

SECTION 26 05 01**MECHANICAL AND ELECTRICAL COORDINATION****PART 1 - GENERAL****1.1 RESPONSIBILITY**

- A. The Division 22, 23 and 26 contractor(s) shall comply with the provisions of this section. The Division 22 and 23 contractor(s) shall verify electrical service provided by the electrical contractor before ordering any mechanical equipment requiring electrical connections. Provide submittals of all mechanical equipment to Division 26 contractor(s).
- B. The final responsibility for properly coordinating the electrical work of this section shall belong to the Division 22 and 23 system contractor performing the work, which requires the electrical power.
 - 1. Each contractor shall be responsible for providing power wiring for certain devices as described in the specifications and on the drawings. This work shall be provided by a licensed electrician in accordance with all of the applicable provisions of the Division 26 specifications, NEC and local codes.

1.2 WORK INCLUDED

- A. Carefully coordinate the interface between Division 22 (Plumbing Protection) and 23 (Mechanical HVAC) and Division 26 (Electrical), and Division 23 09 00 (Building Management and Automatic Temperature Control Systems) before submitting any equipment for review or commencing installation.
- B. This Division of the Specifications may also be referred by other Divisions of the Specifications, or on the Contract Drawings.

1.3 DEFINITIONS

- A. PC: Plumbing Contractor = Division 22
- B. MC: Mechanical Contractor = Division 23 Contractor who furnishes motor.
- C. TC: Temperature Controls = Division 23 09 00 Contractor who furnishes control.
- D. EC: Electrical Contractor = Division 26 Contractor.
- E. FA: Fire Alarm Contractor = Division 28 Contractor who furnishes Smoke Alarm System.
- F. EP: Electric to Pneumatic Converter.
- G. PE: Pneumatic to Electric Converter.

1.4 RESPONSIBILITY SCHEDULE

- A. Responsibility: Unless otherwise indicated, all motors and controls for Division 23 equipment shall be furnished, set in place and wired in accordance with the following schedule:

ITEM -	Furnished Under	Set In Place Under	Power Wiring Under	Control Wiring Under
MC: Mechanical Contractor TC: Temperature Contractor EC: Electrical Contractor FA: Fire Alarm Contractor				
AHU Interior Marine Lights	MC	MC	EC	MC
Equipment Motors	MC	MC	EC	--
Automatically or Manually Controlled Starters/Contactors: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Motor Speed Controllers: (Note 4)				
-Separate	MC	EC	EC	TC
-Factory Mounted and Wired	MC	MC	EC	TC
Disconnect Switches (Note 1)	EC	EC	EC	--
Thermal Overload Switches (Note 1)	EC	EC	EC	--
Switches (Manual or Automatic other than disconnect) (Note 2)	MC or TC	MC or TC	EC or TC	TC or MC
Control Relays (Note 2)	MC or TC	MC or TC	--	TC
Control Transformers	MC or TC	MC or TC	EC or TC	TC
Thermostat and Controls: Integral with Equipment or Directly Attached to Ducts, Pipes, etc. (Note 2)	MC or TC	EC or TC	EC or TC	TC
Equipment in Temperature Control Panels	TC	TC	TC	TC
Standalone Control Panels (BAS) (Note 6)	TC	TC	TC	TC
Valve Motors, Damper Motors, Solenoid Valves, etc.	TC	TC	TC	TC
EP Valves or Switches, P.E. Switches, etc.	TC	TC	--	TC
Smoke Alarm System (Note 3)	FA	FA	EC	FA
Duct System Smoke Detectors (Note 5)	FA	MC	--	TC/FA
Relays for Fan Control via duct detectors (Note 5)	MC	MC	EC	TC
Room Smoke Detectors Including Relays for Fan Control (Note 3)	FA	FA	--	FA
Smoke Management Controls (Note 7)	FA	FA	EC	FA
CO Sensors	TC	TC	TC	TC
Control Air Compressor	TC	TC	TC	TC
Refrigerated Air Dryer	TC	TC	TC	TC
Equipment Interlocks	TC	TC	--	TC

Notes:

- (1) If furnished as part of factory wired equipment furnished and set in place by MC, wiring and connections by EC.
- (2) If float switches, line thermostats, P.E. switches, time switches, or other controls carry the FULL LOAD CURRENT to any motor, they shall be furnished by MC, but they shall be set in place and connected by EC, except that where such items are an integral part of the mechanical equipment, or directly attached to ducts, piping, or other mechanical equipment, they shall be furnished and set in place by MC and connected by EC. If they do not carry the FULL LOAD CURRENT to any motor, they shall be furnished, set in place and wired by TC contractor.

- (3) Pre-action system initiation signals (such as smoke detectors, or general alarm conditions in a pre-action zone) shall be provided under Division 26.
- (4) Electrical contractor is responsible for wiring from starter to motor, unless factory wired.
- (5) Temperature control contractor shall provide conduit and wire from auxiliary contact in motor starter to the detector so that the unit shuts down in all operating modes. Fire Alarm Contractor to wire from detector to fire alarm panel.
- (6) Each division shall be fully responsible for any control panels as called for on the drawings or specifications.
- (7) Division 23 and 26 shall provide all power and control wiring to fire/smoke or smoke dampers along with initiation signals to temperature control panels as described in the specifications. This often requires dual wiring where components are controlled by both. In such case wiring and relays shall be provided to ensure FA takes precedence in control over TC.

- B. Power Wiring by Division 23: The electrical power for certain equipment provided under Division 23 has not been specifically indicated on the electrical drawings and must be provided by and field coordinated by the Division 23 or Division 22 or Division 21, whichever trade requiring such power.

Sufficient power for this purpose shall be furnished as "spare" dedicated circuit capacity in Division 28's panelboards. All wiring, conduit and electrical devices downstream of the panelboards is the responsibility of the Division 23 trade requires the power.

- 1. Such equipment is hereby defined as:
 - a. Electrical heat trace. Required heat trace locations, capacities and specification are shown on the plumbing drawings.
 - b. Infrared plumbing fixtures. Fixtures requiring power are shown on the plumbing drawings and schedules. Provide junction box and or receptacle as required by manufacturer.
 - c. Temperature control panels, control air compressors and line voltage power for 24v control transformers. Required connections are included in HVAC scope and will be shown by that contractor's control submittal drawings.
 - d. Motorized dampers and VAV boxes. Required locations and specification are shown on the mechanical drawings and HVAC specifications. HVAC contractor shall provide damper, controls and power.

1.5 GENERAL REQUIREMENTS

A. Connections:

- 1. Connections to all controls directly attached to ducts, piping and mechanical equipment shall be made with flexible connections.

B. Starters:

- 1. Provide magnetic starters for all three phase motors and equipment complete with:
 - a. Control transformers.
 - b. 120V holding coils.
 - c. Integral hand-off-auto switch.
 - d. Auxiliary contacts required for system operation plus one (1) spare.
 - e. Refer to Section 23 05 13 Motors, Starters and Electronic Speed controllers.

C. Special Requirements:

1. Motors, starters and other electrical equipment installed in moist areas or areas of special conditions, such as explosion proof, shall be designed and approved for installation in such areas with appropriate enclosure.

D. Identification:

1. Provide identification of purpose for each switch and/or pushbutton station furnished. Identification may be either engraved plastic sign permanently mounted to wall below switch, or stamping on switch cover proper. All such identification signs and/or switch covers in finished areas shall match other hardware in the immediate area.

E. Control Voltage:

1. Maximum allowable control voltage 120V. Fully protect control circuit conductors in accordance with National Electrical Code.

F. DDC Control Interface:

1. Fully coordinate the requirements of each division with regard to supplying a complete DDC Control System prior to submitting bid.
2. All control power shall be furnished via dedicated line voltage circuits.
3. Dedicated control circuits from electrical panelboards to DDC control panels and from electrical panelboards to dedicated DDC J-boxes (for distributed control components such as VAV boxes), and control transformer line voltage connections shall be provided under Division 23 09 00 where required and as shown on the drawings.
 - a. Exceptions: The following Division 23 equipment has been provided with electrical power feeders downstream of the panelboards by Division 28:
 - 1) Fire Alarm System Panels.
 - b. See the drawings for additional exceptions.
4. Low voltage wiring from J-boxes to distributed control components, all low voltage connections, all control panels and all control transformers (not part of unitary equipment) shall be provided under Division 23 09 00.
5. Any additional power requirements shall be the responsibility of the Division 23 09 00 Contractor requiring same, and provided at no additional cost to the City of New York.

1.6 CEILING AND CHASE CAVITY PRECEDENCE

- A. Coordinate ceiling cavity space carefully with all trades. In the event of conflict, install mechanical and electric systems within the cavity space allocation in the following order of precedence. A system with higher precedence may direct that systems of lower precedence be relocated from space, which is required for expedient routing of the precedent system.

1. Plumbing waste, cooling coil drain piping, and roof drain mains and leaders.
2. Steam and condensate piping.
3. Plumbing vent piping.
4. Supply, return and exhaust ductwork.
5. Electrical conduit greater than 4" diameter.
6. Domestic water piping.
7. Domestic hot and cold water branches.
8. Electrical conduit branch feeders.

- B. Light fixtures have precedence in a zone, which is the same height above the ceiling as the depth of the fixture (plus 2").

- C. Examine the contract documents of all trades (e.g. all Division 25 and 26 drawings, the architectural floor plans, reflected ceiling plans, elevations and sections, structural plans and sections, etc.).
- D. Coordinate necessary equipment, ductwork and piping locations so that the final installation is compatible with the materials and equipment of the other trades.
- E. Prepare shop drawings for installation of all new work before installation to verify coordination of work between trades.
- F. Provide access doors for all equipment, valves, clean-outs, actuators and controls which require access for adjustment or servicing and which are located in otherwise inaccessible locations.
 - 1. For equipment located in "accessible locations" such as lay-in ceilings: Locate equipment to provide adequate service clearance for normal maintenance without removing architectural, mechanical, electrical or structural elements such as the ceiling support system, electrical fixtures, etc. "Normal maintenance" includes, but is not limited to: filter changing; greasing of bearings; using p/t ports for pressure or temperature measurements; and replacement of ballasts, fuses, etc.

PART 2 – PRODUCTS

2.1 MOTOR HORSEPOWER

- A. In general, all motors ½ HP and above shall be three phase, all motors below ½ HP shall be single phase.
- B. Voltage and phase of motors as scheduled on the electrical drawings shall take precedence in the case of a conflict between the mechanical and electrical drawings or general condition 2.1. A., above.
- C. Work under Divisions 22 or 23 includes coordinating the electrical requirements of all mechanical equipment with the requirements of the work under Division 28, before ordering the equipment.
 - 1. If motor horsepowers are changed under the work without a change in duty of the motor's driven device, coordination of additional electrical work (if any) and additional payment for that work (if any) shall be provided under the section of that Division initiating the change. Increases or decreases in motor horsepower from that specified shall not be made without written approval from the Commissioner.

PART 3 - EXECUTION - (Not Used)

END OF SECTION

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- L. Any or all of the temporary services herein specified shall be disconnected, removed, or relocated when its or their use is no longer required, or if it or they should impede the progress of the work, and as requested by the General Contractor. Should a change in location of any temporary equipment herein specified be necessary to progress the work, the contractor shall remove and relocate such equipment as directed by the General Contractor. The temporary equipment herein specified shall be removed and disposed of when directed by General Contractor.
- M. Any Contractor requiring overtime use shall reimburse the Electrical Contractor by private agreement between Contractors.
- N. Provide construction site lighting as required or directed. This lighting shall be mounted on shanties and shall be wired on separate circuits to permit illumination from dusk to dawn.
- O. Immediately upon activation of permanent service, the contractor shall distribute temporary power from the permanent service.
- P. It is the intent of these specifications to generally indicate to the contractor the scope and requirements of temporary light and power. It is understood that these requirements shall vary during construction as required by field conditions, etc and as directed by the General Contractor. It shall be the responsibility of the Contractor to adjust and modify the temporary wiring requirements accordingly.

3.15 MINOR CHANGES

- A. The Commissioner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the City of New York.

3.16 ELECTRICAL SYSTEMS OPERATIONAL TESTS, CERTIFICATION, AND DESIGN AUTHORITY ASSISTANCE

- A. Testing
 - 1. Refer to the individual specification sections for test requirements.
 - 2. Prior to the final inspection, the systems or equipment shall be tested and reported as herein specified. Six (6) typewritten copies of the tests shall be submitted to the Commissioner for approval.
 - 3. All electrical systems shall be tested for compliance with the specifications.
- B. Manufacturers' Certifications
 - 1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers' recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been installed in accordance with the manufacturers' recommendations and is operating as specified in the contract documents.
 - 2. Provide manufacturers' certification for the smoke alarm system.

3.14 TEMPORARY LIGHTING AND POWER

- A. Provide temporary power as requested by the general contractor and in accordance with OSHA and local code requirements. Lighting and power outlets shall be provided throughout the project. Check with general contractor prior to bid for special lighting and power outlets and provide as needed.
- B. Electrical services for temporary light and power shall be obtained from the nearest existing switchboard and extended as required. Consult the Commissioner prior to making any connections to existing services.
- C. The Electrical Contractor shall furnish, install and maintain the temporary lighting and power system for all Contractors. The use of electricity shall be kept to a minimum.
- D. Provide all wiring, supports, lamp sockets, receptacle sockets and any other materials, supplies or equipment necessary for temporary light and power system.
- E. Ground fault protection required by OSHA for temporary receptacle circuits shall be accomplished by providing branch circuit panels containing ground fault protection branch circuit breakers.
- F. Provide a grounding conductor connection to each receptacle grounding terminal. Minimum size branch circuit and ground conductors shall be No. 12 AWG.
- G. Install separate stringer circuits for lighting and receptacles. Provide one lamp socket and one duplex receptacle (or two single receptacles) for every 400 square feet of new general construction area. (Approximately 20 feet on centers). Furthermore, provide one lamp socket and one duplex receptacle every 20 feet along the peripheral walls of the construction areas for temporary conditions. Each lamp socket shall be provided with a 100 watt lamp. Replace burned out lamps as required for as long as the temporary lighting system is maintained in operation.
- H. Provide sufficient supplementary temporary lighting to permit proper execution of the work. This supplementary lighting shall consist of but not be limited to the following:
 - 1. Construction hoist landings.
 - 2. Stairways and stairway landings where existing illumination is inadequate due to alterations or construction.
 - 3. Interior rooms not covered with general construction area lighting.
- I. Provide power wiring to operate construction hoist. Provide fused disconnect switch at hoist location. Fuse size, wiring size and disconnect shall be as required.
- J. Provide 50 trailer extension cords, each 25 feet long. Cords shall be 16-3, Type SJ. 25 of the trailer cord sets shall be receptacle type ITT No. 6112 and 25 of the trailer cord sets shall be trouble light type with receptacle ITT No. J-3270.
- K. Keep the temporary lighting and power system operational commencing fifteen (15) minutes before the established starting time of that trade which starts work earliest in the morning and ending fifteen (15) minutes after the established quitting time of that trade which stops work latest in the evening. This applies to all weekdays, Monday through Friday inclusive, which are established as regular working days for any trade engaged in the work, and shall continue until Final Acceptance of the work or until these services are ordered terminated by the Commissioner or the Commissioner's Representative.

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Commissioner or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, etc.
2. Remove equipment covers (i.e., panelboard trims, panelboards, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceiling shall be removed as directed for inspection of equipment installed above ceilings. Reinstall all covers or ceilings after inspection.
3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment as directed by Commissioner.
4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Commissioner compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Commissioner. Refer to the appropriate specification section for additional testing requirements. Representatives of the emergency generator/automatic transfer switch and fire alarm systems are required for demonstrations.

3.17 COMMISSIONING

- A. After startup and testing of each system has been completed, the Commissioner shall have an independent firm conduct detailed observations of the equipment and systems to confirm compliance with the Contract Documents.
- B. The Division 26 Contractor shall include, as part of the work of his contract, costs to cover manpower, equipment, tools, ladders, instruments, etc., necessary to expedite the system performance observations.
- C. The independent firm shall develop systems, equipment checkout procedures and data forms for recording compliance of the systems to the Contract Documents, performance, and construction observation lists, and will assist in developing schedules for checkout and Commissioner acceptance, at a future date during the construction phase.

END OF SECTION

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SECTION 26 05 03**TESTING****PART 1 - GENERAL****1.1 RELATED WORK SPECIFIED ELSEWHERE**

- A. Acceptance and startup testing requirements for electrical power distribution equipment and systems. Contractor shall retain and pay for the services of a recognized independent testing firm for purpose of performing inspections and tests as herein specified.
 - 1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
 - 2. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 - 3. The tests and inspections shall determine suitability for startup and energization.
 - 4. The following equipment shall be tested and calibrated:

Low Voltage Power Wires and Cables - Section 26 05 19
 Panelboards – Section 26 24 13
 Grounding - Section 26 05 26

1.2 SUBMITTALS

- A. Provide submittal per Contract General Conditions, General Conditions, and Section 26 05 02.
- B. Qualification of testing firm.
- C. Submit five copies of certified test reports to Engineer for approval.
- D. Five copies of blank forms for checklists, test reports, and other related forms for Engineer's review and approval.

