINT STUDIES".

### B. Seismic Restraint Types

1. TYPE I: Same as TYPE B. Cast or aluminum housing, (except ductile iron) are not acceptable.
  - a. Mason Industries TYPE SLR
2. TYPE II: Where required, each corner or side of equipment base shall incorporate a seismic restraint snubber having an all directional resilient pad limit stop. Restraints shall be fabricated of plate, structural members or square metal tubing. Angle bumpers are not acceptable.
  - a. Mason Industries Type Z-1225 / Z-1011
3. TYPE III: Restraints for suspended systems
  - a. Vibration isolated systems shall be braced with multiple 7 x 19 strand galvanized cable rope.
    - 1) Mason Industries Type SCB
  - b. Non-isolated systems shall be braced with structural steel strut type with approved fastening devices to equipment and structure.
    - 1) Mason Industries Type SSB
  - c. Steel angles (by contractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint vendor's submittals. Steel angles shall be attached to the rods with a minimum of three ductile iron clamps at each restraint location. Welding of support rods to angles is not acceptable. Rod clamp assemblies shall have Anchorage Preapproval "R" number from California OSHPD.
    - 1) Mason Ind. Model "SRC".
  - d. Pipe clevis cross braces are required at all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the clevis cross bolt. Clevis cross braces shall have Anchorage Preapproval "R" number from California OSHPD.
    - 1) Mason Ind. Model "CCB".
4. TYPE IV: Double deflection neoprene isolator encased in ductile iron or steel casing.
  - a. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
    - 1) Mason Industries Type RC or BR
5. TYPE V: Rigid attachment to structure utilizing wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Powder shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with manufacturer's published standards.

C. Vibration Isolator Types

1. TYPE A: Spring Isolator - Free Standing
  - a. Spring shall have a minimum outer diameter to overall height ratio of 0.8: 1 at rated deflection.
  - b. Reserve deflection (from published load ratings to solid height) of 50% of the rated deflection.
  - c. Ductile top cup with adjusting bolt tapped for equipment attachment locking cap screw.
  - d. Minimum 1/4" thick neoprene acoustical base pad or cup on underside, unless designated otherwise.
    - 1) Mason Industries Type SLF
2. TYPE B: Spring Isolator - Restrained
  - a. Shall be the same as TYPE A with the following additional features.

- 1) Integral restraining bolts with elastomeric cushions preventing metal-to-metal contact.
  - 2) Internal spring adjusting nut or bolt with leveling capability.
  - 3) Built-in all-directional limit stops with minimum 1/4" clearance under normal operation.
  - 4) Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
    - a) Mason Industries Type SLR, SSLFH
3. TYPE D: Double deflection neoprene isolator encased in ductile iron or steel casing.
  - a. Mountings shall have Anchorage Preapproval "R" number from California OSHPD, certifying the horizontal and vertical seismic load ratings.
    - 1) Mason Industries Type RC or BR
4. TYPE E: Elastomer Hanger Isolator
  - a. Molded neoprene element with an integral bushing to insulate lower support rod from the hanger box.
  - b. Steel hanger box shall withstand three times the rated load without failure.
    - 1) Mason Industries Type HD

D. Submittal Requirements

1. Catalog cuts or data sheets on specific seismic restraint devices restraints to be utilized detailing compliance with the Part 2 "SEISMIC RESTRAINT STUDIES" specification. Reference seismic restraint types per section of this specification. An itemized list of all isolated and non-isolated equipment. Detailed schedules showing seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
2. When walls and slabs are used as seismic restraint locations, details of acceptable methods must be included.
3. Coordinated drawings shall be marked-up with the specific locations and types of restraints shown for all electrical systems including but not limited to, conduit, cable tray. Rod bracing at various installation angles and assigned load at each restraint location shall be clearly delineated. Any and all tributary loads shall be considered for proper restraint sizing.
4. For ceiling suspended equipment provide minimum/maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.

E. Related Work

1. The electrical subcontractor shall coordinate with the Construction Manager for all concrete pads and all attachments. Coordinate with the seismic restraint manufacturer for edge distance of pads, but shall be as minimum 10 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.
  - a. Coordinate to ensure that the concrete pad is restrained itself to the structure to resist the seismic forces.

F. Supplementary Support Steel

1. Contractor shall supply supplementary support steel and connections for all equipment and piping as required.

### PART 3 - EXECUTION

#### 3.1 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-throughs, etc.
- G. No splicing of wires will be permitted in Fire Alarm System.
- H. 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.

