

## **DIVISION 280000 – FIRE ALARM, SAFETY AND SECURITY**

### **PART 1 – GENERAL REQUIREMENTS**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SCOPE:**

- A. The electrical contractor shall furnish all labor, material, tools, equipment and services necessary and incidental for installing all Fire Alarm system(s) shown on the drawings, indicated in the specifications, or necessary to provide a finished installation. The finished installation shall be in perfect working condition and be ready for continuous and satisfactory operation. The project area as indicated on drawings (6<sup>th</sup> Floor). The project area is located in the School of Nursing, Floor 6.
- B. This section includes Fire Alarm devices to be connected to fire alarm system.

#### **1.3 CODES & REGULATIONS**

- A. All materials furnished and all work installed shall comply with the latest rules, regulations, and recommendations of the following bodies:
  - 1. International Building Code
  - 2. National Electric Code
  - 3. National Fire Protection Association
  - 4. Fire Protection Bureau State of Maryland
  - 5. Underwriters Laboratories

#### **1.4 RESPONSIBILITY**

- A. The construction manager/general contractor (CM/GC) shall be responsible for all work included in Division 28. The delegation of work to contractors shall not relieve him of this responsibility. Contractors who perform work under these sections shall be responsible to the CM/GC.

#### **1.5 SITE EXAMINATION**

- A. Failure to visit the site and become familiar with existing project conditions prior to bidding will not relieve the Contractor of responsibility for complying with the Contract Documents.

## 1.6 OUTAGES

- A. For all work requiring an outage, the electrical contractor shall submit an outage request to the UMB Project Manager, using the UMB Standard Request for Outage Form which is available through the UMB Design and Construction Web Site at <https://www.umaryland.edu/designandconstruction/design-and-construction-documents/umb-standard-project-forms---current-editions/>
- B. The existing systems shall remain operational unless turned off by University personnel during the construction of the project. For each outage request include a photograph or description of the area affected by the outage.
- C. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten business days (10) days in advance with the UMB Design and Construction Department. Outages shall be performed during normal duty hours. If necessary some outage work may be performed outside normal hours if approved by UMB.
- D. The electrical contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the UMB Design and Construction Department.
- E. The operation of electrical/fire alarm/safety/security panels or power switches; required to achieve an outage must be accomplished by University personnel only. Unauthorized operation of fire alarm, by contractors their personnel will result in extremely serious consequences for which the contractor will be held accountable.

## 1.7 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions:
  - 1. Notify UMB Project Manager no fewer than ten (10) days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with fire-alarm outage without UMB Project Manager's written permission.
  - 3. Where a required existing fire protection system is out of service or during system Outage, the contractor shall provide fire watch as required by the UMB Fire Marshal until the existing system is restored.  
<http://www.umaryland.edu/media/umb/af/ehs/firesafety/FireWatchProcedures.pdf>

## 1.8 SUBMITTALS

A. General Requirements: For general requirements see Architectural Specification Division 01 Section "Submittal Procedures" and the following:

1. After contract award and before material is ordered submit electrically all product data, shop drawings, drawings and other such descriptive data as the Engineer may require to demonstrate compliance with the contract documents as required by the contract clauses for review and approval.
2. Submittals shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference, applicable publication references, years of satisfactory service, and other information necessary to establish contract compliance of each item the Contractor proposes to furnish.
3. All equipment shall be approved and listed by Underwriters' Laboratories (UL) and shall bear nameplate indicating same.
4. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.
5. Submittals shall include the following items:
  - a. Article 2.2, Fire Stops, Smoke Seals and Rated Wall/Floor Penetrations
  - b. Article 2.8, Raceway
  - c. Article 2.9, Boxes and Enclosures
  - d. Article 2.10, Wire and Cable
  - e. Article 2.11, General Wire and Cable Requirements
  - f. Article 2.12, Identification
  - g. Article 2.13, O & M Manual Do not include this data in the Fire Alarm Submittal.
  - h. Warranties and maintenance instructions shall be included in the O & M Manual only. Do not include this data in the Fire Alarm Submittal.
6. Submittal File Format: File formats and names for each submittal shall be electronically as follows:
  - a. File Formats:
    - 1) Product Data: "pdf" file format.
    - 2) Design Shop Drawings: "pdf" and "dwg" file formats.
    - 3) Coordinated Drawings: "pdf" or "dwg" file formats.
    - 4) Schedules: "xl" file format.

- B. Fire Alarm Submittal: In addition to the requirements identified in paragraph 1.8.A the fire alarm contractor shall also comply with the following:
1. UMB requires the Fire Alarm Submittal to be submitted electronically as one (1) complete submission as a “pdf” file for review. Partial Submittals will be rejected.
    - a. The complete submittal must be reviewed and approved by the A/E and the UMB Fire Marshal before installation can take place. The submission shall include the following:
      - 1) Product data for each type of product specified.
      - 2) Shop drawings (See Paragraph ‘2’ below for requirements)
      - 3) Voltage drop calculations
      - 4) Installers qualifications
    - b. The warranty information and maintenance manuals shall be included in the Division 28 Project O & M Manual. Do not include this data in the Fire Alarm Submittal.
  2. Shop Drawings shall be prepared by persons trained and certified by the manufacturer in fire-alarm system design. Shop drawings shall be signed or stamped by an individual with one of the following qualifications:
    - a. NICET fire-alarm technician, Level IV minimum.
    - b. Professional Engineer registered in the State of Maryland.
    - c. The qualified individual signing the shop drawings must attend any and all review comment resolution meetings requested by the University.
  3. Submittal drawings must include the following:
    - a. Provide floor plans with all device locations and their associated addresses. Floor plans must be drawn to scale. Provide graphic scales on the drawings.
      - 1) For new building construction projects or replacement of existing building entire fire alarm system projects, use NFPA 170 symbols.
      - 2) For renovation projects match the symbols used on As-Builts.
      - 3) Provide a riser diagram regardless of system size.
      - 4) Wiring Diagrams: Provide the following:
        - a) Detail wiring and differentiate between manufacturer-installed and field-installed wiring.
        - b) Include diagrams for equipment and for system with all terminals and interconnections identified.
        - c) Include all internal network cards and boards in FACP and Transponder Panels.
    - b. Calculations shall include the following:

- 1) Battery: Sizing calculations.
    - 2) Load Calculations - Provide load calculations for all NAC circuits while noting both current demand future capacity in amperes.
  - c. System Sequence of Operation: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
  - d. Details of graphic and alphanumeric annunciators.
4. Renovation Projects: For projects involving only modifications to the existing FAS, the University will provide electronic copies to the FAS manufacturer of their latest version of the FAS As-Built. The FAS manufacturer will make all necessary revisions to the FAS as-builts and submit them for review/approval. Once the project is completed, the FAS manufacturer will update the copies for forwarding electronically to the University for archiving. In revising the electronic copies of the University's as-builts, please perform the changes in the following format:
  - a. CAD Dwg Format: Show all new wiring and equipment in BOLD so it is convenient to differentiate between new and existing.
5. Submissions to UMB Fire Marshal:
  - a. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval.
- C. Safety System (SAF) Submittals: In addition to the requirements identified in paragraph 1.8.A the safety system contractor shall also comply with the following:
  1. UMB requires the Safety System Submittal to be submitted electronically as one (1) complete submission as a "pdf" file for review. Partial Submittals will be rejected.
    - a. The complete submittal must be reviewed and approved by the A/E and UMB before installation can take place. The submission shall include the following:
      - 1) Product data for each type of product specified.
      - 2) Shop drawings (See Paragraph '2' below for requirements)
      - 3) Installers qualifications

- b. The warranty information and maintenance manuals shall be included in the Division 28 Project O & M Manual. Do not include this data in the Safety System Submittal.
- 2. Shop Drawings shall be prepared by persons trained and certified by the manufacturer in safety system design.
- 3. Submittal drawings must include the following:
  - a. Provide floor plans with all device locations and their associated addresses. Floor plans must be drawn to scale. Provide graphic scales on the drawings.
    - 1) Provide a riser diagram regardless of system size.
    - 2) Wiring Diagrams: Provide the following:
      - a) Detail wiring and differentiate between manufacturer-installed and field-installed wiring.
      - b) Include diagrams for equipment and for system with all terminals and interconnections identified.
      - c) Include all internal network cards and boards in the Safety Control Panel.
  - b. Calculations shall include the following:
    - 1) Battery: Sizing calculations.
  - c. Device Address List shall include the following:
    - 1) Coordinate with final system programming.
    - 2) Floor plans shall include address numbers for all devices.
- D. Informational Submittals: Submit following:
  - 1. Operating Instructions: For mounting at FACP.
  - 2. Product Certificates: Signed by manufacturers of system components certifying that products furnished comply with requirements.
  - 3. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
  - 4. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Comply with NFPA 72.
- E. Project Closeout Submittals: Submit the following in accordance with the UMB General Conditions.
  - 1. Electronic Copies of Each System Program: Provide a minimum of two (2) electronic copies of the system program on USB Flash Drive. Store one (1) USB Flash Drive copy of the program at the FACP and hand the other copy over to the Project Manager. Besides being required by NFPA 72, the purpose for this

requirement is to ensure the owner always has on hand a “bug free” copy of the original.

2. Manufacturer’s As-Built Drawings: Upon successful testing and commissioning of the FAS and approval by the University’s Fire Marshal, the FAS manufacturer shall provide the following:
  - a. As-Built Drawings: The Manufacturer shall revise/update the Shop Drawings to accurately reflect the following field installation data/conditions:
    - 1) All individual device addresses on the floor plans.
    - 2) Conduit/SLC & NAC Loop Wiring Layout - Show routing of all FAS wiring and raceway including riser runs and while noting all FAS device and panel locations. Identify all panels with their respective ID numbers/lettering as entered in the FAS programming software. Where multiple FAS circuits are run in parallel and/or grouped together, attach drawing notes to the runs to identify the individual FAS circuits in the grouped or parallel run. Delineate overhead versus underground runs by using dashed lines for underground.
    - 3) Riser and/or connection diagram.
    - 4) Equipment Data - Provide Manufacturer’s catalog information on all internal network cards/option modules in the system.
    - 5) Provide both paper copies and electronic files in AutoCAD 2018 or latest edition used by UMB in “dwg” and “PDF” file formats. Provide two (2) full-size paper copies (24 inches x 36 inches) and three (3) half-size copies for UMB review personnel only. Provide graphic scales on the drawings.
  - b. Updated copies of load calculations, System Program and Sequence of Operation as submitted during in the shop drawing phase.
  - c. Maintenance Data: For fire alarm systems. Comply with NFPA 72.
  - d. Certificate of Completion: Comply with NFPA 72.

## 1.9 WORK PERFORMANCE

- A. All electrical work must comply with the requirements of NFPA 70 (NEC), NFPA 70B, NFPA 70E, OSHA Part 1910 subpart J, OSHA Part 1910 subpart S and OSHA Part 1910 subpart K in addition to other references required by the contract.
- B. Before initiating any work, a job specific work plan must be developed by the contractor. The work plan must include procedures to be used on and near the live electrical equipment, barriers to be installed, and safety equipment to be used and exit pathways.
- C. Job site and worker safety are the responsibility of the contractor. Compliance with the

requirements of NFPA 70E is subject to ongoing inspection by University personnel and failure to comply will result in an immediate Stop Work order being issued and enforced at the contractor's expense.