1.3 GENERAL REQUIREMENTS

- A. At the time of the final inspection and tests, all connections at the panels and all splices, etc., must have been completed. All fuses must be in place and the circuits continuous from service switches to all receptacles, outlets, motors, etc.
- B. Prior to performing tests, the contractor shall notify the Commissioner a minimum of one week in advance, so that the Commissioner may schedule a representative to be present while tests are being conducted.
- C. The tests shall be performed by competent personnel and shall demonstrate the following:
 - 1. That all lighting, power and control circuits are continuous and free from short circuits.
 - 2. That all circuits are free from unspecified grounds.
 - 3. That all connections within panelboards are tight and do not produce excess heating.

4. That the resistance to ground of all non-grounded circuits is not less than one megohm.
 5. That all circuits are properly connected in accordance with the applicable wiring diagrams.
 6. That all circuits are operable by which a demonstration shall include functioning of each control not less than three times and continuous operation of each lighting and power circuit for not less than 1/2 hour.
 7. That all alarm and signal systems and all emergency and exit lights are properly functioning.
- D. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to and in addition to any acceptance testing.
- E. The Contractor shall test all lighting, low voltage relays and circuits to ensure proper operating conditions prior to acceptance testing.
- F. The Contractor shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.
- G. The Contractor shall be responsible for all final settings and adjustments on protective devices and tap changes, submitting settings to the Commissioner for review.
- H. When wiring systems are "megger" tested, the insulation resistance between conductors and between conductors and grounds, based on maximum load, shall not be less than that required by Electrical Code and local authorities having jurisdiction.
- I. Any defects shall be corrected at once, and the tests reconducted.
- J. Provide a complete short-circuit study, equipment interrupting/withstand evaluation, and a protective device coordination study for the electrical distribution system described below. This study shall be submitted with electrical equipment submission and electrical room layouts.
- The studies shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
- The study shall be calculated from the service entrance section to the lowest overcurrent device or equipment. The utility conductors shall not be used for calculations.
- The short circuit and coordination study shall be completed and forwarded for review within 120 days after award of the contract.*
- K. The Contractor shall engage the services of a recognized corporate and financially independent testing firm for the purpose of performing inspections and tests as herein specified.
- L. The firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
- M. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.

- N. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.
- O. A typewritten record of all test data shall be supplied to the Commissioner (three copies). The tests shall cover but not be limited to the following:
 - 1. Primary service and distribution system.
 - 2. Secondary service and distribution system.
 - 3. Smoke alarm, and detection systems.
 - 4. All communications, signaling and alarm systems.
 - 5. Power installations and motor controls.
 - 6. Light installations and circuit switching.
 - 7. Any part of the work called for in the Specification, or Drawings and as designated by the Commissioner.
- P. If in the opinion of the Commissioner, the results of such tests show that the work has not complied with the requirements of the Specifications or Drawings, the Contractor shall make all additions or changes necessary to put the system in proper working condition and shall pay for all the expenses and for all subsequent tests which are necessary to determine whether the work is satisfactory. Any additional work or subsequent tests shall be carried out at the convenience of the City of New York, prior to final payment.

1.4 QUALIFICATIONS OF TESTING FIRM

- A. The testing firm shall be a recognized corporate and financially independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.
- B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.
- C. The testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or be a Full Member company of the InterNational Electrical Testing Association (NETA).
- D. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.
- E. The testing firm shall utilize engineers and technicians who are regularly employed by the firm for testing and engineering services. All studies, tests, and reports shall be sealed by a licensed electrical professional engineer with a current New York State stamp.
- F. The testing firm shall submit proof of the above qualifications with bid documents, when requested.
- G. The terms used herewith, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing firm.

1.5 APPLICABLE CODES, STANDARDS, AND REFERENCES

- A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:
 - 1. National Electrical Manufacturer's Association - NEMA

2. American Society for Testing and Materials - ASTM
 3. Institute of Electrical and Electronic Engineers - IEEE
 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1991
 5. American National Standards Institute - ANSI C2: National Electrical Safety Code
 6. State and City of New York Codes and Ordinances
 7. Insulated Cable Engineers Association - ICEA
 8. Association of Edison Illuminating Companies - AEIC
 9. Occupational Safety and Health Administration - OSHA
 10. National Fire Protection Association - NFPA
 - a. ANSI/NFPA 70: National Electrical Code
 - b. ANSI/NFPA 70B: Electrical Equipment Maintenance
 - c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
 - d. ANSI/NFPA 78: Lightning Protection Code
 - e. ANSI/NFPA 101: Life Safety Code
- B. All inspections and tests shall utilize the following references:
1. Project design specifications.
 2. Project design drawings.
 3. Short-circuit and coordination study.
 4. Manufacturer's instruction manuals applicable to each particular apparatus.
 5. Project list of equipment to be inspected and tested as stated above.

PART 2 - SHORT-CIRCUIT AND COORDINATION STUDY

2.1 SHORT-CIRCUIT STUDY

The electrical equipment manufacturer shall perform a short-circuit analysis of the specified electrical power distribution system. This analysis shall include:

- A. Calculation of the maximum RMS symmetrical three-phase short-circuit current available at significant locations in the electrical system. The results shall represent the highest short-circuit currents to which the equipment might be subjected under the reported system conditions. The short-circuit currents shall be calculated with the aid of a digital computer. Appropriate motor short-circuit contribution shall be included in the calculation.
- B. The study shall include all portions of the electrical distribution system from the normal and alternate sources of power throughout the low-voltage distribution system. Normal system operating method, alternate operation, and operations which could result in maximum fault conditions shall be thoroughly covered in the study.
- C. The study shall be calculated from the utility meter to the unit substation to the lowest overcurrent device or equipment on the electrical distribution system. The utility conductors shall not be used for calculations.
- D. An evaluation of the adequacy of the short-circuit ratings of the electrical equipment supplied by that manufacturer.
- E. Provide five copies of the short-circuit analysis for the engineer's approval within 60 days of contract award.

- F. A computer printout of input data, a computer printout of calculated results and an explanation of how to interpret the printouts.
- G. A one-line diagram identifying all bus locations and the maximum available short-circuit current at each bus.
- H. A bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X/R ratio of the fault current.
- I. A table of equipment short-circuit ratings versus calculated short-circuit current values.
- J. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements. These recommendations shall be incorporated by the electrical equipment manufacturer to the electrical equipment at no cost to the City of New York. Where approved by the Engineer.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

The electrical equipment manufacturer shall perform a protective device time-current coordination analysis of the specified electrical power distribution system. This analysis shall include:

- A. A determination of settings or ratings for the over-current protective devices supplied. Where necessary, an appropriate compromise shall be made between system protection and service continuity with system protection and service continuity considered to be of equal importance. The time-current coordination analysis shall be performed with the aid of a digital computer.
- B. An evaluation to the degree of system protection and service continuity possible with overcurrent devices supplied.
- C. Provide five copies of the protective device time-current coordination analysis for the Engineer's approval.
- D. Log-Log plots of time-current characteristic curves.
- E. A tabulation of the suggested settings of the adjustable overcurrent protective devices supplied.
- F. The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the setting or ratings of the overcurrent protective devices supplied.
- G. The degree of service continuity and system protection achieved with the overcurrent protective devices supplied.
- H. An analysis of the results in which any inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.

PART 3 - INSPECTION AND TEST PROCEDURES

3.1 PROCEDURE

- A. Testing firm to provide and comply with the following:
1. Acceptance test procedures for each individual equipment listed in Part 1 of this section for Engineer review and approval prior to any test and after thorough evaluation of the system. Testing shall conform to the latest version of InterNational Electrical Testing Association (NETA) specifications and standards for electrical power distribution equipment and systems and manufacturer's instructions.
 2. Refer to each individual specification section for testing requirements and comply.
 3. Inspect installed equipment, record results and report any discrepancy and deficiency with contract documents and governing codes prior to testing. All results shall be submitted to the Engineer for approval.

3.2 SYSTEM FUNCTION TESTS

- A. General:
1. Perform system function tests upon completion of equipment component tests as define in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.
 2. Implementation:
 - a. Develop test parameters for the purpose of evaluating performance of all integral components and their functioning as a complete unit within design requirements.
 - b. Test all interlock devices, and trip settings on breakers.
 - c. Record the operation of alarms and indicating devices.

3.3 DEFICIENCIES

- A. All deficiencies reported by testing firm to be corrected by Contractor and Acceptance Test to be re-done accordingly.

END OF SECTION

SECTION 26 05 05**MANUFACTURERS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. The following lists of manufacturers are for the specifications as identified.
- B. All submittals and documentation shall be in accordance with the project General Requirements, General Conditions.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Manufacturing firms regularly engaged in manufacture of this material with characteristics and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Provide product produced by the manufacturers, which are listed in Section "Approved Manufacturer's List".
- C. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed herein. Refer to General Conditions for pre-approval format.

TITLE	SPECIFICATION SECTION	MANUFACTURER
Electrical Identification	26 05 53	Ideal Industries, Inc. National Band and Tag Co. Panduit Corp. Seton Name Plate Co. W.H. Brady, Co.
Raceways		
Conduit & Tubing	26 05 33	Al Flex Corp. Allied Carlson, Inc. Liquatite Triangle PWC, Inc.
Conduit Bodies	26 05 33	Appleton Electric Co. Crouse-Hinds Div. Killark Electric Mfg. Co. OZ/Gedney Co. Steel City

TITLE	SPECIFICATION SECTION	MANUFACTURER
Wireway & Enclosures	26 05 33	Circle AW Products Hoffman Engineering Co. Hammond Mfg. Square D Co.
Surface Raceways	26 05 33	Hubbell Isoduct Square D Co. The Wiremold Co.
Wire and Cables	26 05 19	American Insulated Wire Corp. Cablec Continental Cables Co. Okonite Co. Southwire Co. Triangle PWC, Inc.
Electrical Boxes & Fittings		
Raintight outlet boxes	26 05 34	Appleton Electric Co. RACO Div.; Hubbell, Inc. OZ/Gedney Co. Steel City
Bushings, knockout closures and locknuts	26 05 34	Appleton Electric Co. Midland-Ross Corp. Midwest Electric OZ/Gedney Co. RACO Div.; Hubbell, Inc. Thomas & Betts Co., Inc.
Wiring Devices		
Receptacles & Switches Dimmers	26 27 26 26 27 26	Hubbell, Inc. Leviton Lutron Wattstopper Lightolier Arrow Hart
Supporting Devices		
Slotted metal Angle & U-channel Systems	26 05 29	American Electric B-Line Systems, Inc. Unistrut Diversified Products
Conduit Sealing Bushings	26 05 29	OZ/Gedney Co. RACO, Inc. Spring City Electrical Mfg. Thomas and Betts Corp.
Panelboards	26 24 13	Cutler-Hammer General Electric Company Siemens (I-T-E-) Square D Company

TITLE	SPECIFICATION SECTION	MANUFACTURER
Motor, Disconnects and Fuses		
Circuit and Motor Disconnects	26 28 16	Cutler-Hammer General Electric Company Siemens (I-T-E-) Square D Company
Fuses (See Note)	26 28 16	Bussman (Basis of Design) Gould Shawmut
Connections	26 28 16	Appleton Electric Co. Burndy Corp. Ideal Industries, Inc. Thomas and Betts Corp.
NOTE: Contractor shall submit fuse coordination for the entire electrical distribution if alternate manufacturer is used.		
Motor Controllers	26 29 13	Allen Bradley, Co. Cutler-Hammer, Eaton Corp. Siemens Square D Co.
Transient Voltage Surge Suppression	26 43 13	Refer to Section
Grounding	26 05 26	Cadweld Div.; Cooper Industries Ideal Industries Okonite Burndy Electrical
Lighting Fixtures	26 51 00	Refer to Drawings
Smoke Alarm System	28 31 02	Edwards System Technology Notifier Pyrotronics

PART 3 - EXECUTION - Not Used.

END OF SECTION

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SECTION 26 05 06**BASIC MATERIAL AND METHODS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. This Section supplements General Conditions.

1.2 DESCRIPTION OF WORK

- A. Work included in this section consists of conduits, wires and other miscellaneous materials not specifically mentioned in other sections of Division 26, but necessary or required for equipment or system operation or function, and the labor to install them.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Commissioner.

PART 2 - PRODUCTS**2.1 MANUFACTURERS:** Refer to Section 26 05 05.**2.2 CONDUIT RACEWAYS:** Refer to Section 26 05 33.**2.3 WIRES AND CABLES:** Refer to Section 26 05 19.**2.4 WIRING DEVICES:** Refer to Section 26 27 26.**2.5 OUTLET BOXES, JUNCTION AND PULL BOXES**

- A. Outlet Boxes: Hot-dipped galvanized or sherardized of required size, 4" square minimum, for flush mounted devices and lighting fixtures. Cast-type FD with gasketed covers for surface-mounted devices.
- B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes shall be fabricated from sheet steel, sized according to code, with screw-on covers, galvanized where required for outdoor exposure.
- C. All exterior boxes shall be cast, gasketed, weatherproof type with cast covers.
- D. Refer to Section 26 05 34 for additional requirements.

2.6 WIRE CONNECTORS

- A. For wires that are #8 AWG and smaller: Insulated pressure type with live spring, rated 105°C, 600 volt, for building wiring and 1000 volt in signs or fixtures.
- B. For wires that are #6 AWG and larger: Compression type with 3M #33 or equal tape insulation.

2.7 CONDUIT HANGERS

- A. Galvanized steel with special accessories for purpose and adequate to support load imposed. Support individual conduit 1-1/2-inch and larger and all multiple conduit runs with hangers. Clamp conduits individually to each support.
- B. Refer to Section 26 05 29 for additional requirements.

2.8 FUSES: Refer to Section 26 28 16.**2.9 ACCESS PANELS**

- A. Electrical Contractor to provide access panels for electrical equipment which are required for accessibility by code.

2.10 TERMINAL CABINETS AND BACKBOARDS

- A. Fabricate from code gauge steel, size as indicated on drawings, with flush latch and concealed hinge. Where size is not indicated, minimum size shall be 20" wide x 24" high x 4" deep. Finish shall be ANSI 61 light gray baked enamel.
- B. Provide inside terminal cabinet, 3/4" thick plywood backboard and terminal strips, one terminal point for each wire within the terminal cabinet.
- C. Provide 3/4" thick plywood backboards, size as indicated on drawings, for telephone where indicated on drawings. Reference Division 27 for additional requirements.

2.11 CONDUIT SLEEVES

- A. Sleeves for Conduit Penetration: Pipe Shields, Inc., model WFB at walls and QDFB at floors. Refer to Division 7 "Firestopping" for additional requirements.

2.12 EQUIPMENT MOUNTING AND SUPPORT HARDWARE

- A. Steel channels, bolts and washers, used for mounting or support of electrical equipment shall be galvanized typed. Where installed in corrosive atmosphere, stainless steel type hardware shall be used.
- B. Refer to Section 26 05 29 for additional requirements.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Provide complete raceway systems for all conductors including control wiring and low voltage wiring unless otherwise noted.
- B. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

- C. All home runs to panelboards are indicated as starting from the outlet nearest to the panel and continuing in the general direction of that panel. Continue such circuits to panel as though routes were completely indicated.
- D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of the Commissioner, and conform to all structural requirements when cutting or boring structure.
- E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc., required for equipment specified under this Section.

3.2 RACEWAY: Refer to Section 26 05 33.

3.3 OUTLETS

- A. Exact location of outlets and equipment shall be governed by structural conditions and obstructions or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to room layout and will not interfere with other work or equipment. Verify final location of all outlets, panels, equipment, etc., with the Commissioner.
- B. Provide zinc-coated or cadmium-plated sheet steel outlet boxes not less than 4" octagonal or square, unless otherwise noted. Equip fixture outlet boxes with 3/8" no-bolt fixture studs. Where fixtures are mounted on or in an accessible type ceiling, provide a junction box and extend flexible conduit to each fixture. Outlet boxes in finished ceilings or walls shall be fitted with appropriate covers, set to come flush with the finished surface. Where more than one switch or device is located on one point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes will not be permitted. Provide tile box or a 4" square box with tile ring in masonry walls which will not be plastered or furred, or where "dry-wall" type materials are applied. Through the wall type boxes are not permitted. Install minimum 12" lateral separation for back to back boxes.
- C. Surface-mounted devices are to be mounted in cast type boxes with gasketed covers: (Crouse-Hinds condulets or equal).
- D. Dimensions, unless shown on drawings, are given below and are from finished floor to center line of outlets unless noted otherwise. Adjust heights of outlets in masonry walls to correspond with consistent brick or block course. Outlets in block walls shall be installed in core of block.