#### 3.2 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.
- B. 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 DCAMM. Any defects or deficiencies discovered in any of the electrical work shall be corrected.
- C. The Electrical Subcontractor shall:
  1. Replace wiring and equipment found defective (defined as failing to meet specified requirements) at no additional cost to DCAMM.



2. Submit three copies of test results to the engineer.
- D. 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.
  1. 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 DCAMM.
- E. 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.
- F. 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.
- G. 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.
- H. Testing and checkout work is to be performed with fully qualified personnel skilled in the particular tests being conducted. Personnel are to have at least five years of experience with tests of same type and size as specified
- I. Inspections and tests shall be in accordance with the following applicable codes and standards as amended to date, unless otherwise specified.
  1. National Electrical Manufacturer's Association - NEMA.
  2. American Society for Testing and Materials - ASTM.
  3. Institute of Electrical and Electronic Engineers -IEEE.
  4. National Electrical Testing Association - NETA.
  5. American National Standards Institute - ANSI.
    - a. C2: National Electrical Safety Code.
    - b. Z244-1: American National Standard for Personnel Protection.
  6. Insulated Cable Engineers Association - ICEA.
  7. Association of Edison Illuminating Companies - AEIC.
  8. Occupational Safety and health Administration.
    - a. OSHA Part 1910; Subpart S, 1910.308.

- b. OSHA Part 1926; Subpart V, 1926.950 through 1926.960.
  9. National Fire Protection Association - NFPA.
    - a. 70B: Electrical Equipment Maintenance.
    - b. 70E: Electrical Safety Requirements for Employer Workplaces.
    - c. 70: National Electrical Code.
    - d. 78: Lightning Protection Code.
    - e. 101: Life Safety Code.
  10. Inspections and tests shall utilize the following references:
    - a. Contract Drawings and Specifications.
    - b. Contractor's Short Circuit and Coordination Study.
    - c. Manufacturer's printed test procedures for respective equipment.
- J. Test Equipment:
  1. Test equipment used by the Contractor is to be inspected and calibrated.
  2. Perform calibration and setting checks with calibrated test instruments of at least twice that of that of the accuracy of the equipment, device, relay or meter under test. Dated calibration labels shall be visible on test equipment. Calibrations over 6 months old are not acceptable on field test instruments. Inspect test instruments for proper operation prior to proceeding with the tests. Record serial and model numbers of the instruments used on the test forms.
- K. Test Procedures:
  1. The Electrical Subcontractor is responsible for the preparation of the procedures and schedules for the work specified herein. This work is to be coordinated and compatible with both the work and schedule of the other crafts. Sequence the tests and checks so that the equipment can be energized immediately after the completion of the application tests.
  2. Submit proposed testing and check out forms. The procedures shall provide specific instructions for the checking and testing of each electrical component of each system. Schedule tests and inspections as the job progresses. Test procedures submitted shall include job safety rules.
- L. 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.
- M. 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.