- D. Energized electrical conductors and circuit parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee performs work any time the employee is within the limited approach boundary or, where an increased risk of injury from an exposure to an arc flash hazard exists.
- E. Outages should be scheduled a minimum of ten (10) days in advance.
- F. Mandatory Requirements: The following requirements are mandatory:
  - 1. Protective Equipment: Electricians must use full protective equipment (i.e., certified and tested insulating material to cover exposed energized electrical components, certified and tested insulated tools, etc.) while working on energized systems in accordance with NFPA 70E.
  - 2. UMB Energized Work Permit: A UMB Energized Work Permit is required for any work on energized circuits or equipment. Permit must be approved by UMB Department of Operations and Maintenance prior to performing energized work. Submit the work permit with the outage request.

#### 1.10 QUALITY ASSURANCE

##### A. Installer's Qualifications:

- 1. The Contractor or security sub-contractor shall be a licensed security Contractor with a minimum of five (5) years' experience installing and servicing systems of similar scope and complexity. The Contractor shall be an authorized regional representative of the Electronics Safety and Security manufacturers.
- 2. The Contractor shall only utilize factory-trained technicians to install, program, and service the Electronic Safety and Security systems. The technicians shall have a minimum of five (5) continuous years of technical experience in electronic security systems. Upon request the Contractor shall provide copies of system manufacturer certification for all technicians.
- 3. Copy of Maryland Master Electrician's License.
- 4. Local or State license where required.
- 5. NICET certification, where required by these specifications.



6. The Fire Alarm contractor shall have (or contractually be supported by a company who has) on staff and assigned to the project a NICET Level III certified person for fire alarm systems.
7. A NICET Level II or higher Fire Alarm Technician or a Fire Alarm Technician with minimum of two (2) years' experience shall install and terminate fire alarm devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings
8. An electrician or NICET Level II Fire Alarm Technician shall install conduit for the fire alarm system.

#### 1.11 SYSTEM DESCRIPTION

- A. Fire Alarm System Non-coded, UL-certified addressable system, with multiplexed signal transmission, dedicated to fire-alarm service only.
- B. Fire Alarm System Non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

#### 1.12 IDENTIFICATION BADGES

- A. Contractors must obtain photo identification cards for all employees who will be at the construction site. The University will charge the contractor twenty five (\$25.00) dollars for each badge as a deposit of which twenty (\$20.00) dollars will be returned when the badge is returned. Lost photo I.D. card will cost twenty five (\$25.00) dollars for another replacement card. (The above charges are subject to change without notice.)

#### 1.13 HAZARDOUS MATERIALS

- A. Identification and removal of hazardous materials (asbestos, lead paint, PCBs) is not part of this contract. If questionable material is encountered, notify the University Project Manager and the University Environmental Health and Safety in writing immediately. The University shall then arrange for investigation and possible abatement of the material. Contractor shall schedule his work to accommodate hazardous material removal by the Owner.

#### 1.14 COMMISSIONING NEW FIRE ALARM, SAFETY AND SECURITY SYSTEMS

- A. Summary: This section includes the requirements for commissioning electrical systems, assemblies and equipment related to the project area.

B. Commissioning Agent (CxA): The CxA for the project shall be as assigned by UMB.

1. Description: The following equipment and/or accessories shall be commissioned as part of this project: Fire Alarm System.

1.15 GUARANTEE/WARRANTEE:

- A. All materials, equipment, etc. provided by the general contractor and/or his subcontractors shall be guaranteed and warranted to be free from defects in workmanship and materials for a period of two (2) years from the date of substantial completion and acceptance of work by UMB. Any defects in workmanship, materials, or performance which appear within the guarantee period shall be corrected by the contractor without cost to the owner, within a reasonable time, to be specified by UMB. In default thereof, owner may have such work done and charge the cost of same to the contractor. In addition to the above statement the Guarantee/Warranty Period shall include all labor cost related to all warranty work.
- B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of guarantee shall be delivered to the Owner.

**PART 2 – PRODUCTS:**

2.1 LISTED MANUFACTURERS

- A. The manufacturers indicated in Part 2 represent the design and identify the minimum level of quality for materials and equipment, specified in this section, that are acceptable to UMB. All submitted materials and equipment are subject to approval by the A/E and UMB.
- A. New Construction: All new penetrations shall be provided with a pipe sleeve and sealant materials.
- B. Existing Construction: All new service penetrations through existing rated assemblies shall be provided with a pipe sleeve and sealant materials. All existing unsealed penetrations for services passing through existing rated assemblies within the project area shall be provided with sealant materials.
- C. Project Area: The project area shall include the finished spaces and related sections of the utility shafts within the project area footprint.
- D. Wall Pipe Sleeve Applications: Pipe sleeves shall be required for all new conduit penetrations through rated wall assemblies and non-rated CMU walls. Where pipe sleeves are installed in non-rated CMU walls fire rated sealant materials are not required. Provide acoustical caulking to seal the annular spaces between the sleeve and the bare pipe or pipe insulation on each end with one half (1/2) inch caulking all around the annular space.

- E. Floor Pipe Sleeves Applications: Pipe sleeves are required for all new conduit risers passing through floor slabs.