Wall Switches	4' - 0" (to top of switch)
Convenience outlets	1' - 6" (to bottom of outlet)
Receptacle outlets in mechanical spaces	3' - 0" (to bottom of outlet)
Hallways	1' - 6" (to bottom of outlet)
Workroom wall outlet	4' - 4" (field verify height of backsplash)
Panelboards wall-mounted	6' - 6" (to top of trim)
Wall phone outlet	4' - 0"
Telephone outlets	1' - 6"
Telephone outlet for wall phone	42-48"
Receptacles at counters	4'-0" or as required.
Motor controllers	5'-0"
Safety and disconnect switches	5'-0"

Confirm final location and heights of all outlets, wall switches, and television outlets with architectural drawings and furniture plans prior to installation.

- E. Outlets except over counters, benches, special equipment, baseboards, fin tube radiators, etc., or at wainscotting, shall be at a height to prevent interference to service equipment, or as noted on drawings.
- F. Refer to Section 26 05 34 for additional requirements.

3.4 JUNCTION PULL BOXES

- A. Construct junction or pull boxes not over 150 cubic inches in size shall be standard outlet boxes, and those over 150 cubic inches shall be constructed the same as "Cabinets," with screw covers of same gauge metal. Removal covers must be accessible at all times.
- B. Provide a standard access panel having a hinged metal door neatly fitted into a flush metal trim, where a junction box or equipment is located above non-accessible ceilings or behind finished walls. Coordinate location and type with the Commissioner.

END OF SECTION

SECTION 26 05 09**ELECTRICAL DEMOLITION AND RELOCATION****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. This Section supplements General Conditions. Where contradictions occur between this Section and General Conditions, the more stringent of the two shall apply. The Commissioner shall decide which is most stringent.
- B. Requirements of the following Divisions and Sections apply to this Section:
 - 1. Division 26 Section 26 05 02 "Electrical Requirements."
 - 2. Division 9 Section "Painting" for related requirements.
- C. Refer to other Division 26 Sections for additional specific electrical demolition or relocation associated with specific items.

1.2 SUMMARY

- A. This Section includes basic requirements for demolition and relocation of electrical materials, equipment, and installations. The Contractor shall be responsible for visiting the site prior to bid to determine the actual conditions, which might affect the bid or contract price. No allowance will be made subsequently resulting from the neglect to visit the site and make such determinations.
- B. Generally, electrical items that are to be replaced with other equipment in the same location is work covered by this section. Also covered by this section are electrical items that are to be removed in their entirety or that are to be relocated to another place.

1.3 UTILITY SERVICES

- A. Existing utility service shall be replaced. Refer to plans for additional information.
- B. Coordinate the replacement of electrical service with utility company.
- C. The contractor for construction, excavation and demolition operations at or near existing underground utilities shall use Industrial Code 53 of Title 12, Rules and Regulations of the State of New York to verify and/or relocate existing utilities in the area of the proposed new utility service. The telephone number to contact Code 53 in N.Y. State is 1-800-245-2828.

1.4 PROTECTIVE MEASURES

- A. Provide the following protective measures:
 - 1. Wherever existing roofing surfaces are penetrated by electrical conduit, they shall be protected against water infiltration. Water leaks shall be repaired immediately upon discovery when they occur.
 - 2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled, and equipment moved or relocated.
- B. The Contractor shall be responsible for contacting utilities or locating services and obtaining locations of all underground services in the general area of demolition work.

PART 2 - PRODUCTS**2.1 EQUIPMENT AND MATERIALS**

- A. The Contractor shall provide all equipment and materials necessary for the removal or relocation of electrical equipment.
- B. Materials used in restoration or repairing work related to demolition and relocation shall conform in type, quality, and function to that of the original existing construction or as otherwise indicated.

2.2 DISPOSAL AND RETENTION

- A. Materials and equipment resulting from work and removed from the building or structures, or parts thereof, shall become the property of the Contractor and shall be removed from the site by the Contractor.
- B. Items removed or noted to be retained by the Owner but which are declined to be retained by the Owner shall be removed from the site by the Contractor.
- C. Combustible waste material and rubbish shall not be stored or allowed to accumulate within a building or its vicinity, but shall be kept in a suitable trash container for subsequent removal or shall be removed from the premises as rapidly as practical.

PART 3 - EXECUTION**3.1 GENERAL**

- A. Disconnect, remove and/or relocate electrical material, equipment, devices, components, and other work noted and required by demolition or alterations in existing construction.
- B. Where the drawings indicate that equipment is to be replaced or where other equipment requires the relocation of existing equipment, the existing equipment shall be removed or relocated as though it was specifically noted to be removed or relocated.
- C. Provide new material and equipment required for relocated equipment.
- D. Wherever electrical materials have been removed from surfaces of the building or structure, those surfaces shall be patched and repaired.
- E. Remove, cut, alter, replace, patch, and repair existing work as necessary to install new work. Unless otherwise indicated or specified, do not cut, alter, or remove any structural members, ducts, piping, or service lines without approval of the Owner's representative.
- F. Existing work or equipment to be altered or extended and found to be defective shall be reported to the Owner's representative before it is disturbed or any further work is performed on it.
- G. Where electrical equipment is indicated to be removed or relocated, the work shall include the complete disconnection from its source, dismantling as necessary, and removal or installation

of all conduit, wires, cables, etc. Unless noted otherwise, wires shall be removed from conduits back to the last utilization device or to the panelboard. No wiring shall be removed that prevents operation of other equipment not scheduled or indicated to be removed.

- H. Perform and schedule all demolition work with other trades and work of the contract as necessary for the efficient progress and flow of the work.
- I. Remove conductors from existing raceways to be rewired. Clean raceways as required prior to rewiring.
- J. Tape both ends of abandoned conductors, and cap outlets and abandoned raceways.
- K. Cut and cap abandoned floor raceways flush with concrete floor or behind walls and ceilings.
- L. Dispose of removed raceways and wiring.
- M. Where any fixture or wiring device is removed, provide adequate size and type of blank plates over each outlet.
- N. Dispose of removed electrical equipment as directed.
- O. All electrical work in adjoining areas which is indicated on the Drawings to continue to function but is affected by demolition work shall be reconnected and restored to present function as part of the electrical system of the Buildings.
- P. Connect new work to existing work in a neat and acceptable manner, with minimum interference to existing facilities.
- Q. Maintain continuous operation of existing facilities affected by the work.
- R. Where indicated on the Drawings or required by the alteration scheme, the Contractor shall remove all electrical outlets, switches, and other devices, complete with associated wiring, conduit, etc., from partitions, walls, and floors that are to be removed. When the removal of these makes dead electrical wiring that is to remain, Contractor shall install junction boxes or other devices necessary to make the circuits affected continuous and ready for operation. Otherwise, wiring shall be removed back to the nearest electrical outlet box that is to remain, or to the panelboard.
- S. All raceways which become exposed beyond finished surfaces because of the alteration work shall be removed and rerouted behind finished surfaces.
- T. Wiring that is to be removed as a result of demolition work, but is required to continue to function, shall be interrupted at convenient locations, rerouted (new wiring and conduits) and reconnected for continuation of their original function. New wiring extensions shall match existing ones in all respects, conductor ampacity, conduit size, etc.

END OF SECTION

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SECTION 26 05 10**PROJECT CLOSEOUT****PART 1 – GENERAL****1.1 WORK INCLUDED**

- A. The contractor shall summarize and document adherence with the requirements of the specifications for project closeout including:
 - 1. Copies of all warranties
 - 2. Operation & Maintenance Manuals
 - 3. Required tests
 - 4. Certifications
 - 5. Record drawings
 - 6. Permit requirements
- B. The contractor shall compile a closeout manual which shall include:
 - 1. A list of all required tests and a place for signoff of date completed.
 - 2. A list of all submittals with dates of acceptance by the engineer.
 - 3. A schedule indicating dates for beginning testing and startup of equipment and dates of tests to be witnessed by the engineer, or designated representative, as required by the specifications.
 - 4. Test procedures to be used for life safety systems.
 - 5. Project close out check list.
- C. The final closeout manual shall include the following:
 - 1. Test reports as required by the specifications with signoff by the appropriate individual (engineer, architect, building official, etc.).
 - 2. Documentation indicating all equipment is operating properly and is fully accessible for maintenance.
 - 3. Copies of all warranties.
- D. This section only includes the requirements for documentation of the contract documents, by the contractor, for project completion. This section does not in any way decrease the scope of any of the drawings or specifications.

1.2 SUBMITTALS

- A. Within 90 days after notice to proceed submit a preliminary closeout manual with the following:
 - 1. A list of all required tests.
 - 2. Preliminary schedule showing major milestones for completion of the electrical and technology systems.
- B. Within 30 days of the first major milestone submit the completed closeout manual as described in Part 1.

- C. Within 2 weeks of substantial completion submit a completed "Project Closeout Check List", and the Final Closeout Manual.
- D. Listed below is a checklist for use by the contractor. This list is not all inclusive for this project.

Project Close-Out Summary - Electrical

- ☐ The following tests have been completed. Submit test report for record.
 - ☐ Feeder Testing and Reporting (Megger Result)
 - ☐ Cable Testing and Reporting
 - ☐ Grounding System Testing and Reporting
- ☐ All main components of the electrical system cleaned and vacuumed. This includes unit substations, switchboards, distribution boards, panel boards, etc. Provide M-E Engineers with schedule when this is going to occur and a letter stating it has been completed.
- ☐ The contractor shall schedule a walk through with the engineer to inspect all main feeder sizes. Covers for panel boards and distribution boards should be removed by the contractor for visual inspection of feeder sizes.
- ☐ Temporary cable tray hooks inspected.
- ☐ Fixtures re-lamped per specifications.
- ☐ The smoke alarm system manufacturer shall provide the Owner/Architect with a "Letter of Certification" indicating the system is fully functional and meets all manufacturers requirements as well as code and design requirements. Fire department must sign off the system.
- ☐ Panelboard directories completed.
- ☐ Record drawings submitted.
- ☐ All lighting control systems complete with controls fully operational for visual inspections.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EQUIPMENT STARTUP AND TESTING

- A. Prior to completion and punchlist by the engineer, the contractor shall startup and test each piece of equipment as required by the specifications. The contractor shall provide documentation of all required tests with signoff of by the appropriate individual (engineer, architect, and building official).

3.2 LIFE SAFETY SYSTEMS

- A. All life safety systems shall be fully and successfully tested by the contractor before being witnessed by the engineer or building official.

- B. The contractor shall provide a detailed test procedure, with instrumentation to be used, for approval by the engineer and building official prior to any testing.
- C. Once tested by the contractor and fully operation the systems shall be demonstrated to the engineer. Once accepted by the engineer the system shall be demonstrated to the building and fire officials.

3.3 COORDINATION WITH OTHERS

- A. The Division 26 contractor shall coordinate his requirements with the general contractor to ensure the other building systems are completed to the point that they will not adversely affect the operation of the Division 26, 27 and 28 systems.

END OF SECTION

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SECTION 26 05 11**ELECTRIC SERVICE SYSTEM****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and make ready for operation by the City of New York, electrical service as shown on the drawings and hereinafter specified.
- B. Equipment and wiring shall be provided and installed in part by Con Edison referred to as Utility Company and in part under this contract.

1.3 SUBMITTALS

- A. Materials list with manufacturer, style, series or model identified.
- B. Manufacturer's descriptive literature and/or sample if requested by the Commissioner.

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: Firms with at least 3 years successful installation experience on projects utilizing switchboards and panelboards similar to those required for this project.
- B. All work shall be performed in accordance with all rules, regulations, and standards of Utility Company, and all applicable codes.
- C. Where deemed necessary, perform all work under the supervision of the Utility Company representative.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store equipment in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle equipment carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of property line box, enclosures and all required appurtenances with the utility company.

PART 2 - PRODUCTS

- 2.1 MANUFACTURERS:** Refer to Section 26 05 05.
- 2.2 CONDUIT RACEWAYS:** Refer to Section 26 05 033.
- 2.3 WIRES AND CABLES:** Refer to Section 26 05 19.
- 2.4 PULL BOXES:** Refer to Section 26 05 06.
- 2.5 WIRE CONNECTORS:** Refer to Section 26 05 06.
- 2.6 CONDUIT HANGERS:** Refer to Section 26 05 06.
- 2.7 CONDUIT SLEEVES:** Refer to Section 26 05 06.
- 2.8 EQUIPMENT MOUNTING AND SUPPORT HARDWARE:** Refer to Section 26 05 06.

PART 3 - EXECUTION**3.1 SCOPE OF WORK**

- A. The following work shall be performed by the Utility Company:
 - 1. Service wiring as noted.
 - 2. Supply metering transformers.
 - 3. Supply and install watt hour and demand meters.
 - 4. Final connections to metering equipment.
- B. The following work shall be performed by the Contractor.
 - 1. Arrange with the Utility Company for service facilities and pay all charges.
 - 2. Extend service from Utility Company termination.
 - 3. Provide sleeves for service entrance raceways.
 - 4. Provide limiter lugs on both ends of service entrance cable.
 - 5. Metering transformer enclosures and meter pans.
 - 6. Install metering transformers.
 - 7. Meter wiring except final connections
 - 8. Obtain Utility Company approval for all electric service work and service equipment shop drawings.
 - 9. Provide all associated installation components and accessories.

3.2 SERVICE EQUIPMENT AND CONNECTIONS

- A. Service and meter equipment indicated on the drawings or the service layouts of the utility company shall be furnished and installed complete with all connections.
- B. All work at the service shall be performed in accordance with the utility company's rules and regulations, and as directed by the Chief Engineer of Light and Power of the Bureau of Gas and Electricity.
- C. Contractor shall apply and receive from the utility company all information relative to the requirements for property line splice boxes, meter pans, meter blocks, all metal enclosures, current transformer cabinets, meter loops, service wiring, etc.

- D. The contractor shall note that after the contract award, the final approved equipment, current transformer cabinet and meter provisions, including property-line box and end-line boxes shall be of the type which includes terminating devices (crab-joints) and protective devices (limiters), connections, hardware, etc.
- E. Any work the utility company performs as part of this installation which is chargeable to the project shall be paid for by this contractor as part of this Contract.

3.3 TYPE OF ELECTRIC SERVICE

- A. The current supply for this building shall be the standard electric service 208Y/120V, 3 phase, 4 wire, 60 Hz Alternating Current Service.

3.4 LIMITER LUGS

- A. In the service end-line box, furnish and install straight line limiter lugs on each conductor of each phase of the incoming secondary service feeder, if required by the utility company.
- B. Limiter lugs shall have proper link element characteristics, based on applicable cable size that will carry normal overloads of short duration, but will clear on overloads liable to damage cable insulation.
- C. Limiters shall have heat resistant shell to confine the arc and insulating sleeve. Provide sufficient cable slack for replacement for at least one unit per phase.
- D. Limiter lugs shall be equal to Burndy type YFS-CR.

3.5 SERVICE END BOXES (INSIDE BUILDING)

- A. Service end boxes of the type and size indicated on the drawings or required shall be furnished and installed at the location designated. Splices in service end boxes shall be performed by this contractor, in accordance with requirements of utility company.

3.6 METER CABINETS, ETC

- A. Cabinets of meter pans, current transformers, service switches, and all other service equipment shall be constructed from galvanized or other approved rust resistant steel or aluminum and shall be painted on all exposed surfaces with a priming coat and a coat of paint (color as selected). Cabinet doors shall have steel hinges and non-ferrous pins.

3.7 MOUNTING OF SERVICE EQUIPMENT, ETC

- A. Service equipment shall be mounted a minimum of ½" out from wall. Lightweight equipment may be mounted on spacers, while heavy equipment shall be fastened to wall by using suitable metal framework.
- B. The various elements of the service equipment, such as service switches, cutouts, metering equipment with conduit and cable connections are indicated diagrammatically on the drawings. Contractor may re-arrange and/or group the various elements including main distribution panel where practical using separate or common wireways or equivalent built-in gutters for cable or copper bus connections in one or more cabinets with separate access doors to fit space available.
- C. Each unit of equipment shall be completely identified by attaching phenolic nameplates with lettering, etc 1 " in height.

- D. This contractor shall be responsible for the number, location and size of all necessary openings in the building walls for the entrance of service conduits and other conduits into the building.

3.8 INSPECTION

- A. Contractor shall examine location where electric service equipment and raceways are to be installed, determine space conditions and notify Commissioner in writing of conditions detrimental to proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.9 INSTALLATION

- A. Install equipment and components where shown or as directed, in accordance with manufacturer's written instructions, Utility Company's instructions (where applicable), and with recognized industry practices, to ensure that installation complies with requirements and serves intended purposes.
- B. Coordinate with other work as necessary to coordinate installation of equipment with other components of systems.

END OF SECTION

SECTION 26 05 19**WIRES AND CABLES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirement of the following Division 26 Sections apply to this section:
 - 1. Electrical Requirements

1.2 SUMMARY

- A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.
- B. Related Sections: The following Sections contain requirements that relate to this section:
 - 1. Division 26 Section "Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.
- C. The work includes providing wire and cable complete with all accessories in accordance with Drawings and Specifications and as required for a complete system. Wiring size referenced in this Section shall be AWG, except as noted. For special wiring for individual systems refer to respective Section of these Specifications.