- N. 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.
- O. 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.
- P. 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.
- Q. When the electrical tests and inspections specified or required within this Section are completed and results reported, reviewed, and approved by the engineer, the Contractor may consider that portion of the electrical equipment system or installation electrically complete. The Contractor will then affix appropriate, approved, and dated completion or calibration labels to the tested equipment and notify the engineer of electrical completion. If the engineer finds completed work unacceptable, he will notify the Contractor in writing of the unfinished or deficient work, with the reason for his rejection, to be corrected by the Contractor. The Contractor will notify the engineer in writing when exceptions have been corrected. The Contractor will prepare a "Notification of Substantial Electrical Completion" for approval by the engineer following engineer's acceptance of electrical completion. If later in-service operation or further testing identifies problems attributable to the Contractor, these will be corrected by the Contractor, at no additional cost to the Authority.
- R. Specific Tests:
  - 1. Perform the following specific tests where applicable to the work scope. De-energize and isolate equipment and cable prior to performing the tests.
  - 2. Motors:
    - a. Before energizing any machine, visually inspect for serviceability. Check manufacturer's instruction manual for correct lubrication and ventilation. Align motor with driven equipment. Check nameplate for electrical power requirements.
    - b. Test run motors uncoupled or unloaded, before placing into operation. Check the motor for rotation, speed, current and temperature rise under normal load and record the results. Maintain the proper color codes for phase identifications. This may require swaps at the motor for proper rotation. Use motor phase rotation meter prior to lead connection at motor in order to minimize later swaps.
  - 3. 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.
- 4. Power Distribution System:
  - a. Small Transformers - Dry Type, Air Cooled
    - 1) Inspect for physical damage, broken insulation, tightness of connections, defective wiring and general condition.
    - 2) Thoroughly clean unit.
  - b. Circuit Breakers - Molded Case
    - 1) Circuit breaker shall be checked for proper mounting, conductor size and feeder designation.
    - 2) Operate circuit breaker to ensure smooth operation.
    - 3) Inspect case for cracks or other defects.
    - 4) Check tightness of connections with calibrated torque wrench. Refer to manufacturer's instruction for proper torque levels.
    - 5) Perform a contact resistance test or measure millivolt drop at rated current.
    - 6) Perform an insulation resistance test at 1000 volts dc for one (1) minute from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase - 500V D.C. if circuit breaker is solid state.
    - 7) Adjustable trip breakers shall have minimum pickup current determined by primary current injection where applicable.
    - 8) Perform long time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Determine trip time.
    - 9) Determine short time pickup and delay by primary current injection if applicable to the particular breaker.
    - 10) Determine ground fault pickup and time delay by primary current injection if applicable to the particular breaker.
    - 11) Determine instantaneous pickup current by primary injection using run-up or pulse method. Clearing times shall be within four (4) cycles.
    - 12) Verify trip unit reset characteristics.
    - 13) Perform adjustments for final settings in accordance with breaker setting sheet if applicable to the particular breaker.
    - 14) Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.
    - 15) Insulation resistance shall not be less than 100 megohms.
    - 16) Trip characteristic of adjustable trip breakers shall fall within manufacturer's published time-current characteristic tolerance band.
    - 17) All circuit breakers mounted in switchboards and distribution boards shall be time-current tested by primary current injection where possible, and also any remotely mounted breakers of frame size 400 ampere and larger.
    - 18) Adjust settings and calibrate all circuit breakers as recommended in the short circuit analysis and coordination study.
  - c. 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.

- d. Low Voltage Systems: Including, but not limited to the following: door position control, toilet flusher system, communication/ telephone, sound systems, CCTV system.
  - 1) Visually inspect all components for physical damage, dents, scratches and missing hardware.
  - 2) Check all wiring for proper identification numbering and/or color coding.
  - 3) Thoroughly clean all components.
  - 4) Inspect all wiring for tightness of connections.
  - 5) Operate and perform each of the system components and functions to verify system operation per plans and specs.
- e. The Fire Alarm systems shall adhere to the general requirements of this section in addition to complying with the specific test requirements outlined in the respective sections listed.
- f. Operating Instructions: Furnish operating instructions to User Agency's designated representative with respect to operations, functions and maintenance procedures for equipment and systems installed. Cost of such instruction up to a full five (5) days of Electrical Subcontractor's time shall be included in contract. Cost of providing a manufacturer's representative at site for instructional purposes shall also be included.

### 3.3 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. 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.
- D. For circuitry indicated as being protected at 20 Amps or less, abide by the following:
  - 1. All 20 amp, 120/208 volt, 3 phase, 4 wire combined branch circuit homeruns shall be provided with a #10 AWG neutral conductor.
  - 2. Minimum conductor size shall be No. 12 A.W.G. copper.
  - 3. Conductors operating at 120 volts extending in excess of 120 Ft., or the last outlet or fixture tap shall be No. 10 A.W.G. copper throughout.
  - 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.
- E. Type MC Cable Installation:
  - 1. Where cable is permitted under the products section, the installation of same shall be done in accordance with code and the following:
    - a. Cable shall be supported in accordance with code. Tie wire is not an acceptable means of support. Cable supports such as Caddy WMX-6, MX-3, and clamps such as Caddy 449 shall be used. Where cables are supported by the structure and only need securing in place, then ty-raps will be acceptable. Ty-raps are not acceptable

as a means of support. All fittings, hangers, and clamps for support and termination of cables shall be of types specifically designed for use with cable, i.e., Romex connectors not acceptable.

- b. Armor of cable shall be removed with rotary cutter device equal to roto-split by Seatek co., not with hacksaw.
- c. Use split "insuliner" sleeves at terminations.