## 2.2 SLEEVES

- A. Steel Pipe Sleeves: Steel pipe sleeves shall be standard black steel pipe Type E, Grade B, with plain ends conforming to ASTM A53/A53M.

## 2.3 FIRE ALARM SYSTEM

### A. General Requirements:

1. UMB does not have a service contract with any other company to work on the existing fire alarm system. Any certified Notifier Fire Alarm System distributor can work on the existing system. Upon request the contractor shall provide proof of their Notifier Engineered System Distributor Agreement to the University.
2. The existing UMB Campus Notifier Network System is under warranty with MC Dean. Any required work with the Network System must be coordinated with the UMB Project Manager.

### B. Existing Fire Alarm System NOTIFIER:

1. Fire Alarm Control Panel Model NFS2-3030 with display.
2. Digital Voice Command (DVC), Voice Evacuation Control System.

- C. System Expansion: Confirm existing Signaling Line Circuit (SLC) and Notification Appliance Circuit(s) (NAC) will support the additional fire alarm devices shown on the contract drawings. Provide additional circuits and/or amplifier boards where necessary.

- D. Prior to programming of the new/existing FACP, the contractor shall verify in field exact room numbers and names for all initiating devices, elevator numbers and stair numbers to program the correct device address.

- E. Speaker/strobes shall be semi-flush mounted with red covers and clear strobe lens. Ceiling mounted devices are acceptable.

- F. Speaker/strobes signals shall comply with the requirements of the ADA. Ceiling mounted devices are acceptable.

- G. Strobe units shall consist of a red cover and clear lens. Strobe signals shall comply with the requirements of the ADA.

- H. Strobes shall be provided with a candela rating as indicated.

## 2.4 RACEWAY

- A. For indoors above floor slab, use EMT conduit with compression fittings with a minimum size of three quarter (3/4) inch (regardless of function/purpose) and maximum size of two (2) inches. Above two (2) inches, conduit shall be rigid steel conduit, zinc coated with threaded type fittings.
  - 1. For low-voltage, special systems provide the following color-coated EMT raceway:
    - a. Fire Alarm System – Red.
- B. Non-Metallic Raceway: Provide expansion joints in every twenty (20) foot of run and at least once in every run in all outdoor, rooftop, and garage locations. Provide PVC 40 pipe, non-metallic NEMA 4X boxes and non-metallic NEMA 4X enclosures supported via non-metallic fiberglass strut and/or pipe clamps at the following locations:
  - 1. All outdoor locations including, but not limited to, inside garages and on rooftops.
  - 2. Embedded in concrete, brick, CMU or other structural material.
  - 3. Below-slab and -grade.
  - 4. All unconditioned-air spaces/rooms in Parking Garages.
- C. Supports: For all indoor, conditioned-space locations utilize conduit clamps, conduit straps, bean clamps, etc. and/or channel strut supports. For all outdoor applications (as specified above for PVC 40) and where non-metallic raceway is provided, provide only non-metallic fiberglass (or other non-metallic material) or PVC-Coated Galvanized Steel conduit supports and/or channel strut. Support conduits at a minimum of two (2) times per ten (10) ft. length and at a frequency rate as directed by the NEC.
- D. Bushings: Provide only threaded type for IMC, RGS and PVC-RGS raceway. Provide only steel compression type for all EMT raceway systems. Provide insulated-throat, threaded type bushings for all tel/data raceway systems.
- E. Surface metal raceways shall be used only in finished areas and only where specifically noted on the drawings. Surface mounted raceways shall be Wiremold 500, 700, 1000, or 4000 series or pre-approved equivalent with buff finish used as follows:
  - 1. # 500: 2-#10 or 3-#12 wires maximum.
  - 2. # 700: 3-#10 or 4-#12 wires maximum.
  - 3. #1000: 9-#10 or 12-#12 wires maximum.
  - 4. Other combinations of conductors shall be in accordance with the manufacturer's published data and the National Electrical Code.
  - 5. All elbows, boxes fittings supports, etc., shall be by the raceways manufacturer. Finish shall match that of the raceway.
  - 6. Wire trough shall be steel enclosed wireway meeting all UL requirements.

- F. All new raceways in finished areas shall be concealed unless specifically noted otherwise.
- G. Grout around all conduits at ceiling, floor, and wall penetrations to provide airtight seal. All floor slab and fire-rated wall penetrations shall be sealed with a rated system/installation that is pre-approved by the UMB Fire Marshal. Submit manufacturer's engineering drawing of the proposed fire-proofing system to the UMB Project Manager for approval.
- H. Group together exposed conduit insofar as possible. Install all conduits parallel or perpendicular to the building surfaces. Maintain minimum six (6) inch spacing from parallel flues, steam pipes, or hot water pipes and two (2) inches from perpendicular flues, steam or hot water pipes.
- I. All conduits shall be rigidly supported to building structure. Conduits shall not be supported from suspended ceiling support wires.
- J. All conduit bends shall be made with an approved conduit bender and no bend shall have a centerline radius less than six times the diameter of the conduit.
- K. Core Drilling/Floor Penetrations: Coordinate with the UMB Project Manager prior to making any core drills for floor penetrations. Prior to core drilling/floor penetrations provide X-ray examination/GPD of the floor structure to locate structural steel for avoidance. The contractor is responsible for maintaining structural integrity of all floors and walls after core drills for conduits are made.