1.3 SUBMITTALS

- A. Product Data for electrical wires, cables and connectors.
- B. Shop drawings shall include detail drawings and data sheets for all wire and cable, compression wire connectors, large aluminum wire connectors, and large copper wire connectors.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following code:
- B. NFPA 70 "National Electrical Code."
 - 1. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
 - 2. Comply with most restrictive code.
- C. UL Compliance: Provide components, which are listed and labeled by UL under the following standards.

<ul style="list-style-type: none"> 1. UL Std. 44 2. UL Std. 83 3. UL Std. 486A 	<ul style="list-style-type: none"> Rubber Insulated Wires and Cables Thermoplastic-Insulated Wires and Cables Wire Connectors and Soldering Lugs for Use with Copper Conductors
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4. UL Std. 854 Service Entrance Cable
- D. NEMA/ICEA Compliance: Provide components which comply with the following standards:
1. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
 2. WC-7: Cross Linked Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- E. IEEE Compliance: Provide components, which comply with the following standard.
1. Std. 82: Test procedures for Impulse Voltage Tests on Insulated Conductors.
- F. QUALITY ASSURANCE
1. "Manufacturers" - Firms regularly engaged in manufacture of wire and cable of types and ratings whose products have been in satisfactory use in similar service for not less than 3 years.
 2. Provide wire and cable which has been listed and labeled by Underwriters' Laboratories, and comply with applicable portions of National Electrical Manufacturers Association Standards.
 3. Provide wire and cable produced by a manufacturer listed as an Approved Manufacturer in this section.
 4. Provide equipment whose performance under specified conditions, is certified by the Manufacturer.

PART 2 - PRODUCTS

2.1 WIRES AND CABLES (600 VOLT COPPER CONDUCTORS)

- A. General: Provide suitable wire and cable for the temperature, conditions and location where installed. All wires and cables shall be new and delivered to the site in unbroken packages and reels.
- B. All wires and cables shall be of the same manufacturer throughout the entire project.
- C. Conductors:
1. Provide solid conductors for power and lighting circuits #10 AWG and smaller. Provide stranded conductors for #8 AWG and larger.
 2. Minimum conductor size shall be No. 12 for lighting and power and No. 14 for control and alarm. Increase wire as noted hereinafter for long runs.
 3. Communications and signal wiring shall conform to the recommendations of the manufacturer's communication and signal systems and shall be as specified in respective Sections of these Specifications.
- D. Conductor Material: All wires and cables shall be copper, single conductor rated at 600 volts, which conform to or exceed ICEA specifications and the following:
1. In sizes 1/0 AWG to 4/0: Cross-linked polyethylene insulation type XHHW-2 (75 - 90°C) or THWN.
 2. In sizes 250 KCMIL and larger: Type XHHW-2 (75°C) or THWN.
 3. In sizes 1 AWG and smaller: All conductors shall have heat/moisture resistant thermoplastic insulation type THWN (75°C) except as follows:
 - a. Where conduit temperature will exceed 100°F, use type THHN (90°C).

- b. In 120 volt incandescent fixtures, type SF-2 or SFF-2 (150 - 200°C).
 - c. In wireway of fluorescent lighting fixtures type THHN (90°C).
- E. Grounding conductors: Shall be of the same type as its associated phase conductors.
- F. All conductors shall be label with wire size, insulation rating, etc using an engraved process. Computer scan or labels are not permitted.
- G. Color Coding for phase identification in accordance with Table 1 in Part 3 herein.
 - 1. Where color-coded cable is not available, certify in writing and request permission for overlap color taping conductors (minimum length 6 in.) in accessible locations.
 - 2. Conductors for control circuits and signal systems shall also be consistently color coded to avoid confusion and permit easy identification of conductors. The IPCEA color code shall be used wherever possible. No two wires in the same raceway shall be the same color, unless provided with flameproof linen identification tags on each end.
- H. Connectors for Conductors:
 - 1. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.
- I. Splices and Taps:
 - 1. No. 10 AWG and smaller - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.
 - 2. No. 8 AWG and larger - Hydraulically applied crimping sleeve or tap connector sized for the conductors. Insulate the hydraulically applied connector with 90-degree, 600-volt insulating cover provided by the connector manufacturer. Insulator materials and installation shall be approved for the specific application, location, voltage, and temperature and shall not have an insulation value less than the conductors being joined.
- J. Wire Sizes
 - 1. For General Use:
 - a. No. 12 minimum copper wire shall be used for lighting and power.
 - b. No. 10 minimum copper wire shall be used at 120 volts and over 90 ft. for 15 amp circuit and 60 ft. for 20 amp circuit length.
 - c. No. 10 minimum copper wire shall be used at 265 volts and over 175 ft. circuit length.
 - 2. For Control and Alarm (unless otherwise noted):
 - a. No. 14 minimum copper wire shall be used.
 - b. No. 12 minimum copper wire shall be used at 120 volts and over 60 ft. circuit length.
 - 3. For Other Voltages and Phases and for Longer Circuit Lengths: Size wire as required to maintain equivalent voltage drop.
 - 4. Raceways: Increase raceway sizes for larger wire as required.

K. Insulation:

1. Rubber and thermoplastic insulation shall comply with ASTM and IPCEA standards. Paper and lead insulation shall comply with AEIC standards

PART 3 - EXECUTION**3.1 WIRING METHOD**

A. Use the following wiring methods as indicated:

1. Install all wire in raceway. Power and control wiring shall be installed in separate raceways.

3.2 INSTALLATION OF WIRES AND CABLES

- A. General: Install electrical cables, wires, and connectors in compliance with NEC.
- B. Coordinate cable and wire installation with other Work.
- C. Wire and cable shall not be drawn into conduit and raceways until all conduit work is complete - joints made up tightly and the entire run secured in place.
- D. Do not install more conductors in a raceway than indicated on the drawings. A maximum of six branch circuits are to be installed in any one conduit on a 3-phase, 4-wire system, unless specifically noted otherwise on the drawings. When more than three branch circuits are installed in a raceway, the conductor size shall be increase per code for derating.
- E. Minimum wire size shall be a No.12 AWG except for control or signal circuits, which may be No. 14 AWG.
- F. Unless otherwise indicated on drawings, all wiring for branch circuits shall be a minimum No. 12 AWG in $\frac{3}{4}$ " conduit, protected by 20 amperes circuit breakers.
- G. Size of current carrying conductors, unless noted otherwise on drawings, shall be determined from Table 310-16 of the latest NYC Code for the load served.
- H. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.
- I. Care shall be exercised in pulling to avoid damage to the wire or cable. Lubricants shall be used for pulling wire or cable if the character of the pull would otherwise damage the conductors, insulation or jacket. Pull no thermoplastic wires at temperatures lower than 0°C.
- J. Use pulling means including: fish tape, cable, rope, and basket weave wire/cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable.
- K. Size of conduits, unless specifically shown, shall be determined from Appendix C of the latest NYC Code.

- L. Keep conductor splice to minimum. All splices shall be made within junction boxes, wiring troughs and other enclosures as permitted by the NYC Code. Do not splice conductors in panelboards, safety switches, or motor control enclosures. Splices in conductors installed below grade will not be permitted, unless approved in writing by the Commissioner.
- M. Install splice and tap connectors, which possess equivalent or better mechanical strength and insulation than conductors being spliced.
- N. Use splice and tap connectors which are compatible with conductor material.
- O. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than No. 10 AWG cabled in individual circuits. Make terminations so there is no bare conductor at the terminal.
- P. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturers' published torque tightening values. Where manufacturers' torque requirements are not indicated, tighten connectors and terminals to comply with tightening torque values specified in UL 486A and UL 486B.
- Q. 600 Volt Wire and Cable:
 - 1. The inside of conduits and raceways shall be dry and clean before wires are pulled.
 - 2. Cables shall be supported at the upper end of all risers and at intermediate points as required by the NYC Code. Supports shall be O.Z. Type "R" or approved equal, insulation wedges or Kellems grips.
 - 3. Wire and cable shall be installed in accordance with manufacturer's instructions.
 - 4. Seal, between the wire and conduit with a non hardening compound approved for the purpose, all cable and wire entering a building from underground where cable exits the conduit.
 - 5. Cable spacers shall be installed where required. Spacers shall be conduit fittings for spacing of cables at terminations and shall consist of galvanized or cadmium plates, steel or malleable iron threaded conduit and fittings and inserts of non-metallic insulating material with openings adequate to accommodate cables being spaced. Cable spacers shall be adequate to accommodate cables being spaced. Cable spacers shall be O.Z. Mfg. Co., Inc. Type E or Type EL with grounding lug or approved equal.
 - 6. Install cable limiters at each end of each conductor of more than three (3) paralleled conductors per phase, over 100 ft. in length. Limiters shall be rated 600 volts, 200,000 amps RMS interrupting capacity and shall have waterproof sleeves.
 - 7. Direct burial cables shall be covered with a 1 in. thick by 8 in. wide white-pine board pressure-treated with a non-creasote-type wood preservative, placed over 3 in. layer of clean, well-tamped sand.
 - 8. Under all paving and at crossover of all other utilities, underground cables shall be installed in PVC conduit and encased in concrete.
 - 9. Thermoplastic wires shall not be installed in computer area raised floors.
 - 10. Provide individual raceways for two pole ungrounded circuits.
 - 11. In certain systems, equipment furnished by an approved manufacturer may require a different number and arrangement of conductors from that indicated on the Drawings. In such cases, the Contractor for the work under this Division shall comply with such requirements at no additional cost to the City of New York.
 - 12. In the event the Contractor for the work under this Division or Section chooses to furnish and install a system or item of equipment of different arrangement from that shown or specified, he shall furnish and install any additional wiring and conduit required by the system at no additional cost to the City of New York.

13. In wireways and large pull boxes, lace and tie off conductors in groups of 3 phases and neutral (if used) to limit conductor unbalanced loading. Conductor group shall be as installed in conduits.
14. Tag all feeders and risers in all pull boxes and in all gutter spaces through which they pass. Tags shall be engraved white core nameplates identifying feeders as shown on the Drawings or the circuit protective device from which they originate.
15. Leave all wires with sufficient slack at terminals ends for convenient connections and fixtures and for convenient servicing. Stow loose ends neatly in outlet box.
16. Splices and taps shall be made in accessible boxes, panelboards fittings, gutters, terminal panels, etc. only. Materials shall be compatible with the conductors, insulations and protective jackets on the cables and wires.
17. All copper conductors No. 8 & larger shall be spliced, and tapped with color-keyed compression connectors, as manufactured by Thomas & Betts Co., Series 54000, Ideal Industries Series 87000, or approved equal. The manufacturers recommended tooling shall be used. Mechanical type connectors shall not be used. All copper conductors No. 8 and larger shall be terminated with self crimping, self adjusting, spring action type cable terminators, as manufactured by CYTOLOK or approved.
18. All copper conductors No. 10 AWG & smaller shall be terminated and spliced with Ideal Industries wing-nut wire connectors, or approved equal compression connectors. The nylon self-insulated type shall be used to isolate the terminal from other metal parts and equipment.
19. Splices and joints shall be insulated with materials approved for the particular use, location, voltage, and temperature. Insulation shall be not less than that of the conductors being joined.
20. Plastic electrical insulating tape shall be flame retardant, cold and weather resistant.
21. All circuit and control wiring in cabinets, panels, pullboxes, and junction boxes shall be tied and held with nylon Ty-Rap cable ties as manufactured by Thomas & Betts Co. or approved equal.
22. Wire identification ties fastened to conductors at the point of attachment to terminal blocks and equipment components shall be nylon, self-locking Ty-Raps as manufactured by Thomas & Betts Co., Series Ty-51M, 53M, or approved equal.
23. Cables shall be tagged in all pull boxes, wireways and wiring gutters of panels. Where two or more circuits run to or through a control device, outlet box or junction box, each circuit shall be tagged as a guide in making connections.
24. Tags for feeders shall indicate feeder number, size, phase, voltage, origin and termination. Feeder tags shall identify all phases individually.
25. Tags for control and alarm wiring shall indicate type of control or alarm, size of wire and origin and termination.
26. Tags shall be Thomas Betts Co., Ideal Industries wire-marker dispenser type, self-laminated wire markers.
27. Wire lubricating compound shall be suitable for the wire insulation and conduit with which it is used, and shall not harden or become adhesive. Lubricating compound shall be Ideal Industries, Type Yellow 77, or approved equal. Lubricating compound shall not be used on wire for isolated type electrical power systems.
28. Contractor shall examine the areas and conditions under which wire and cable are to be installed, and notify Commissioner in wiring of conditions detrimental to proper and timely completion of the work.
29. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.3 FIELD QUALITY CONTROL

- A. Prior to energizing, check installed wires and cables with megohm meter to determine insulation resistance levels to assure requirements are fulfilled.

- B. Prior to energizing, test wires and cables for electrical continuity and for short circuits.
- C. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.
- D. Prior to completion of project, an infrared scan of switchgear and panelboard feeder equipment connection shall be performed when all loads are energized.
- E. TABLE I: Color Coding for Phase Identification:
 - 1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

<u>208V/120 Volts</u>	<u>Phase</u>
Black	A
Red	B
Blue	C
White	Neutral
Green	Ground

3.4 FEEDER TESTING

- A. Products
 - 1. Material: Contractor shall provide all necessary testing equipment and devices required to perform the test described in this section.
- B. Execution
 - 1. Visual and Mechanical Inspection
 - a. Inspect cables for physical damage and proper connection in accordance with one-line diagrams.
 - b. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
 - c. Check cable color coding with Table I in this section and National Electrical Code standards.
 - 2. Electrical Tests
 - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
 - b. Perform continuity test to insure proper cable connection.
 - c. Megger conductors phase-to-phase and phase-to-ground for continuity and insulation tests before connection to utilization devices for the following:
 - 1. 100 percent of feeders.
 - 2. 10 percent of branch circuits.
 - 3. 100 percent of 3-phase motor branch circuits.
 - d. Verify phase rotation for all three-phase motor circuits.
 - 3. Test Values
 - a. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.
 - b. Submit results to Engineer for approval in accordance with Section 26 05 02 and 26 05 03.

PART 4 – APPROVED MANUFACTURERS

A. For Wire and Cable:

1. Pirelli
2. Cyprus
3. Phelps Dodge Electric
4. Triangle
5. Okonite

B. For Wire and Cable Termination and Connections:

1. The Thomas and Betts Co.
2. Burndy
3. Elastimold
4. Cytolok

END OF SECTION

SECTION 26 05 26**GROUNDING****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. Division-26 Basic Materials and Methods sections apply to work of this section.
- C. Requirements of this section apply to electrical grounding and bonding work specified elsewhere in these specifications.

1.2 SUMMARY

- A. Extent of electrical grounding and bonding work is indicated by drawings and schedules and as specified herein. Grounding and bonding work is defined to encompass systems, circuits, and equipment.
- B. Type of electrical grounding and bonding work specified in this section includes the following:
 - 1. Solidly grounded.
- C. Applications of electrical grounding and bonding work in this section includes the following:
 - 1. Underground metal piping.
 - 2. Underground metal water piping.
 - 3. Underground metal structures.
 - 4. Building frames - structural steel.
 - 5. Electrical power systems.
 - 6. Grounding electrodes.
 - 7. Separately derived systems.
 - 8. Raceways.
 - 9. Service equipment.
 - 10. Enclosures.
 - 11. Equipment.
 - 12. Lighting Standards.
- D. Refer to other Division-26 sections for wires/cables, electrical raceways, boxes and fittings, and wiring devices which are required in conjunction with electrical grounding and bonding work; not work of this section.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on grounding and bonding products and associated accessories.
- B. Wiring Diagrams: Submit wiring diagrams for electrical grounding and bonding work which indicates layout of ground rods, location of system grounding electrode connections, routing of grounding electrode conductors, also include diagrams for circuits and equipment grounding connections.

- C. Shop drawings shall include splice kits, ground rods, and ground wire.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of grounding and bonding products, of types, and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, grounding electrodes and plate electrodes, and bonding jumpers whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with electrical grounding work similar to that required for project.
- C. Codes and Standards:
 - 1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction, and NEC as applicable to electrical grounding and bonding, pertaining to systems, circuits and equipment.
 - 2. UL Compliance: Comply with applicable requirements of UL Standards No.'s 467, Electrical Grounding and Bonding Equipment", and 869 "Electrical Service Equipment", pertaining to grounding and bonding of systems, circuits and equipment. In addition, comply with UL Std 486A, "Wire Connectors and soldering Lugs for Use with Copper Conductors." Provide grounding and bonding products which are UL-listed and labeled for their intended usage.
 - 3. IEEE Compliance: Comply with applicable requirements and recommended installation practices of IEEE Standards 80, 81, 141 and 142 pertaining to grounding and bonding of systems, circuits and equipment.
 - 4. For patient care area electrical power systems, grounding shall conform to Article 517 of the NEC.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials and Components:
 - 1. Provide electrical grounding and bonding system; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is installer's option. Where materials or components are not indicated provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications indicated.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductors, 1/3 inch (6 mm) in diameter.