### 3.4 REQUIREMENTS GOVERNING ELECTRICAL WORK IN DAMP OR WET LOCATIONS

- A. Outlets and outlet size boxes shall be of galvanized cast ferrous metal only.
- B. The finish of threaded steel conduit shall be galvanized only.
- C. Wires for pulling into raceways for lighting and appliance branch circuitry shall be limited to "THWN".
- D. Wires for pulling into raceways for feeders shall be limited to "THWN".
- E. Plates for toggle switches and receptacles shall have gasketed snap shut covers suitable for wet locations while in use.
- F. Final connections of flexible conduit shall be neoprene sheathed.
- G. Apply one layer of half looped plastic electric insulating tape over wire nuts used for joining the conductors of wires.
- H. Enclosures, junction boxes, pull boxes, cabinets, cabinet trims, wiring troughs and the like, shall be fabricated of galvanized sheet metal, shall conform to the following:
  - 1. They shall be constructed with continuously welded joints and seams.
  - 2. Their edges and weld spots shall be factory treated with cold galvanizing compound.
  - 3. Their connection to circuitry shall be by means of watertight hub connectors with sealing rings.
- I. Enclosures for individually mounted switching and overcurrent devices shall be NEMA Class IV weatherproof construction.
- J. The covers, doors and plates and trims used in conjunction with all enclosures, pull boxes, outlet boxes, junction boxes, cabinets and the like shall be equipped with gaskets.
- K. The following shall be interpreted as damp or wet locations within building confines:
  - 1. Spaces where any designations indicating weatherproof (WP) or vaporproof appear on the drawings.
  - 2. Below waterproofing in slabs applied directly on grade.
  - 3. Spaces defined as wet or damp locations by article 100 of the National Electric Code.

### 3.5 REQUIREMENTS GOVERNING ELECTRIC WORK IN AIR HANDLING SPACES

- A. Within air handling duct work or plenums (other than spaces within suspended ceilings used for air handling purposes): Area B and the media shall comply with requirements for return air plenums.
  - 1. Abide by the requirements specified for electric work in damp locations within building confines.
  - 2. Where circuitry passes through duct walls, include, in accordance with instructions issued in the field, air tight sealing provisions which allow for a relative movement between the circuitry and the duct walls.
- B. In spaces within suspended ceilings used for air handling purposes, abide by the requirements specified for normal electric work conditions except:
  - 1. Lighting fixtures recessed into the ceilings shall be certified as being suitable for this purpose.

### 3.6 IDENTIFICATION AND TAGGING

- A. Identify individually:
  - 1. Each switch and circuit breaker.
  - 2. Each feeder, wire or cable of all systems.
  - 3. 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 lamaroid 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 in panelboards or load centers without doors same as for individually enclosed.

2. 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.
- 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. 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.
- K. Prior to installing identifying tags and nameplates, submit their nomenclature for approval. Conform to all revisions issued by the Designer.

### 3.7 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" 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.
- 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. Supports should be located in such a manner not to interfere in any way with occupants.
- 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. Fasten electric work to building structure in accordance with the best industry practice.
- L. Floor mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastenings in all cases.
- M. 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.
- N. 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.
- O. 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.

### 3.8 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.

### 3.9 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. Leave sufficient slack on all runs of wire and cable to permit the secure connection of devices and equipment.
- C. 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.
- D. Pulling lubricants shall be used. They shall be products manufactured specifically for the purpose.
- E. 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.

### 3.10 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" of the exposed surface of the building materials concealing the circuitry and apply a blank or device plate to suit the functional requirements.
  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.
  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.
- 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.

### 3.11 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. If for field conditions requires raceways to be embedded in field poured structural building construction concrete fill or slab shall conform to the following:
1. All proposed embedded raceways shall be indicated on plan and elevation and submitted to the Designer and Structural Engineer for review and written approval prior to installation. Any costs associated with the review and approval shall be borne by the Electrical Subcontractor.

2. They shall be run "single layer" with their outside surface no closer than 1" to any surface of the structural concrete.
3. They shall not be located in any configuration which places the outside surface of one closer than 3" to the outside surface of another, except at tees, crosses or other single level wide angle junction points.
4. Where crossovers or close grouping are unavoidable, circuitry shall be carefully field coordinated so as not to cause structural weakness.
5. Where turned up or down into a wall or partition they shall, before entering same, be routed parallel for a long enough distance to assure that no relocation of the wall or partition will be necessary to conceal the required bend.
6. They shall be routed in such a manner as to coordinate with the structural requirements of the building.
7. They shall be routed in accordance with field instructions issued by the Designer where such instructions differ from specifications set forth herein.

- 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.

### 3.12 INSTALLING CIRCUITRY

- A. The outside surface of circuitry which is to be embedded in cinder concrete shall be coated with asphaltum paint.
- 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.

END OF SECTION