## 2.5 BOXES AND ENCLOSURES

- A. Indoor Applications: Provide NEMA 250 interior galvanized steel, minimum 14 gauge, outlet boxes, no less than four (4) inches square with extension rings and mounting brackets at the following locations:
  - 1. Dry and Clean Locations: NEMA Type 1.
  - 2. Locations with Dust, Falling Dirt and Dripping Noncorrosive Liquids: NEMA Type 12.
  - 3. Mechanical and Electrical Rooms: NEMA Type 12.
- B. Outlet boxes shall be rigidly and securely fastened in place. Outlet boxes in finished areas shall be flush mounted unless otherwise noted.
- C. Boxes shall be sized in accordance with NEC Article 370.
- D. All conduit connectors and entry hubs shall be insulated or have insulated bushings.

- E. Outlets shown adjacent to one another on the plans at the same mounting height shall be ganged except where noted.
- F. Outlets shown adjacent to one another on the plans at different mounting heights shall be located with the upper outlet centered directly over the lower outlet.
- G. GEM Boxes – Recessed GEM Boxes are prohibited.

## 2.6 WIRE AND CABLE

- A. All wire shall be copper with insulation rated at 600 volts, 75°C minimum. Aluminum wire is strictly prohibited.
- B. Minimum wire sizes shall be #12 for power wiring, #14 for control wiring and as specially noted for systems wiring.
- C. Molded connectors (wire nuts) may be used for splicing size 10 AWG or smaller wires on lighting and receptacle circuits only. “Scotch Blocks” must be submitted for prior approval. All other wiring shall be spliced only with lugs and/or terminal blocks.
- D. Terminal lugs shall be mechanical clamp or compression type.
- E. Pre-insulated crimp connectors and terminals shall be used on low voltage wiring.
- F. UTP Cable:
  - 1. Four (4) pair unshielded twisted pair (22-24AWG), solid copper conductors, 100 ohms nominal impedance +/- 15%, minimum bandwidth 500 MHz, green CMP Plenum jacket. Complies with EIA/TIA 568 Category 6 performance specifications.
  - 2. Manufacturer: CommScope, BerkTek (LAN Mark-1000), General Cable, Superior Essex
- G. UTP Cable Hardware:
  - 1. Eight (8) pin modular outlet, non-keyed, flat front. Complies with EIA/TIA 568-B.2 Category 6 performance. Outlet wired standards compliant 568B pinning. Outlets must be white.
  - 2. Manufacturer: The Siemon Company, Ortronics

## 2.7 GENERAL WIRE AND CABLE REQUIREMENTS

- A. Fire Alarm System:

B. Fire Alarm Control Cable Type MC

1. For use on fire alarm circuits as required and as recommended by the manufacturer.
2. Interlocking galvanized steel armor, steel strip (painted red).
3. Conductor insulation – TFN/THHN solid copper.
4. Copper grounding conductor.
5. Polyester assembly tape.
6. Neutral conductor.
7. UL Listed Fire Alarm Cable.
8. Rated for use in plenums.
9. Rated for through penetration of 1, 2, and 3-hour fire walls.
10. Individual twisted pairs and shielding, as required per fire alarm system manufacturer.
11. UL 66, 83, 1424, 1569, 1581, and 2556 listed.
12. NEC 300.22, 362, 330, 430.2, 501, 502, 503, 530, 504, 505, 518, 530, 645, 725, 760, 760.154(A) compliant
13. AFC Type MC Fire Alarm/Control Cable.

C. Non-Power –Limited Circuits: Solid copper conductors with 600v rated, 75°C, color coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

2.8 IDENTIFICATION

- A. Coordinate names, abbreviations and other designations used with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment.
- B. Delay installation of identification until painting is complete.
- C. Comply with governing regulations and requests of governing authorities for identification of work.
- D. Install engraved plastic-laminate nameplates on all electrical boxes and cabinets installed under this contract (black letters on white background).
- E. Where conduit is exposed, apply identification on conduit. Except as otherwise indicated, use permanent vinyl, self-adhering markers with black letters on orange background.
- F. Apply self-adhering vinyl or heat-shrink plastic cable/conductor identification markers on

each cable and conductor in each box, enclosure or cabinet where wires of more than one circuit are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings and contract documents.

- G. All field installed control circuits shall have tubular sleeve-type wire markers at each end of the circuit and at all splice points. Wire markers shall be permanently stamped with a numbering system selected by the Contractor. The numbering system shall be thoroughly documented and provided to the Engineer.
- H. Dymo (or equivalent) labels shall not be used.
- I. Ceiling Markers: Provide labels on ceiling grid for accessible electrical equipment that is installed above the ceiling.

## 2.9 PROJECT OPERATION AND MAINTENANCE MANUAL – ELECTRONIC FILES

- A. Project O & M Manual File: The project OM Manual shall include one (1) electronic copy of each approved submittal and any manufacturer's maintenance manuals, and all warranty certificates included in Division 28. Also include the address, phone number and contact person for each supplier. Using the current UMB Standard O&M Manual Template referenced in Division 01 Closeout Procedures insert the submittal files include bookmark and tree structure for accessing each submittal file in the manual.

## 2.10 COMMISSIONING NEW FIRE ALARM, SAFETY

- A. Test Equipment: Refer to Division 01 Section 019113 "General Commissioning Requirements" for requirements pertaining to testing equipment.

## **PART 3 – EXECUTION:**

### 3.1 GENERAL REQUIREMENTS – EXECUTION

- A. All construction work that creates excessive noise will not be permitted during normal business hours. See Division 01 Specification Section "Cutting and Patching" for requirements.
- B. General provisions of the contract apply. All work performed and materials provided shall conform to all applicable codes and standards and the National Electrical Code (NEC).
- C. Prior to starting work, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.