5. Bonding Conductor: No. 4 or No. 5 AWG, stranded conductors.
 6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
1. No. 4 AWG minimum, soft-drawn copper.
 2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.
- D. Grounding Bus: Rectangular bars of annealed copper (1/4 by 2 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.3 CONNECTORS

- A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by Cadweld (or approved equal) manufacturer for materials being joined and installation conditions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper clad steel; not less than 3/4 inch by 10 feet (19 mm by 3 m) in diameter.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches (1200 mm) long.
 2. Backfill Material: Electrode manufacturer's recommended material.
- C. Ground clamps shall be bronze, solderless type with bronze screws suitable for receiving required or noted conductors.
- D. Grounding wires shall be UL and NEC approved types, copper, with insulation color identified green, except where otherwise shown on the Drawings, or specified.

PART 3 – EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

- B. **Underground Grounding Conductors:** Install bare tinned copper conductor, No.3/0 AWG minimum.
 - 1. Bury at least 24 inches (600 mm) below grade.
 - 2. **Duct-Bank Grounding Conductor:** Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.
- C. **Isolated Grounding Conductors:** Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. **Grounding Bus:** Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.
- E. **Conductor Terminations and Connections:**
 - 1. **Pipe and Equipment Grounding Conductor Terminations:** Bolted connectors.
 - 2. **Underground Connections:** Welded connectors, except at test wells and as otherwise indicated.
 - 3. **Connections to Ground Rods at Test Wells:** Bolted connectors.
 - 4. **Connections to Structural Steel:** Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits. The conduit shall not be acceptable as an equipment ground.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Armored and metal-clad cable runs.
 - 8. **Computer and Rack-Mounted Electronic Equipment Circuits:** Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
- C. **Air-Duct Equipment Circuits:** Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. **Water Heater:** Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

- E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 EXAMINATION

- A. Examine areas and conditions under which electrical grounding and bonding connections are to be made and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.4 INSTALLATION OF ELECTRICAL GROUNDING AND BONDING SYSTEMS

- A. General: Install electrical grounding and bonding systems in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements.
- B. Coordinate with other electrical work as necessary to interface installation of electrical grounding and bonding system work with other work.
- C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- D. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
 - 3. Where required to obtain the specified ground resistance, install multiple rods.
 - 4. Where rock prevents the driving of vertical ground rods, install grounding electrodes in horizontal trenches to achieve the specified resistance.
- E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment
 - 3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

- F. Grounding and Bonding for Piping: Bond the water piping to the building ground with approved grounding clamps. All ground connections shall be executed with the same thorough workmanship as the connections for normal current carrying parts. The work must be neatly installed, as careless grounding either in appearance or workmanship will be rejected.
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment each unit substation, or each main electrical room grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.
- I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.
1. Install tinned-copper conductor not less than No.4/0 AWG for ground ring and for taps to building steel.
 2. Bury ground ring not less than 24 inches (600 mm) from building foundation.
- J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6m) of bare copper conductor not smaller than No. 4/0 AWG.
1. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.
- K. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torquing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.
- L. Apply corrosion-resistant finish to field-connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.
- M. Install all connectors on clean metal contact surfaces, to ensure electrical conductivity and circuit integrity.

- N. The complete electrical installation shall be permanently and effectively grounded before the water meter and grounded in accordance with all code requirements, whether or not such connections are specifically shown or specified. Measured resistance to ground shall be 5 ohms. maximum.
- O. Parts of the electrical installation to be grounded shall include, but not be limited to, the following: underground distribution, outdoor substation service equipment, electrical service system neutral, conduit system for light and power, switchgear housings, cabinets, housings and neutrals of transformers, motor frames, housings of alarm and control panels and associated devices, lighting fixtures, lightning protection system, emergency distribution system, telephone system, fire alarm system, smoke detection system, communications and security system, busway enclosures, motor control centers, individual starters and other non-current carrying metal parts of electrical equipment.
- P. All copper bars for grounding shall be medium hard drawn. After installation, the copper bar shall be painted with one coat of an approved lacquer.
- Q. Ground conductors shall be of sizes and material in accordance with the requirements of the National Electrical Code. Cable for grounding connections shall be bare in accordance with the latest revisions of ASTM Designations B3 and B8. All open bare grounding cable shall be secured in place with cast and honed malleable clamps and clamp backs, and 1/4 inch bolts.
- R. Ground wires shall be continuous without splices. There shall be no soldered joints in any ground connection. Connectors, clamps, etc. shall be solderless type.
- S. Unless otherwise shown or required, conduit shall provide grounding for motors and electrical equipment.
- T. Ground outdoor electrical equipment to driven ground rods, as required by code.
- U. Ground interrupted metallic raceways with ground conductors connected to metallic raceway at each end.
- V. Separately ground center taps of wye connected transformers in accordance with National Electrical Code (NFPA 70).
- W. Where ground connections will be permanently concealed, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connections.
- X. Service at power company interface points shall comply with the power company ground resistance requirements.
- Y. Connect outdoor fences to the grounding electrode system.

3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of electrical grounding and bonding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 5 ohms, take appropriate action to reduce resistance to 5 ohms, or less, by driving additional ground rods; then retest to demonstrate compliance.
- B. Inspect all connections prior to concealing same.

PART 4 – APPROVED MANUFACTURERS

A. For ground rods.

1. Carolina Galvanizing.
2. Weaver Electric

END OF SECTION

SECTION 26 05 29
SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. Related Sections: The following Sections contain requirements that related to this Section:
 - 1. Division 3 Section "Cast-In-Place Concrete" for inserts, anchors, and sleeves to be installed in concrete for use with supporting devices.
 - 2. Division 5 Section "Metal Fabrications" for requirements for miscellaneous metal items involved in supports and fastenings.
 - 3. Division 7 Section "Firestopping" for requirements for firestopping at sleeves through walls and floors that are fire barriers.
 - 4. Refer to Division 26 Sections for additional specific support requirements that may be applicable to specific items.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and General Conditions Specification Sections.
- B. Product data for each type of product specified.
 - 1. Hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.
- C. Shop drawings indicating details of fabricated products and materials.
- D. Engineered Design consisting of details and engineering analysis for supports for the following items:
 - 1. Conduit (racked)
 - 2. Ceiling mounted boxes, transformers.
 - 3. Conduit - Ceiling mounted, concrete encased.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with local codes as well as NFPA 70 "National Electrical Code."
- B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
- C. Installation shall comply with local authorities seismic requirements.

PART 2 - PRODUCTS**2.1 COATINGS**

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

2.2 MANUFACTURED SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.
- B. Fasteners: Types, materials, and construction features as follows:
 - 1. Expansion Anchors: Carbon steel wedge or sleeve type.
 - 2. Toggle Bolts: All steel springhead type.
- C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.
- E. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.3 FABRICATED SUPPORTING DEVICES

- A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.
- B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Install supporting devices to fasten electrical components securely and permanently in accordance with local codes and NEC requirements.
- B. Coordinate with the building structural system and with other electrical installation.
- C. Raceway Supports: Comply with local codes, the NEC and the following requirements:
 - 1. Conform to manufacturer's recommendations for selection and installation of supports.
 - 2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 lbs., provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.
 - 3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 - 4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
 - 5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring fasteners that are specifically designed for supporting single conduits or tubing.
 - 6. Space supports for raceway in accordance with NEC.
 - 7. Support exposed and concealed raceway within 1 foot of an unsupported box and access fittings. In horizontal runs, supports at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminals are not made with chase nipples or threadless box connectors.
 - 8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.
- D. Vertical Conductor Supports: Install simultaneously with installation of conductors (i.e., strain reliefs).
- E. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- F. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.
- G. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and wall for raceways and cable installations. For sleeves through fire-rated wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Stopping" requirement of Division 7.

- H. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- I. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:
 - 1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions or light steel construction, use sheet metal screws.
 - 2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
 - 3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
- J. TESTS: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
 - 1. Expansion anchors.
 - 2. Toggle bolts.

Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

NOTES:

- 1. Maximum spacing of supports (feet).
- 2. Maximum spacing for IMC applies to straight runs only. Otherwise the maximum of EMT applies.
- 3. Support for cable tray shall be as directed in their respective sections.

END OF SECTION

SECTION 26 05 33**RACEWAYS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this section.
- B. Requirements of the following Division 26 Sections apply to this Section:
 - 1. "Electrical Requirements."

1.2 SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
 - 1. Electrical metallic tubing (EMT).
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit (IMC).
 - 4. Liquid-tight flexible conduit.
 - 5. Rigid metallic conduit (RMC).
 - 6. Metal clad cable (MC).
 - 7. Surface raceways.
 - 8. Rigid non-metallic conduit.
 - 9. Electrical non-metallic tubing (ENT)
 - 10. Wireway.
- B. Related Sections: The following section contains requirements that relate to this section:
 - 1. Division 26 Section "Electrical Boxes and Fittings" for conduit connectors, fittings, and couplings.
 - 2. Division 7 Section "Firestopping" for conduit penetrations through rated walls and slabs.

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of contract and General Conditions Specification Section.
- B. Product Data for the following products:
 - 1. Raceways and fittings.
 - 2. Wireways and fittings.
- C. Installation Instructions: Manufacturer's written installation instructions for wireway, surface raceway, and nonmetallic raceway products.

1.4 QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL.
- D. Manufacturers - Firm regularly engaged in manufacture of raceways of types and capacities required and whose products have been in satisfactory use in similar service for not less than 5 years.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Rigid Steel Conduit: ANSI C80.1
 - 1. Shall be full weight steel pipe, hot dip galvanized inside and outside, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- B. Intermediate Steel Conduit: UL 1242.
 - 1. Shall be intermediate steel pipe, hot dip galvanized, threaded, minimum 3/4 inch.
 - 2. Shall be painted with two protective coats of asphaltum compound where located underground or below slab.
- C. Electrical Metallic Tubing and Fittings: ANSI C80.3.
 - 1. Shall be thin wall steel pipe, galvanized, threadless, minimum 3/4 inch, maximum 2 inch. EMT shall not be used for cable rated above 600 volts.
- D. Flexible Metal Conduit: UL 1, zinc-coated steel.
 - 1. Shall be continuous single strip, galvanized, minimum 3/4 inch.
- E. Liquid-tight Flexible Metal Conduit and Fittings: UL 360.
 - 1. Liquid-tight, flexible steel, conduits shall be zinc coated flexible galvanized steel tubing over which is extruded a liquid- tight jacket of polyvinyl chloride (PVC). Conduit shall be provided with a continuous copper bonding conductor wound spirally between the convolutions.
- F. Rigid Aluminum Conduit:
 - 1. Rigid aluminum conduit shall be full weight pipe, threaded, minimum 3/4 inch.

2.2 METAL CLAD CABLE, TYPE MC

- A. The multi-conductor metal clad cable shall comply with UL 1569 "Metal Clad, Type MC," UL 83 "Thermoplastic Insulated Wires and Cables" Federal Specification J-C-30B "Wire and Cable," Local and National Electrical Codes.

- B. The metal clad cable shall be THHN insulation, copper conductors in sizes #12 through #8 AWG only for continuous operation at a maximum conductor temperature of 90 degree C dry.
- C. These cables shall bear appropriate Underwriters Laboratories labels for metal clad cable and be suitable for use as branch circuits in both exposed and concealed work in accordance with applicable sections of the National Electrical Code.
- D. An insulated grounding conductor sized in accordance with Table 5.3 Underwriter's Standard UL 1569 shall be cabled with the circuit conductors and shall be identified in compliance with Section 29 of UL 1569. The grounding conductor shall not be smaller than size indicated in NEC Article Table 250.122.
- E. A galvanized steel or aluminum armor shall be applied over the inner cable assembly with a positive interlock in compliance with Section 10 of UL 1569. A PVC jacket shall completely cover the steel or aluminum armor when installed in the slab.

2.3 NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.
 - 1. Shall be self-extinguishing, UL listed.
 - 2. Where noted as concrete encased, it shall be thin wall, type EB.
 - 3. Located in building interiors and direct burial, shall be heavy wall, Schedule 40.
- C. Conduit, Tubing and Duct Accessories: Types, sizes and materials complying with manufacturer's published product information. Mate and match accessories with raceway.
- D. Electrical non-metallic tubing (ENT): NEMA TC13 and UL1653.

2.4 CONDUIT BODIES AND FITTINGS

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
 - 1. Metallic conduit fittings shall be corrosion resistant.
- C. EMT Conduit Bodies: Use bodies with steel set screw connectors and couplings for interior applications and steel compression gland connectors and couplings for exterior applications.
 - 1. Material shall be steel or malleable iron only.
 - 2. Couplings and connectors shall be "concrete tight" or "raintight", couplings and connectors for conduit sizes 2-inch and smaller shall be of the gland and ring compression type. Connectors shall have insulated throats.
 - 3. Set screw or indent type connectors are not permitted. Compression waterproof connection type fittings only shall be utilized.
- D. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL514B.

- E. Liquid-Tight Flexible Conduit Fittings: With threaded grounding cone, a steel, nylon or equal plastic compression ring, and a gland for tightening. Either steel or malleable iron only with insulated throats and male thread and locknut or male bushing with or without O-ring seal. Each connector shall provide a low resistance ground connection between the flexible conduit and the outlet box, conduit or other equipment to which it is connected.
- F. Bushings: Insulated type, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system, for rigid steel conduit and IMC – and EMT, larger than $\frac{3}{4}$ " size.
 - 1. Bushings shall be of the metallic insulated type.
- G. Expansion Fittings: Each conduit that is buried in or secured to the buildings construction on opposite sides of a building expansion joint and each long run of exposed conduit that may be subject to excessive stresses shall be provided with an expansion fitting. Expansion fittings for rigid steel conduit shall be hot-dipped galvanized malleable iron with factory installed packing and a grounding ring. Expansion fittings for rigid non-metallic conduit shall be of the short type in runs 25' or less, and the long type in runs 26' to 80'. The long type shall be a two piece barrel and piston joint, providing 6" of the total movement range in $\frac{3}{4}$ " through 6" conduit sizes. The short type shall be a one piece, coupling with O-ring, providing 2" of total movement range in $\frac{3}{4}$ " to 2" conduit sizes.
 - 1. Shall comply with UL 467 and UL 514 and shall accommodate, 0.75 inch deflection, expansion, or contraction in any direction, and shall allow 30 degree angular deflections.
 - 2. Shall include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents in accordance with UL 467, and the NEC tables for ground conductors.
 - 3. Shall be watertight, seismically qualified, corrosion- resistant, threaded for and compatible with rigid or intermediate metal conduit.
 - 4. Jacket shall be flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- H. Seal Off Fittings: Threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.
- I. For weatherproof and dust-tight installations provide liquid-tight fittings with sealing ring and insulated throat.
- J. Set screw fittings are not acceptable.
- K. Rigid steel and IMC conduit fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be steel or malleable iron only.
 - 2. Locknuts shall be of the bonding type with sharp edges for digging into the metal wall of an enclosure.
 - 3. Bushings shall be of the metallic insulating type, and shall consist of an insulating insert molded or locked into the metallic body of the fitting. Bushings made entirely of metal or nonmetallic material are not permitted.
 - 4. Sealing fittings shall be of the threaded cast iron type. Sealing fittings used to prevent passage of water vapor shall be of the continuous drain type. In concealed work, each fitting shall be installed in a flush steel box with blank coverplate having the same finish as that of other electrical plates in the room.

- L. Rigid aluminum conduit fittings:
 - 1. Fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper.
 - 2. Locknuts and bushings shall be as specified for rigid steel and IMC conduit.
 - 3. Set screw fittings shall not be used with aluminum conduit.
- M. Direct burial plastic conduit fittings shall be as recommended by the conduit manufacturer.
 - 1. Surface metal raceway fittings shall be as recommended by the raceway manufacturer.
- N. Flexible steel conduit (Greenfield) fittings:
 - 1. Material shall be steel or malleable iron only.
 - 2. Shall be multiple point type, threading into the internal wall of the conduit convolutions, and shall have insulated throat.

2.5 WIREWAYS

- A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC. Wireways shall be steel and of sizes noted and shall have a minimum of No. 16 gauge thickness.
- B. Wireway covers shall be hinged type.

2.6 SURFACE RACEWAYS

- A. General: Sizes and channels as indicated. Provide fittings that match and mate with raceway. Provide internal barriers for areas with power and communications sections. Shall be steel with baked enamel finish, of sizes noted, and a minimum of No. 20 gauge thickness.
- B. Surface Metal Raceway: Construct of two piece galvanized steel with snap-on covers, with 9/32-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required. Sizes 1-3/4" H x 4-3/4" W.
- C. Provide labeling for each outlet with panel and circuit number where multi-outlet raceways are utilized.
- D. Accessories:
 - 1. Couplings for joining raceway sections.
 - 2. Wire clips for conductors.
 - 3. Blank end fittings.
 - 4. Circuit breaker housings for single pole breakers.
 - 5. Device brackets for single or two gang devices.
 - 6. Combination receptacle and telephone outlet covers.
 - 7. Outlet boxes with hubs for conduit connectors.

- E. Covers for the surface metal raceways shall be snap-on type, unless otherwise noted.