- D. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing all doors and passageways.
- E. Confirm the locations of all existing utilities. Repair any damage to existing utilities caused by construction forces.
- F. Leave all areas broom clean daily. Remove all construction debris and trash from the site daily.
- G. Before ordering any materials or equipment, submit to the engineer data for all materials and equipment. Check equipment dimensions of proposed substitute equipment. The cost of any redesigning caused by a substitution shall be borne by the Contractor.
- H. Contractor shall do all cutting, drilling and patching required by his work. All repairs to finish shall be of like kind, color and quality as existing. Structural members shall not be cut without approval from the architect.
- I. Take necessary precautions to protect building's occupants and contents, and prevent the spread of dust and dirt into occupied areas.

### 3.2 SLEEVES

- A. Non-Fire-Rated Sound Proof Partition Penetrations: Where new and existing conduits pass through interior partitions with sound proofing provide a pipe sleeves. Seal the annular spaces between construction openings, the sleeves, and conduits with sound proof insulation material equal to the width of the opening. The sound proof insulation shall match the insulation in the partition.

### 3.3 CONTRACT DOCUMENTS:

- A. Contract drawings for the work are diagrammatic, intended to convey scope and general arrangement.
- B. Correction of faulty work due to resolving discrepancies without authorization shall be the responsibility of the Contractor.
- C. Should the Contractor discover any discrepancies or omissions on the drawings or in the specifications, he shall notify the Engineer of such conditions prior to the bid date. Otherwise, it will be understood that the drawings and specifications are clear as to what is intended and shall be as interpreted by the Engineer.

### 3.4 COORDINATION:

- A. Coordinate all work and cooperate with all other trades to facilitate execution of work.

### 3.5 GENERAL WIRING REQUIREMENTS

- A. Door Hardware: Door hardware is provided and installed under Division 8 of these documents. The security contractor shall coordinate with the Division 8 contractor for the locations of all door hardware requiring connections to the security system and shall provide all connections between power supplies and the locking equipment.
- B. Method of Wiring
1. General: Wire each alarm, trouble, and supervisory signal, initiating circuit, communication circuit, and each security notifying appliance circuit for supervised operation.
  2. Wiring within Cabinets: Provide wiring within cabinets installed parallel with or at right angles to the sides and back of the enclosure. All conductors which are terminated, spliced, or otherwise interrupted in any enclosure associated with the security system shall be connected to terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. Make all connections with either crimp-on terminal spade lugs or approved pressure type terminal blocks. Terminal blocks shall be secured in each junction box to the junction box cover plate.
  3. Interior Work: Cables installed in plenums shall meet UL 910, and cables to be installed in risers shall meet UL 1666.
  4. Installation in Ducts or Conduits: A cable lubricant compatible with the cable sheathing material shall be used on all cables pulled. Pulling fixtures shall be attached to the cable strength members. If indirect attachments are used, the grip diameter and length shall be matched to the cable diameter and characteristics. If indirect attachment is used on cables having only central strength members, the pulling forces shall be reduced to ensure the fibers are not damaged from forces being transmitted to the strength member. During pulling the cable pull line tension shall be continuously monitored and not exceed the maximum tension as given by the cable manufacturer. The mechanical stress placed upon a cable during installation shall not twist or stretch the cable.
    - a. A cable feeder guide shall be used between the cable reel and the face of the duct or conduit to protect the cable and guide it into the duct or conduit as it is played off the reel. As the cable is played off the reel, it shall be carefully inspected for jacket defects. Precautions shall be taken during installation to prevent the cable from being kinked or crushed and the minimum bend radius of the cable is not exceeded at any time. Cable shall be hand fed and guided through each manhole and additional lubricant shall be applied at all intermediate manholes.
    - b. When practicable, the center pulling techniques shall be used to lower pulling tension. That is, the cable shall be pulled from the center point of the cable run towards the end termination points. The method may require the cable to be pulled in successive pulls. If the cable is pulled out of a

- junction box or manhole the cable shall be protected from dirt and moisture by laying the cable on a ground covering.
5. Vertically Run Cable: When possible, use gravity to assist in cable pulling; pull cable from top of run to bottom of run. Hand-pull cables if possible; if machine assistance is required, monitor tension and do not exceed the specific cable tension limits. After installation, the vertical tension on the cable shall be relieved at maximum intervals of 30.48 m (100 ft) using a split support grip.
  6. Cable Taps: The Contractor shall provide a terminal cabinet where any circuit tap is made.
  7. Color Coding: The Contractor shall distinctively color code all wiring differently from the normal building wiring. Identify conductors by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Wire the alarm initiating and notification signal devices so removal will cause the system trouble device to sound. Each conductor used for the same specific function shall be distinctively color coded. Use two (2) different color codes for each interior alarm circuit; one (1) for each loop. Each circuit color code wire shall remain uniform throughout the circuit.
  8. Termination: End-of-line supervisory resistors or devices are to be provided at the sensor device location. The end of line resistor network shall be per manufacturer's recommendations; in the absence of such, it shall consist of two (2) 1k resistors, one (1) across the normally closed contact of the device and the other in series with the normally closed circuit. See drawing details for further information. Use of GRI Resistor Packs is preferred.
  9. No "stick-on" cable ties shall be used within the enclosure.