2.7 CONDUIT SUPPORTS:

- A. All parts and hardware shall be zinc-coated or have equivalent corrosion protection.
- B. Individual conduit hangers shall be designed for the purpose, with pre-assembled closure bolt and nut, and provisions for receiving hanger rod.
- C. Multiple conduit (trapeze) hangers shall be of not less than 1-1/2 by 1-1/2 inch, 12 gage steel, cold formed, lipped channels. Hanger rods shall be not less than 3/8-inch diameter steel.
- D. Solid masonry and concrete anchors shall be a type approved for the purpose.

2.8 SLEEVES

- A. Provide and assume responsibility for locating and maintaining in proper position all sleeves required for the work.
- B. For raceways in sleeves, provide seals of oakum packing and lead or O.Z. Type WSK series compound on both sides.
- C. For cables through sleeves, provide seals similar to O.Z. Type WSCS compound.
- D. Through floors, exterior masonry walls, roof, and underground, sleeves shall be schedule 40 galvanized steel pipe. For area not requiring schedule 40 pipe, sleeves shall be 18 gauge galvanized sheet steel.

2.9 CONCRETE MARKERS

- A. Provide over all underground raceway bends and terminations, cylindrical concrete columns markers. The markers shall be 5 in. diameter and 18 in. deep and shall have imbedded marked bronze plate noting the direction of the raceway.

2.10 FIRE SEALANTS

- A. Openings through floors and walls in which cables, conduits, or pipe pass shall be sealed by U.L. classified smoke and fire stop fittings, and have an hourly rating equal to the fire rating of the floor or wall. Fittings shall be similar to O-Z Gedney Type "CES" or "CAFS".
- B. Penetrations through fire-rated floors in which wiring for floor service outlets are routed shall be sealed by U.L. classified smoke and fire-stop fittings, and shall have an hourly rating equal to the floor rating. Fittings shall be similar to O-Z Gedney Type "PTFS".

2.11 BOXES

- A. Outlet Boxes
 - 1. Outlet boxes for concealed work shall be galvanized steel, 4 in. square or octagon (except as otherwise required by construction, devices or wiring) and as follows:
 - a. Above ceiling: 1-1/2 in. deep.
 - b. In ceiling or slab: 3 in. deep.
 - c. In wall for fixtures: 2-3/4 in. deep.
 - d. In wall for receptacles and switches: 1-1/2 in. deep.

- e. With raised covers and fixtures studs where required.
- f. Through-the-wall type are not permitted.
- 2. Outlet boxes for exposed work shall be galvanized cast iron or aluminum with threaded hubs. Except as otherwise required by construction, devices or wiring the outlet boxes shall be in 4 in. round x 2 in. deep for mounting on ceilings and 4 in. square x 2 in. deep for mounting on walls.
- 3. Outlet boxes located outdoors and damp locations shall be weatherproof.
- 4. Outlet boxes without fixture or device, shall have blank cover.
- 5. Offset back-to-back outlets, shall have minimum 6 in. separation between them.
- 6. Extension rings shall be provided as required to suit various conditions.
- 7. Grounding screw and cable wiring connector shall be provided as required by wiring method.

2.12 JUNCTION AND PULL BOXES

- A. Junction and pull boxes shall be made of galvanized sheet steel and with screw-on covers, except as noted, and will include insulated supports for cables.
- B. Provide junction and/or pull boxes as noted or as required. All junction and pull boxes shall be accessible.
- C. Junction and pull boxes located outdoors and in damp locations shall be galvanized cast iron with threaded hubs and gaskets.

2.13 FLOOR BOXES

- 1. Floor boxes shall be galvanized cast iron watertight, corrosion-resistant with brass covers and flanges. They shall be suitable for the conduits and the devices noted. Floor Boxes shall be similar to Hubbell Dualevel Series.
- 2. Flush poke-thru fire rated fittings shall be utilized where indicated on the drawings. Poke-thru fitting shall be adaptable for flush mounted duplex receptacle, combination receptacle/telephone jack or conduit adapter (flex) for power and communications. Fitting shall be similar to that as manufactured by Raceway Components Inc.

PART 3 - EXECUTION

3.1 WIRING METHOD

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: Intermediate metal conduit, rigid steel conduit.
 - 2. Concealed: Intermediate metal conduit, rigid steel conduit.
 - 3. Underground, Single Run: Rigid non-metallic conduit.
 - 4. Underground, Grouped: Rigid non-metallic conduit.
 - 5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
- B. Indoors: Use the following wiring methods:
 - 1. Exposed (below 10 ft. to floor): Intermediate metal conduit, rigid steel conduit.
 - 2. Exposed (above 10ft. or in electrical room): Electrical metallic tubing.
 - 3. Concealed: Electrical metallic tubing.

4. Concealed: Metal clad cable will be allowed as final branch wiring of receptacles and light fixtures (maximum total length of 50' from homerun J-box or hard piped J-box to outlet). MC is not allowed for homeruns to panels, connections to mechanical equipment. Maximum conductor size is in MC cable #8 AWG.
5. Connection to Vibrating Equipment including transformers, pneumatic or electrical solenoid, and motor-operated equipment: Flexible metal conduit.
6. Connection to Vibrating Equipment in Moist/Humid or Corrosive Atmosphere including pneumatic or electric solenoid, and motor-operated equipment: Liquid-tight flexible metal conduit.
7. Within concrete slabs: electrical non-metallic tubing, PVC coated MC cable, or rigid non-metallic conduit. PVC coated MC cable is not allowed for homeruns. Maximum sizes and locations as approved by the Structural Engineer.

3.2 INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturers' written installation instructions, applicable requirements of NEC, and as follows.
- B. Conceal conduit and EMT, unless indicated otherwise, within finished wall, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.
- C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.
- D. Complete installation of electrical raceways before starting installation of conductors within raceways.
- E. Provide supports for raceways as specified elsewhere in Division 26 and in accordance with NEC and local authorities seismic requirements.
- F. Prevent foreign matter from entering raceways by using temporary closure protection.
- G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab. All elbow penetration through the slab shall be PVC coated rigid metallic conduit Ells.
- H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated.
- J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated.
- K. Raceways embedded in slabs shall only be permitted with the strict written approval of the Structural Engineer and Commissioner.
- L. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical. All exposed conduit runs shall be approved by the Commissioner prior to installing.

- M. All exposed conduits in public areas shall be painted to match surrounding walls. Verify exact color with the Commissioner. Painting specified herein shall be provided by others.
- N. Run exposed, parallel, or banked raceways together. Make bends in parallel or banked runs from the same center line so that the bends are parallel. Factory elbows may be used in banked runs only where they can be installed parallel. This requires that there be a change in the plane of the run such as from wall to ceiling and that the raceways be of the same size. In other cases, provide field bends for parallel raceways. All exposed conduit routing shall be approved by the Commissioner prior to installing.
- O. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors. Use expansion fittings at building expansion joints.
- P. Tighten set screws of threadless fittings with suitable tool.
- Q. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with concave side against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside of the box. All conduit connections to junction boxes shall have insulated bushings.
- R. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- S. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave no less than 12 inches of slack at each end of the pull wire.
- T. Telephone and Signal System Raceways: In addition to the above requirements, raceways 2-inches and smaller, shall have a maximum length of 150 feet with a maximum of two 90° bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.
- U. Install raceway sealing fittings in accordance with the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
 - 1. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces, air-conditioned spaces and walk-in coolers.
 - 2. Where required by the NEC.
- V. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver-operated threaded flush plugs flush with floor.

- W. Flexible connection: Use length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid-tight flexible conduit in wet locations. Install separate equipment grounding conductor across flexible connections.
- X. Install nonferrous conduit or tubing for circuits operating above 60 Hz.
- Y. PVC externally coated rigid steel conduit: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduit.
- Z. All underground conduits shall be installed a minimum of 48 inches below finish grade for primary medium voltage feeders and 30 inches for 480 volt feeders. All other conduits shall be installed in accordance with the NEC and coordinated depth with other trades.
- AA. Grounding: Install a separate green equipment grounding conductor in all raceways from the panelboard/junction box supplying the raceway to the receptacle or equipment ground terminals. Conduits will not be permitted as a ground conductor.

3.3 RACEWAYS

- A. Install conduit and tubing products as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with the recognized industry practices to ensure that products serve intended function.
- B. Run raceways concealed, except as noted. Exposed raceways shall be run parallel with or at right angles to walls.
- C. Raceways supports shall be provided by means of ceiling trapeze, strap hangers, or wall brackets, structural steel angles or channels. Provide U-bolts at each floor level or riser raceways and connected to acceptable supports. Secure raceways to supports with pipe straps or U-bolts. Spacing of support shall be as per NEC and per manufacturer's recommendations.
- D. Mount supports to structure with toggle bolts on hollow masonry, expansion shields or inserts on concrete and brick, machine screws on metal, wood screws on wood. Nails, rawl plugs or wood plugs are not permitted.
- E. Allow a 6 in. minimum separation between raceways and steam and hot water pipes. Provide approved thermal insulation for electric lines where this separation cannot be maintained.
- F. Keep raceways clear of motor foundations and from underside of boilers. Also, install raceway so that they will not obstruct headroom, doorways, or walkways.
- G. For outlets located in hung ceilings, run raceways in hung ceilings and support from structure above. For lay-in ceilings, install conduits high enough to permit removal of ceiling tiles.
- H. In walls, run raceways vertically only.
- I. Mechanically join all metal raceways, enclosures and junction boxes to form a continuous electrical conductor. Connect all electrical boxes, fittings and cabinets so as to provide effective electrical continuity and firm mechanical assembly. Maintain grounding continuity of interrupted metallic raceways with ground conductor.

- J. Install complete conduit runs before pulling in wire or cable. Install raceways so that required conductors may be drawn in without injury or excessive strain to raceway or cable. Where raceway size is not indicated, follow applicable code.
- K. Do not cross pipe shafts or ventilation duct openings with raceway. Route raceway to avoid present or future openings in floor, wall or ceiling construction, when so indicated on the drawings.
- L. Keep end of raceways plugged or capped during construction.
- M. For empty raceways over 10 ft. long, provide fish or pull wire. Pull wire shall consist of steel core nylon rope and terminal ball.
- N. Concrete encased conduits run exposed inside the building shall have Class I concrete encasement. They shall be marked (stenciled) 10 ft. on centers, including in hung ceiling, with the notations, "Danger, High Voltage".
- O. Damaged or deformed raceway is not permitted and shall be removed.
- P. Branch circuit conduits shall not be supported by the suspended ceiling or its supporting members, lighting fixtures, mechanical piping, or air-conditioning ducts.
- Q. Wiring 600 volts above, shall be installed in rigid steel conduit.
- R. Conduits located underground beyond the building shall be installed as follows:
 - 1. With a minimum of 24 in. top cover, above the conduits, and sloped away from the building.
 - 2. Placed over well-tamped trench bottom and on concrete blocks 5 ft. on center. Conduits shall be anchored to prevent their movement. Conduit joints shall be staggered a minimum of 6 in. apart. All joints shall be watertight.
 - 3. With a minimum separation between the electric and telephone conduits of 12 in. of well tamped earth or 6 in. of concrete.
 - 4. With entry into manholes through end bells.
- S. For conduits and direct burial cable entering the building, and for the manholes preceding the conduits entry to the building, perform the following:
 - 1. Plug all empty raceways.
 - 2. Enter through floor or wall entrance fittings. The entrance fittings shall have a gland assembly which shall be capable of providing a seal around the conduit or cable to withstand 50 foot head of water without leakage. For greater than 50 foot head, the sealing assembly shall be similar to O-Z Gedney Type "FSK" or "FSCS".
- T. Work with extreme care near existing ducts, conduits, cables and other utilities to avoid damaging them.
- U. Rigid steel conduit:
 - 1. Rigid steel conduit shall be used for underground installation, in wet or damp locations, for exposed runs on the exterior of the building, in concrete slabs, for all feeder conduits, in mechanical equipment spaces, for fire alarm systems; for smoke, sprinkler, and fire detection systems, and as noted.

2. Paint male threads of field threaded conduit with graphite base pipe compound.
 - a. Where located in slabs, the maximum outside diameter of the conduit shall be less than $\frac{1}{3}$ the slab thickness. When locating in the slab, place conduits in a manner so as to interfere with the placement of reinforcing bars or cause damage to structural members or structural support.
 - b. Where located in concrete fill, the conduit shall have a minimum of 1 in. cover.
 - c. In terrazzo floor finish, rigid steel conduit is not permitted.
 - d. Where conduit is directly buried, provide two coats of asphaltum paint. Dry thoroughly between paintings and before backfilling.
 - e. Where located under the building, conduit shall be concrete encased.

V. Intermediate metal conduit:

1. Where applicable and permissible by New York City Electrical Code, the selective use of Intermediate Metal Conduit may be submitted to the Commissioner for consideration and approval.
2. Paint male threads of field threaded conduit with graphite base pipe compounds.
3. Where located in slabs, the maximum outside diameter of the conduit shall be less than $\frac{1}{3}$ the slab thickness. When locating conduit in the slab, place conduits in a manner so as not to interfere with the placement of reinforcing rods or cause damage to structural members of structural support.
4. Where located in concrete fill, the conduit shall have a minimum of 1 in. cover.
5. In terrazzo floor finish, intermediate metal conduit is not permitted.
6. Where located under the building, conduit shall be concrete encased.
7. IMC shall not be used in hazardous areas or for direct burial.
8. IMC shall not be used for service cables installed by Utility Co.

W. Electric metallic tubing (EMT):

1. EMT is permitted to be used with the following limitations: for branch circuits only, and in dry locations (hung ceilings, hollow block walls and furred spaces).
2. EMT is not permitted to be used in mechanical equipment spaces, for fire alarm system, for smoke and fire detection system.

X. Flexible steel conduit:

1. Flexible steel conduit "Greenfield", shall be used for the following applications: for short connections where rigid conduit or tubing is impracticable, from outlet box to recessed lighting fixture with minimum length of 4 ft. and a maximum length of 6 ft., and for final connections to vibrating equipment other than motors and transformers in dry locations only.
2. For final connections to motor terminal boxes, transformers and other vibrating equipment, the flexible steel conduit shall have polyvinyl sheathing "Sealtite" and a ground conductor. The minimum length of the flexible conduit shall be 18 in. with slack. Connect the ground conductor to the enclosure or raceway at each end.

Y. Aluminum conduit:

1. Shall not be used in or on concrete or masonry, and shall not be used in wet locations.
2. Where routed through concrete and masonry walls and floors, conduit shall be painted with asphaltum.

3. Maintain clearance between aluminum conduits and surfaces for the following conditions: in moist locations, in interior spaces below exterior finished grade, and boiler rooms.
 4. When connecting to steel surfaces, maintain galvanized-to-aluminum contact, or paint with asphalt base paint.
- Z. Polyvinyl chloride conduit (PVC):
1. Cut ends square, ream smooth, wipe clean, apply approved solvent cement and quarter turn as drawing up tight.
 2. Convert to steel conduit using adaptors when entering the building from underground locations.
 3. Maintain a 3 ft. minimum clearance of PVC conduits from hot water and steam lines.
- AA. Surface metal raceways shall be used only where shown on the drawings or as directed by the Commissioner.
- BB. Provide expansion-deflection fittings at expansion joints and on length of runs in accordance with manufacturer's recommendations. Expansion-deflection fittings shall be of size as required complete with bonding jumper.
- CC. For Wet, Damp, or Moist Locations:
1. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, much as refrigerated spaces, air conditioned spaces, or similar spaces.

3.4 SLEEVES

- A. Sleeves shall be provided in accordance with the following guidelines:
1. Set required sleeves and inserts in place during progress of construction to avoid cutting of completed work.
 2. Provide sleeves for raceway passing through floors and foundations. Determine exact location of sleeves in field to avoid interference with structural members or equipment of all trades.
 3. Install sleeves rigidly so that proper position and alignment will be maintained during construction and pouring of concrete.

3.5 FIRE STOPS

- A. Where wiring, conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, or floors, install an approved fire-stop that provides an effective barrier against the spread of fire, smoke and gases. Fire-stop material shall be packed tight and shall completely fill clearances between raceways and openings.
- B. Floor, exterior wall, and roof seals shall also be made watertight.

3.6 OUTLET BOXES

- A. Set boxes square and true with the building finish. Boxes shall be secured to the building structure by adjustable strap irons.