C. Cable Installation

1. All field wiring required for interconnection of the various security system components shall be installed within conduit.
2. All circuits shall be protected to avoid interruption of service due to short-circuiting or other conditions which may adversely affect the connecting devices. Each individual signaling circuit shall be classified as a circuit pair.
3. Screw terminal blocks or connectors shall be furnished for all cables which interface with racks, cabinets, consoles or equipment modules. No more than 2 mm of exposed bare wire may show when either crimped or fastened to a connector block or terminal strip.
4. Care shall be exercised in wiring to avoid damage to the cables or the equipment. All joints and connections shall be made with mechanical butt splice connectors. The crimping tool used shall be recommended by the manufacturer. Wire nuts shall not be an acceptable splice method.
5. To reduce the possibility of signal contamination, all cables shall be grouped according to the signals being carried. The horizontal and vertical cable runs should be bundled or grouped as follows:
  - a. Low Voltage Power
  - b. Signal, Control Cables, and Video Cables

6. All cabling shall be U.L. listed for its intended application and meet or exceed the standards as recommended by the manufacturers of the components being interconnected. All shielded cabling used shall be 100 percent shielded.
7. All system wiring shall be installed in accordance with the instructions provided by the manufacturers of the components being used in the system and in accordance with codes, specifications, and standards as referenced herein.
8. Splices shall not be permitted in system wiring between components which are incorporated in the system. Wiring runs must terminate at either a system component or a junction box where wiring is interconnected using terminal strips or connectors. Wire ends shall be prepared for attachment to component terminals in accordance with the recommendations of the equipment manufacturers. If there is no alternative and a wire/cable splice must be made, the Contractor shall notify the OWNER and request approval through a formal RFI process prior to making the wire splice.
  - a. The RFI shall include the following:
    - 1) The Contractor shall identify the device and/or system affected by the proposed splice and why the splice is required.
    - 2) Provide in detail the methodology which shall be utilized for the wire/cable splice. A diagram may be used to demonstrate methodology but shall not replace the written methodology requirement.
    - 3) If splicing is required for more than five (5) wires/cables, a formal wire management plan shall be developed to provide methodology for maintaining wire/cable consistency and performance.
    - 4) In all instances the Contractor shall provide the OWNER with a mock-up of the proposed splice and samples of the materials to be used.
    - 5) The Contractor shall not proceed until written approval has been received from the OWNER for the splice and the splice materials.
  - b. The following criteria shall be utilized for installing wire/ cable splices.
    - 1) Twist type connectors shall not be used for wire splicing.
    - 2) Wire splices shall be made on binding screw captive mechanical compression terminal strips.
    - 3) Soldered and crimped connections are allowed and shall be accomplished with crimping Lug Manufacturers Calibrated Tool.
    - 4) Solder connections shall be applied in accordance with BICSI standards.
    - 5) Mechanical splices shall utilize a UL listed ratchet type connector. The Contractor shall select the appropriate connector size based on gauge of the wire/cable being spliced. The Contractor shall only use manufacture approved full cycle ratchet crimping devices.
    - 6) The Contractor shall utilize appropriately sized UL listed heat shrink tubing. Splices shall be encapsulated with an epoxy or ultraviolet

- light cured splice encapsulator, particularly if the spliced wire/cable is direct-buried, environmentally exposed, or located in an exterior hand hold.
- 7) The Contractor shall ensure all completed splices are accessible. Splices shall be made in lockable/tampered security enclosures or in security junction/pull boxes. At no time shall spliced wires/cables be permitted to be pulled into the conduit system.
  - 8) All spliced wires/cables shall be tested in witness of the OWNER to ensure system performance is not adversely affected by the splices' presence.
- c. All copper conductor splices shall be accomplished in the following method:
- 1) Strip insulation from wires to be spliced using caution not to score or strip away the actual conductor.
  - 2) Twist together the stripped conductors for a minimum of four rotations.
  - 3) Solder the twisted conductors using rosin core solder.
  - 4) Trim the twisted and soldered conductors to a length accommodated by the vinyl insulated closed end splice or butt splices in the next step. Trimmed bare conductors shall not extend beyond the insulated closed end splice (or equal).
  - 5) Crimp insulated closed end splice utilizing a full cycle ratchet crimp tool approved by the splice manufacturer. The crimped connections shall be free of any movement between the wire and crimp splice device.
9. Connections at devices shall be soldered or fastened with approved crimp connectors. No wire nuts will be permitted. Wire should be twisted four times before a crimp connector is applied. The Manufacturers crimping tool shall be utilized for the crimp connectors of choice. Environmental connectors shall be used in harsh or outdoor environments. Devices requiring connections within metal extrusions associated with perimeter windows and doors are considered to be a harsh environment.
  10. All mounted wire ties shall be the screw down type. Wire ties utilizing only an adhesive back are not acceptable.
  11. Heat shrink tubing must be installed on all cable ends within cabinets.
  12. Cable shields are to be grounded only for alarms. Shields are to be carefully insulated to prevent conductor shorts.

### 3.6 INSTALLATION – FIRE ALARM SYSTEM

- A. All field wiring shall be installed in conduit. Conduit and boxes shall be sized according to National Electrical Code requirements based on the number of conductors. Initiating device circuit wiring shall be two-conductor twisted with integral shield and ground. Indicating appliance circuits shall be minimum 14 AWG. Provide new wiring as necessary and extend

and connect to the nearest SLC/NAC loop. **Do not T-TAP to existing wiring. T-TAP is not allowed.**

- B. Fire alarm circuits shall be identified by red junction box covers stenciled in white letters "fire alarm". Fire alarm wiring shall be color coded in accordance with requirements of local authority having jurisdiction.
- C. Final Acceptance test shall be witnessed by the UMB Fire Marshal.
- D. Prior to testing of the system with UMB Fire Marshal, the contractor shall conduct pre-testing of the system and correct all deficiencies.
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- F. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
- G. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- H. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- I. Prepare test and inspection reports.
- J. Contractor Pretesting: After installation, align, adjust, and balance system and perform complete pretesting. Determine, through pretesting, compliance of system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results. Provide documentation summarizing pretesting to UMB Fire Marshal. Documentation should include statement that system is working properly and summary of corrections made during pretesting. Project Manager may attend contractor pretesting as desired.