- B. Verify outlet locations in finished spaces with Architectural Drawings of interior details and finishes. Take caution in locating outlet to allow for overhead pipes, ducts, and variations in arrangement, thickness in finish, window trim and other Architectural Construction Details.
- C. Correct any inaccuracy in locating outlets without additional expense to the City of New York. Refer to Commissioner any condition that would place an outlet box in an unsuitable location, such as a molding, break glass in wall finish, or behind radiator.
- D. Mount outlet boxes for similar equipment at uniform height within same or similar areas. Where mounting height or location of outlets is not shown or specified, mount outlet as best suited for equipment connected thereto, or as directed.
- E. Close all unused openings in outlet boxes with knockout closers manufactured for this purpose. Provide blank plates on outlet boxes in which no device is installed or device installed does not provide a suitable cover.
- F. Provide barriers between switches connected to different phases for voltages exceeding 150 volts to ground.
- G. Outlet boxes for fixtures recessed in hung ceilings, shall be accessible through the opening created by the removal of the fixture.
- H. Securely fasten exposed outlet boxes by attaching to permanent inserts or lead anchors with machine screws. Adequately support all boxes during construction to prevent movement.
- I. Boxes for concealed work shall be pressed steel galvanized and shall conform to UL's "Standard for Outlet Boxes and Fittings." Outlet boxes shall be provided with a galvanized steel cover or extension ring depth as required.
- J. All ceiling fixture outlet boxes, except as noted, shall be 4" octagonal and 1-5/8" deep and with 3/8" fixture stud. Where cast in slab, boxes shall be open back concrete type.
- K. Wall bracket outlets shall be 4" square and 1-5/8" deep with cover having 2-7/8" round openings and except for lampholders shall be furnished with fixture stud.
- L. Junction outlets shall be the same as bracket outlets but without stud, furnished with covers to suit each condition and as directed. Where number of conductors exceed capacity of standard box, provide special size box.
- M. All outlet boxes for concealed convenience receptacles or local switches shall be 4" square and 1-5/8" deep with regular deep switch extension cover, except where installed on columns they shall be of sufficient depth so that conduits may be installed into these boxes in back of fireproofing. Outlet boxes for gang receptacles and switches shall suit space conditions.
- N. Boxes for use with surface mounted raceways shall be of the same construction and manufacture as the raceway.
- O. Boxes shall be of the cast type for switches and receptacles when installed on the exterior of the project. Such boxes shall be aluminum or malleable iron of the threaded hub type, with covers without projecting edges or corners and with openings suitable for the devices to be contained therein. Outlet boxes and covers shall be galvanized or anodized and shall be gasketed.

- P. Except where special outlets are required, wall outlets for signaling systems shall be 4" square with single gang raised cover and bushed plate.
- Q. Panel, junction and pull boxes:
 - 1. Panel, junction and pull boxes shall be located clear of other trades equipment, accessible, supported from the building structure, and independent of the conduits.
 - 2. Conceal junction and pull boxes in finished spaces.
 - 3. Coordinate size of motor terminal boxes with motor branch circuit conduit and wiring.

3.7 ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

3.8 FIELD QUALITY CONTROL

- A. Contractor shall perform continuity tests by testing the resistance of all feeder conduits from the service to the point of their final distribution using 1 conductor return. The maximum resistance shall be 25 ohms.

END OF SECTION

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SECTION 26 05 34**ELECTRICAL BOXES AND FITTINGS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. This section is a Division 26 Basic Electrical Material and Methods section, and is a part of each Division 26 section making reference to electrical wiring boxes and fittings specified herein.

1.2 DESCRIPTION OF WORK

- A. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the National Electric Code.
- B. Types of electrical boxes and fittings specified in this section include the following:
 - 1. Outlet boxes.
 - 2. Junction boxes.
 - 3. Pull boxes.
 - 4. Bushings.
 - 5. Locknuts.
 - 6. Knockout closures.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical boxes and fittings, of types, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects utilizing electrical boxes and fittings similar to those required for this project.
- C. Local Code and NEC Compliance: Comply with local code and NEC as applicable to construction and installation of electrical wiring boxes and fittings.
- D. UL Compliance: Comply with applicable requirements of UL 50, UL 514-Series, and UL 886 pertaining to electrical boxes and fittings. Provide electrical boxes and fittings which are UL-listed and labeled.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub No.'s OS1, OS2 and PUB 250 pertaining to outlet and device boxes, covers and box supports.
- F. Federal Specification Compliance: Comply with applicable requirements of FS W-C 586, "Electrical Cast Metal Conduit Outlet Boxes, Bodies, and Entrance Caps."

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical boxes and fittings.

- B. Shop Drawings: Submit layout drawings of electrical floor, junction and pull boxes showing accurately scaled box layouts and their spatial relationship to associated equipment.

PART 2 - PRODUCTS

2.1 FABRICATED MATERIALS

- A. Outlet Boxes: Provide galvanized flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities, and sizes (minimum 4 inch square, 1 ½ inch deep), including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes, and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.
 - 1. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- B. Device Boxes: Provide galvanized coated flat rolled sheet-steel non-gangable device boxes, of shapes, cubic inch capacities, and sizes (minimum 4 inch square, 1 ½ inches deep), including box depths as indicated, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with conduit-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide conduit connectors and corrosion-resistant screws for equipment type grounding.
 - 1. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, plaster ears, and plaster ears, and plasterboard expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations. Choice of accessories is Installer's code-compliance option.
- C. Raintight Outlet Boxes: Provide corrosion-resistant cast-metal raintight outlet wiring boxes, of types, shapes and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast-metal face plates with spring-hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners.
- D. Junction and Pull Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws, and washers. Pull boxes installed in finished spaces must be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match flush mounted panelboard trim.
- E. Exterior junction or pull boxes, flush with grade:
 - 1. Junction or pull box to be mounted flush with grade shall be polymer composite raintight with screw cover lids. Box dimensions shall be 30"W x 48"L x 36"D. Covers shall be polymer composite suitable for pedestrian traffic secured to box with stainless steel screws. Box to be furnished with continuous neoprene gasket to seal cover. Conduit entry shall be on side of box with bell ends.
- F. Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant box knockout closures, conduit locknuts and malleable iron conduit bushings, offset connectors, of types and sizes, to suit respective installation requirements and applications.

PART 3 - EXECUTION**3.1 INSTALLATION OF ELECTRICAL BOXES AND FITTINGS**

- A. General: Install electrical boxes and fittings in accordance with manufacturer's written instructions, applicable requirements of local codes, NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
- C. Provide raintight "in use" outlets for interior and exterior locations exposed to weather or moisture.
- D. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- E. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring.
- F. Installing boxes back-to-back in walls shall not be permitted. Provide no less than 12 inches (150 mm) of separation.
- G. Position recessed outlet boxes accurately to allow for surface finish thickness.
- H. Avoid using round boxes where conduit must enter box through side of box, which would result in difficult and insecure connections when fastened with locknut or bushing on rounded surfaces.
- I. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embedded electrical boxes in concrete or masonry.
- J. Provide electrical connections for installed boxes.
- K. Exterior junction or pull boxes shall be mounted flush with grade, unless noted otherwise or indicated to be above ground on the drawings. Boxes shall be surrounded on all sides with 6 inches minimum of concrete. Top of concrete shall flush with grade. Seal all conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
- L. Tap and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.
- M. Subsequent to installation of boxes, protect boxes from construction debris and damage.

3.2 GROUNDING

- A. Upon completion of installation work, properly ground electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 26 05 48**VIBRATION ISOLATION SYSTEMS****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the drawings and as specified herein to provide complete vibration isolation systems in proper working order.

1.2 MATERIAL AND EQUIPMENT

- A. All vibration isolation mounts shall be supplied by one of the approved manufacturers stated in the PRODUCTS Section of this specification. Substitutions of equal equipment beyond the alternatives listed will be permitted only with the written permission of the Commissioner. Accompany each request for acceptance of substitute equipment with manufacturer's certified data proving the equivalence of the proposed substitute in quality and performance. The Commissioner shall be the final judge of the validity of the data submitted.
- B. Unless otherwise specified, supply only new equipment, parts, and materials.

1.3 SUBMITTALS

- A. Refer to related sections elsewhere for procedural instructions for submittals.
- B. The shop drawing submittal for isolated electrical equipment shall include submittal information for the isolation mounts. Information supplied shall be as follows:
 - 1. A complete description of products to be supplied including product data, dimensions, specifications, and installation instructions.
 - 2. Detailed selection data for each vibration isolator supporting equipment, including:
 - a. The equipment identification mark.
 - b. The isolator type.
 - c. The actual load.
- C. Submission of samples may be requested for each type of vibration isolation device. After approval, samples will be returned for installation at the job. All costs associated with submission of samples shall be borne by the Contractor.

1.4 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified requirements.
- C. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

- E. Should any electrical equipment cause excessive noise or vibration, the Contractor shall be responsible for remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.
- F. Upon completion of the work, the Commissioner shall inspect the installation and shall inform the installing contractor of any further work that must be completed. Make all adjustments as directed by the Commissioner that result from the final inspection. This work shall be done before vibration isolation systems are accepted.

PART 2 - PRODUCTS

2.1 FLEXIBLE ELECTRICAL CONNECTIONS

- A. Type A:
 - 1. Flexible Electrical Connection Type A shall be a prefabricated unit incorporating a flexible and watertight outer jacket, grounding strap, plastic inner sleeve to maintain smooth wireway, and end hubs with tapered electrical threads to fit standard threaded rigid metal conduit.
 - 2. Flexible Electrical Connection Type A shall be Crouse-Hinds (Syracuse, NY) "XD Expansion/Deflection Coupling," Spring City Electrical Mfg. Co. (Spring City, PA) "Type DF Expansion and Deflection Fitting," or approved equal.
- B. Type B:
 - 1. Flexible Electrical Connection Type B shall be field fabricated using a minimum 2 (two) foot length of flexible conduit or cable.
- C. Type C:
 - 1. Flexible Electrical Connection Type C shall be field fabricated using a minimum 4 (four) foot length of flexible conduit or cable.

PART 3 - EXECUTION

- A. Mechanical Equipment:
 - 1. Electrical connections to vibration isolated mechanical equipment shall be made using flexible electrical connections Type A or Type C.

3.2 INSTALLATION

- A. General:
 - 1. In all cases, isolated electrical equipment shall be positioned so that it is free standing and does not come in rigid contact with the building structure or other systems.
- B. Flexible Electrical Connections:
 - 1. Type C connections shall be installed in a grossly slack "U" shape or a 360 loop.
 - 2. Rigid conduit on the isolated-equipment side of the flexible connection, and the flexible connection itself, shall not be tied to the building construction or other rigid structures.

END OF SECTION

SECTION 26 05 49**SEISMIC DESIGN****PART 1 – GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

- A. Seismic restraints and/or bracing shall be provided for selected electrical equipment and wiring methods as described hereinafter. These seismic design requirements are complementary to the requirements specified elsewhere for the fastening and support of electrical work. Nothing on the drawings or elsewhere in these specifications shall be interpreted as a reason to waive any of the requirements of this Seismic Design section.
- B. This project is located in Seismic zone 2, an area with an effective peak velocity-related acceleration coefficient (A) of .10 to .19.
- C. Provide seismic support for the following items:
- All pendant or ceiling mounted lighting fixtures if located in public corridors or other portions of egress paths
 - Emergency battery packs
 - Smoke alarm/detection systems
 - All raceways supplying emergency lighting, and smoke alarm/detection system.
 - Raceways mounted in or above public corridors or paths of egress on individual hangers longer than 12 inches or suspended on trapezes or larger than 2 inches.
- D. All seismic restraint and isolation devices, braces, and supports shall be capable of accepting without failure forces produced by seismic acceleration (expressed in multiples of the acceleration of gravity "G") based on the level grade of the attachment of the equipment support system. For design purposes, the following acceleration levels shall be used.

DESIGN LEVEL OF ACCELERATION AT EQUIPMENT CENTER OF GRAVITY			
SEISMIC ZONE 2 $A_v = 0.10$ TO 0.19			
BELOW GRADE UP TO 20 FEET	0.125 "G"	0.500 "G"	1.000 "G"
ABOVE GRADE			
21 FEET – 300 FEET	0.500 "G"	0.750 "G"	
301 FEET – 600 FT.	0.750 "G"	1.000 "G"	

1.3 OEM EQUIPMENT ISOLATION PACKAGES

- A. Internal and/or External Systems
- Substitution of internally or externally isolated or restrained equipment instead of the isolation and restraints specified in this section is acceptable provided all requirements of this section are met. The equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certifying that the seismic restraints are in full compliance with these specifications. Letters from field offices and representatives are unacceptable.
 - All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment manufacturer in the event of non-compliance with the preceding.

3. In the event that the equipment is internally isolated and restrained, the entire unit assembly must be seismically attached to the structure.

1.4 SUBMITTALS

A. Seismic Certification and Analysis

1. Provide seismic restraint calculations certifying that all seismic restraint devices are capable of accepting, without failure, the "G" forces shown in the table above. Calculations shall be provided for all connections of the equipment to the structure. All performance of products (such as strut, cable, anchors, clips, etc.) associated with restraints must be supported by the manufacturer's data sheets or certified calculations. For roof mounted equipment, both the seismic acceleration and wind loads shall be calculated. The highest load shall be used for the design of the restraints and isolators.
2. Calculations to support seismic restraint designs must be stamped by a licensed professional engineer with at least 3 years of seismic design experience.
3. Analysis must indicate calculated dead loads, derived loads, and materials used for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.

1.5 RELATED WORK

A. Housekeeping Steel

1. Where steel sills are called for under a piece of electrical equipment, attachment shall be designed and certified according to this section by the seismic/isolation supplier.
2. Steel sills shall be sized to accommodate a minimum of six inches of clearance all around the equipment and its mounting package. In addition, $\frac{3}{4}$ " clearance shall be provided between the electrical equipment and the steel sills so that the space may be kept clear of debris that would inhibit the isolation.

B. Supplementary Support Steel

1. Structural support and connections for all electrical equipment, including roof mounted equipment, specified in other sections shall comply with the seismic requirements of this section.

C. Design Responsibilities

1. Include the following in the responsibility of the seismic equipment supplier:
 - a. Determine guidelines for vibration isolation and restraint size and location.
 - b. Provide equipment vibration isolation and seismic restraints as required.
 - c. Guarantee specified isolation system deflections.
 - d. Provide installation instructions, drawings, and field supervision to insure proper installation and performance of systems.
 - e. Certify correctness of installation upon completion.

1.6 QUALITY ASSURANCE

- A. Installation of electrical equipment shall, as a minimum, be installed in accordance with the latest applicable edition of the Building Code of the City of New York.
- B. Listing and Labeling: Provide products that are Underwriters Laboratories listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Available manufactures: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. AVNEC, Inc. of Floral Park, NY
2. Mason Industries, Inc. of Hauppauge, NY
3. Vibration Mounting and Control of Butler, NJ
4. Consolidated Kinetics of Columbus, OH

- B. Attachments

1. Hardware and devices such as beam clamps, anchor bolts, cables, and cast-in-place plates must be by this section's supplier to ensure seismic compliance and certification. Alternate anchor bolts may be provided so long as the sizing and dimensions on the seismic submittals are followed:

2.2 SEISMIC RESTRAINTS AND VIBRATION ISOLATORS

- A. General

1. All isolation and seismic restraint devices shall be capable of accepting, without failure, the "G" forces as determined by the seismic certification and calculations described above.
2. Corrosion protection for both indoor and 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.
3. 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.

- B. Seismic Restraint Types:

1. Restraints for suspended systems:
 - a. Isolated systems and, where required elsewhere by this specification, lighting fixtures – braced with multiple steel cable with approved fastening devices to equipment and structure.
 - b. Non-isolated systems – braced with structural steel strut with approved fastening devices to equipment and structure.
2. Restraints for systems rigidly connected to walls or floor or ceiling slabs:
 - a. Rigid attachment to structure using wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Power shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with ICBO National Standards for seismic anchorage.

- C. Vibration Isolator Types:

1. For Conduit Risers – Resilient Conduit Anchors and Guides:

- a. One inch of six pound density Fiberglass packed around the conduit.

PART 3 – EXECUTION

3.1 APPLICATION

- A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all submittal data.
- B. Vibration isolators shall not cause any change of position of equipment resulting in stress on equipment connections.

3.2 INSTALLATION

- A. Equipment shall be restrained as indicated in the table at the end of this specification.
- B. Additional Requirements
 - 1. All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators, and restraints.
 - 2. Spring isolators shall be installed after all equipment is installed without changing equipment elevations.
 - 3. After the entire installation is complete and under full operation load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators.
 - 4. Remove all debris from beneath the equipment and verify that there are no short circuits of the isolation. The equipment's movement shall be free in all directions.
 - 5. All electrical connections to isolated equipment such as transformers and generators shall be in flexible conduit.
 - 6. Use wedge type expansion bolts to bolt the base to the structure.

3.3 SEISMIC RESTRAINTS

- A. Installation
 - 1. All equipment specified to receive seismic support shall be restrained per the table at the end of this section.
 - 2. All floor mounted equipment whether isolated or not shall be snubbed, anchored, bolted, or welded to the structure to comply with the required acceleration. Calculations that determine that isolated equipment movement may be less than the operating clearance of snubbers (restraints) do not preclude the need for snubbers. All equipment must be positively attached to the structure.
 - 3. Lighting fixtures shall be seismically restrained in accordance with the following:
 - a. All lighting fixtures mounted in the paths of egress, and all emergency fixtures and exit signs throughout the building shall be provided with seismic restraints.
 - b. Lighting fixtures recessed into suspended ceilings shall be supported from the ceiling structure by not less than two earthquake clips, or other approved supports, each capable of supporting 50% of the fixture weight.
 - c. Lighting fixtures surface mounted on the underside of suspended ceilings shall be provided with at least two supports, each independently connected to the slab above with cable type restraints as described hereinbefore for suspended systems and each capable of supporting 100% of the fixture weight.