- K. The contractor shall have a fire alarm technician present during all tests and shall have laptop with them to modify and program changes during the tests.
- L. Final acceptance testing with the UMB Fire Marshal: After installation, align, adjust, and balance system and perform complete pretesting with the University Fire Marshal. Determine, through pretesting, compliance of system with requirements of Drawings and Specifications. After pretesting is completed, correct deficiencies observed in pretesting for final testing. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Remove existing devices after pretesting has been completed with the UMB Fire Marshal.
- M. Final acceptance testing: After final acceptance testing is complete, provide letter certifying installation is complete and fully operable, including names and titles of witnesses to preliminary tests.
- N. Final Test Notice: Provide minimum of ten business (10) days' notice in writing when system is ready for final acceptance testing.
- O. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by system test that total system meets Specifications and complies with applicable standards.

### 3.7 FEES

- A. A fee applies if testing with the Fire Marshal reveals that the fire alarm system does not meet applicable codes and standards, the project specifications and/or the design documents. Each failed test will result in a \$250 fee.
  - 1. If any programming changes are required during the test or after, the test is considered a failed test.
  - 2. Any issue that requires re-testing is considered a failed test.
  - 3. Any test in which the contractor fails to show at the scheduled start time or is not prepared to perform the test with testing materials is considered a failed test.
- B. Invoices will be sent to the contract holder from the University of Maryland, Baltimore Central Administration Support Services (CASS) Department. Payment must be made electronically with credit card or via check. Cash payment is not acceptable.
- C. Failure to pay the fee within 30 days of receipt will result in appropriate administrative and/or legal action. Further inspection or testing may not take place until the fee is paid in full. This may result in delay of the issuance of a use and occupancy permit for the building or facility.

### 3.8 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.9 FIRESTOPPING

- A. Apply fire stopping to penetrations of fire-rated floor and wall assemblies for electronic security installations to restore original fire-resistance rating of assembly.
- B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.10 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26.

3.11 CABLE IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26.

3.12 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
  - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
4. Optical Fiber Cable Tests:



- a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- b. Link End-to-End Attenuation Tests:
  - 1) Multimode Link Measurements: Test at 850 or 1,300 nm (wavelength) in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
  - 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
- B. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide or transfer the data from the instrument to the computer, save as text files, print, and submit.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.13 WIRELINE DATA TRANSMISSION

- A. Installation: The Contractor shall install all system components including Owner furnished equipment, and appurtenances in accordance with the manufacturer's instructions, ANSI C2 and as shown, and furnish all necessary connectors, terminators, interconnections, services, and adjustments required for a complete and operable data transmission system.
- B. The Contractor shall provide all personnel, equipment, instrumentation, and supplies necessary to perform all testing.

### 3.14 DEMOLITION

- A. The demolition in the renovation areas indicated on the drawings shall be complete and include all work in the area unless noted otherwise.
- B. Existing systems passing through areas of demolition to serve equipment beyond the demolition areas shall remain in service, or be suitably relocated and restored to normal operation, throughout the demolition and reconstruction of the area. The Contractor shall investigate and identify such equipment prior to demolition.
- C. Provide temporary service to equipment disturbed by the demolition until such time as the permanent service can be restored.
- D. Where conduit and wiring is to remain are inadvertently damaged or disturbed, cut out and remove damaged portion and all damaged wiring from the source to the destination connection point. Provide new wiring of equal capacity.

- E. Exposed conduit to be demolished shall be removed in its entirety. Concealed conduit, abandoned in place, shall be cut out approximately two (2) inches beyond the face of adjacent construction, plugged, and the adjacent surface patched to match existing.
- F. Wiring to be demolished shall be removed from both concealed and exposed conduit. No wiring which becomes unused as a result of the contract shall be abandoned in place.
- G. Equipment specified or indicated to be demolished, shall be removed from the project site and shall not be reused.

### 3.15 COMMISSIONING NEW FIRE ALARM, SAFETY

- A. Testing Preparation:
  - 1. Certify in writing to the CxA that the systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
  - 2. Place systems, subsystems, and equipment into operating mode to be tested.
  - 3. Inspect and verify the position of each device and interlock identified on checklists.
  - 4. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.
- B. General Testing Requirements:
  - 1. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
  - 2. Test all operating modes and verify proper response of controllers and sensors.
  - 3. Tests will be performed using design conditions whenever possible.

### 3.16 CUTTING AND PATCHING

- A. Cutting and patching associated with the work in the existing structure shall be performed a neat and workmanlike manner. Existing surfaces that are damaged by the contractor shall be repaired or provided with new materials to match existing.
- B. Structural members shall not be cut or penetrated. Holes cut through concrete and/or masonry to accommodate new work shall be cut by reciprocating or rotary, non-percussive methods.
- C. Patching of areas disturbed by installation of new work and/or required demolition shall match existing adjacent surfaces as to material, texture and color.

3.17 CLEAN – UP

- A. Excessive debris and dirt, such as occurs from cutting through masonry or plaster walls shall be cleaned up from the equipment and removed immediately after the work of cutting through the walls.
- B. Debris shall be removed from UMB property.
- C. Ceiling panels shall be replaced as soon as work is finished in the area, and shall be kept free of dirty finger prints. Where work is being done in corridors used by patients and visitors, ceiling panels shall be replaced at the close of the day's work even if work is at the particular location is incomplete.
- D. All areas shall be left broom-clean at the end of the work period.

END OF DIVISION 280000