- d. Pendant mounted lighting fixtures shall be supported from the slab above utilizing approved fixture hangers designed to permit a swing of at least 20" in any direction without damage to the fixture, hangers, or structure. Each support shall be capable of supporting 100% of the fixture weight. If there are obstructions preventing the free swing, provide additional support bracing to restrain 50% of the fixture weight. Pendant mounted fixtures below suspended ceilings shall be supported at the ceiling level and shall have cable to the slab above.
 - e. Lighting fixtures surface mounted directly to ceiling slabs, walls or structural elements shall be rigidly attached using restraints specified hereinbefore for rigidly connected ceiling slabs or walls.
4. All horizontally suspended conduit systems shall use restraints for non-isolated suspended systems. Spacing of seismic bracing shall be according to table below.

EQUIPMENT	ON CENTER SPACING	
	TRANS-	LONGITU-
CONDUIT	40 FEET	80 FEET

- 5. For all seismically supported trapeze supported conduit, the individual conduits shall be transversely and vertically restrained to the trapeze support at the designated restraint locations. Restrain at least every third trapeze hanger transversely and every fifth one longitudinally as well as the trapeze on both sides of every change of direction.
- 6. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
 - a. Flanges of structural steel beams.
 - b. Upper truss chords in bar joists.
 - c. Cast in place or drilled and shielded inserts in concrete structures.
- 7. Where conduits pass through cored or sleeved holes, the holes shall be a maximum of 2" larger than the conduit O.D. Pack the space with fireproofing material. No additional horizontal seismic bracing is required at these locations.
- 8. All non-isolated floor or wall mounted equipment such as panelboards, which require restraint shall use restraint for rigid attachment. Where base anchoring of equipment is insufficient to resist seismic forces, additional restraints for suspended, non-isolated equipment shall be located above the unit's center of gravity to suitably resist "G" forces specified.

3.4 INSPECTION

- A. Upon completion of installation of all vibration isolation and seismic restraint devices, a certification report prepared by the manufacturer shall be submitted in writing to the Commissioner indicating that all systems are installed properly and in compliance with the specifications. The report shall identify those areas that require corrective measures or certify that none exist. Any field coordination type changes to the originally submitted seismic restraint designs must be clearly defined and detailed in this report.

END OF SECTION

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SECTION 26 24 13**PANELBOARDS****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. Division 26 Basic Electrical Material and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Provide all panelboards and enclosure work, including cabinets and cutout boxes, as indicated by drawings and schedules, and as specified herein.
- B. Types of panelboards and enclosures required for the project include the following:
 - 1. Power-distribution panelboards.
 - 2. Lighting and appliance panelboards.
- C. All panelboards, disconnect switches, starters, etc., shall be fabricated by the same manufacturer throughout the entire project.
- D. Fuses required in connection with installation of panelboards, and enclosures are specified in another Division 26 section.
- E. Wires/cables, busway, electrical boxes and fittings, and raceways required in conjunction with the installation of panelboards, and enclosures are specified in other Division 26 sections.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on panelboards and enclosures.
- B. Wiring Diagrams: Submit wiring diagrams for panelboards showing connections to electrical power feeders and distribution branches.
- C. Submit electrical room plan view drawings at 1/4" scale showing all equipment, end and front elevation views of distribution panelboards showing: disconnects and ratings, buss work, conduit areas, dimensions, recommended housekeeping pad sizes, mounting of equipment supplied.
- D. The equipment product data, electrical room layouts and short-circuit study shall be submitted together in order to provide proper evaluation.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of panelboards and enclosures, of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.

- B. Installer's Qualifications: Firms with at least 3 years successful installation experience on projects utilizing panelboards similar to those required for this project.
- C. Codes and Standards
 - 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Article 384 as applicable to installation, and construction of electrical panelboards and enclosures.
 - 2. UL Compliance: Comply with applicable requirements of UL 67, "Electric Panelboards", and UL's 50, 869, 486A, 486B, 891, and 1053 pertaining to panelboards, accessories and enclosures. Provide panelboard units which are UL-listed and labeled.
 - 3. Special-Use Markings: Provide panelboards constructed for special-use, with appropriate UL markings which indicated that they are suitable for special type of use/application.
 - 4. NEMA Compliance: Comply with NEMA Stds Pub/No. 250, "Enclosure for Electrical Equipment (1000 Volts Maximum)", Pub/No. PB 1, "Panelboards", and Pub/No. PB 1.1, "Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less".
- D. Federal Specification Compliance: Comply with FS W-P-115, "Power Distribution Panel", pertaining to panelboards and accessories.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store panelboards in clean dry space. Protect units from dirt, fumes, water, construction debris and traffic; where necessary to store outdoors, store electrical components above grade and enclose with watertight wrapping.
- B. Handle panelboards carefully to prevent internal components damage, breakage, denting, and scoring enclosure finish. Do not install damaged components; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate installation of panelboards and enclosures with installation of wires/cables, electrical boxes and fittings, and raceway work.

PART 2 - PRODUCTS

2.1 POWER PANELBOARDS (600 AMPS OR LESS)

- A. General: Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated on drawings, which comply with manufacturer's standard materials; with the design and construction in accordance with published product information; equip with proper numbers of unit panelboard devices as required for complete installation.
- B. Power Panelboards: Provide dead-front safety type power distribution panelboards as indicated, with panelboards switching and protective devices in quantities, ratings, types, and with arrangement shown; with anti-turn solderless pressure type main lug connectors approved for use with copper conductors. Select unit with feeders connecting at top of panel. Equip with copper buss bars with not less than 98% conductivity, and with full-sized neutral buss; provide suitable lugs on neutral bus for outgoing feeders requiring neutral connection. Provide main and branch fused switches for each circuit. Provide panelboards with bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which coordinate and match properly with panelboards. Employ fusible switches that are fully rated for the available short-circuit condition but not less than

65,000 sym AIC.

- C. **Lighting and Appliance Panelboards:** Provide dead-front safety type lighting and appliance panelboards as indicated, with switching and protective devices in quantities, ratings, types and arrangements shown. Equipped with anti-turn solderless pressure type lug connectors approved for use with copper conductors; construct unit for connecting feeders at top of panel; equip with copper buss bars, full-sized neutral bar, with bolt-in type heavy-duty, quick-make, quick-break, single-pole circuit breakers, with toggle handles that indicate when tripped. Provide suitable lugs on neutral buss for each outgoing feeder required; and provide bare uninsulated grounding bars suitable for bolting to enclosures. Select enclosures fabricated by same manufacturers as panelboards, which mate and match properly with panelboards. Employ breakers that are fully rated for the available short-circuit condition but not less than 10,000 sym AIC at 120/208 volts.
- D. **Panelboard Enclosures:** Provide galvanized sheet steel cabinet type enclosures, in sizes and NEMA types as indicated, code-gage, minimum 16-gage thickness. Construct with multiple knockouts and wiring gutters. Provide fronts with adjustable trim clamps, and doors with flush locks and keys, all panelboard enclosures keyed alike, with concealed piano door hinges with door-on door swings. Equip with interior circuit-directory frame, and card with clear plastic covering. Provide baked gray enamel finish over a rust inhibitor coating. Design enclosures for surface mounting. Provide enclosures which are fabricated by same manufacturer as panelboards, which mate and match properly with panelboards to be enclosed.
- E. **Molded-Case Circuit Breakers:** Provide factory-assembled, molded-case circuit breakers of frame sizes, characteristics, and ratings including RMS symmetrical interrupting ratings indicated. Select breakers with permanent thermal and instantaneous magnetic trip, and ampere ratings as indicated on the drawings. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication. Construct breakers for mounting and operating in any physical position, and operating in ambient temperature of 40°C. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine area and conditions under which panelboards and enclosures are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PANELBOARDS

- A. Install panelboards and enclosures as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC standards and NECA's "Standards of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque tightening requirements specified in UL Std 486A and B.
- C. Fasten enclosures firmly to walls and structural surfaces, ensuring that they are permanently and mechanically anchored.

- D. Provide properly wired electrical connections for panelboards within the enclosures.
- E. Provide engraved, plastic laminate labels for all panelboards indicating name, voltage, phase, wire and short circuit rating. In addition, each branch device on the panelboard shall be labeled (engraved). Refer to Section 26 05 03 for more information.
- F. Provide typed panelboards circuit directory card upon completion of installation work to match as-built conditions and nomenclature indicated on engineering drawings and submit directories to the Engineer for review prior to mounting in panelboard.

3.3 DISTRIBUTION BOARD BASES

- A. Construct concrete equipment pads as follows:
 1. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4-inches high and 2-inches larger in all directions than the overall dimensions of the supported equipment. The highest switch shall not exceed 6'-6" above the floor when installed on the pad.
 2. Form concrete pads with framing lumber with form release compounds. Chamfer top edge and corners of pad.
 3. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.
 4. Place concrete and allow to cure before installation of units. Use cement conforming to ASTM C 150, 4,000 psi compressive strength, and normal weight aggregate.

3.4 GROUNDING

- A. Provide equipment grounding connections for panelboard enclosures as indicated herein. Tighten connection to comply with torque tightening requirements specified in UL 486A to assure permanent and effective grounds.
- B. Refer to Section 26 05 26 for additional grounding requirements.

3.5 FIELD QUALITY CONTROL

Tests shall conform to International Electrical Testing Association (INETA) Standard ATS, "Acceptance Testing Specifications for Electrical Power Distribution Equipment".

- A. Infrared Inspection (After Energized)
 1. The scan is to include all electrical panelboards.
 2. All equipment should be energized at normal load levels for at least 1 to 2 hours prior to being scanned.
 3. Access covers are to be removed and reinstalled by the electrical Contractor for the Engineer to inspect and scan all electrical junctions, buss, and cable.
 4. The IR Scan will be made using an video. The camera shall provide infrared photos clearly indicating problem areas.
 5. All problem areas will be noted as to location, description, and recommended solution by providing a typed report including infrared and Polaroid pictures of all problem areas.

B. Panelboards:

1. Visual and Mechanical Inspection:
 - a. Inspect for physical damage and code violations.
 - b. Inspect for proper alignment, anchorage and grounding.
 - c. Inspect for proper identification of protective devices and switches.
 - d. Check tightness of accessible bolted buss joints.
 - e. Physically test all electrical or mechanical interlocks to assure proper function.
 - f. Clean interior and insulator surfaces once a month prior to job completion.
 - g. Inspect for proper operation of space heaters and thermostat settings (if they exist).
2. Electrical Tests:
 - a. Measure insulation resistance of each buss section phase-to-phase and phase-to-ground.
 - b. Check panelboards for electrical continuity of circuits and for short circuits.

3.6 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms for free mechanical movement.
- B. Paint touch-up scratched or marred surfaces to match original finishes.

3.7 DEMONSTRATION

- A. Subsequent to wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

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SECTION 26 27 26**WIRING DEVICES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to this Section.
- B. Requirements of the following Division 26 Sections apply to this section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Receptacles
 - 2. Ground Fault Circuit Interrupter Receptacles
 - 3. Plugs
 - 4. Plug Connectors
 - 5. Snap Switches
 - 6. Incandescent Lamp Dimmer-Switches
 - 7. Wall Plates
- B. Related Sections: The following sections contain requirements that relate to this section:
 - 1. Division 26 Section "Motor Disconnects and Fuses" for devices other than snap switches and plug/receptacle sets used as disconnects for motors.

1.3 SUBMITTALS

- A. Product data for each type of product specified.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following codes.
 - 1. NFPA 70 "National Electrical Code."
- B. UL and NEMA Compliance: Provide wiring devices which are listed and labeled by UL and comply with applicable UL and NEMA standards.

1.5 SEQUENCE AND SCHEDULING

- A. Schedule installation of finish plates after the surface upon which they are installed has received final finish.

PART 2 - PRODUCTS**2.1 WIRING DEVICES**

- A. General: Provide wiring devices, in types, characteristics, grades, colors, and electrical ratings for applications indicated which are UL listed and which comply with NEMA WD 1 and other applicable UL and NEMA standards.
- B. Color of Devices: Color of all devices shall be coordinated with the Commissioner, except special purpose devices shall be black, emergency power system devices which shall be red, corrosion-resistant devices which shall be yellow, or isolated ground devices which shall be orange.
- C. Receptacles: As scheduled in Table 1 in Part 3 indicated herein. Comply with UL 498 and NEMA WD 1 and WD 5.
- D. Receptacles, Industrial Heavy Duty: Provide pin and sleeve design receptacles conforming to UL 498. Comply with UL 1010 where installed in hazardous locations. Provide features indicated.
- E. Ground-Fault Interrupter (GFI) Receptacles: As scheduled in Table 1 in Part 3 indicated herein: Provide "terminal" or feed-through type ground-fault circuit interrupter, as indicated on drawings, with integral heavy-duty NEMA 5-20R duplex receptacles. Provide unit designed for installation in a 2-3/4-inch deep outlet box without adapter, grounding type, Class A, Group 1 per UL Standard 943.
- F. All 15A and 20A, 125V and 250V, non-locking receptacles located in damp or wet locations shall be listed weather-resistant type.
- G. Snap Switches: As scheduled in Table 2 in Part 3 indicated herein:
- H. Wall Dimmer: As scheduled in Table 2 in Part 3 indicated herein.
 - 1. Incandescent wall dimmers shall be 120 volt, solid state type with slide control handle, preset button and semi-flush mounting. Dimmers shall be sized to continuously carry the load they are connected to, the minimum size shall be 1000 watts, and shall be rated larger if indicated on the drawings or required to serve the load.
 - 2. Dimmers indicated on the drawings to serve low voltage incandescent lamps shall be the same as specified for incandescent lamps and in addition shall be specifically rated for the low voltage transformer load. Dimmer shall be UL listed for use with low voltage fixtures.
 - 3. Dimmers indicated to serve fluorescent lamps shall be 120v as required for circuit served, solid state type for use with fluorescent dimming ballasts. Control shall be slide handle and dimmer shall be for semi-flush mounting.
 - 4. All dimmers shall be of the same manufacturer. Faceplate shall be the same color as device plates specified.
- I. Occupancy and Daylight Sensors: See Section 26 51 01.
- J. Surface Mounted Multi-outlet System:
 - 1. Multi-outlet system shall consist of surface mounted all steel raceways for use with number and type of wiring devices installed as shown on the Drawings. System shall be complete with all fittings required for a complete installation.

- a. Wiremold 4000 Series - Raceway with buff finish shall be 4-3/4" high by 1-3/4" deep with dividers deep and snap on cover and shall contain brackets for mounting of grounding type wiring devices located 12" on centers and rated 20 amperes, 120 volts, unless otherwise indicated on drawings.
- b. Wiring devices shall be as specified under "Outlet Boxes and Wiring Devices" with plates having finish to match that of multi-outlet system raceway. Each receptacle cover shall be indent stamped with the voltage and ampere rating of that receptacle.

K. Wireways:

- 1. Wiring troughs shall be 4" x 4" or 6" x 6", brake-formed of code gauge steel, furnished in standard 10-foot sections with knock-outs, as required. Wiring troughs shall be of the screw cover type and shall have a high grade enamel finish baked on a chemically-cleaned and zinc-phosphatized surface providing maximum resistance to corrosion.
- 2. Wiring troughs shall be furnished with all the required components, such as square junction boxes, 90-degree elbows, T-shaped pull boxes, crossover pull boxes, box-connecting couplings, fittings and screw-on cover plates. Lengths of individual sections shall be provided in accordance with installation requirements.

L. All exterior weatherproof receptacles located on the roof, receptacles located in elevator pits and machine rooms shall be GFI type or GFI protected and have "in use" covers.

M. All devices shall be premium specification grade.

2.2 WIRING DEVICE ACCESSORIES

A. Wall Plates: Single and combination, of types, sizes, and with ganging and cutouts as indicated. Provide metal screws for securing plates to devices with screw heads colored to match finish of plates. Provide wall plates with engraved legend where indicated on drawings. Engraving shall be done by the device manufacturer. All lettering shall be 1/8-inch high and shall be black for normal power systems and red for emergency power systems. Provide plates possessing the following additional construction features:

- 1. Material and Finish: 0.04 inch thick, type 302 satin finished stainless steel. Plate shall be Hubbell "S" Series or approved equal.
- 2. Surface mounted wiring devices and blank outlet plates shall be cadmium plated. Interior outlet plates shall be pressed steel. Outlets exposed to weather or corrosive conditions shall be of the cast-metal type.
- 3. Plates for weatherproof receptacles shall consist of cast- aluminum gasketed plate with spring-loaded lift covers providing access to the outlet. Lift cover to correspond to number of outlets to be gasketed. Plates for weatherproof switches shall consist of a cast plate with flexible bubble for activating a push type switch. Plates shall be for corrosion-resistant devices, as manufactured by Hubbell, Inc., or approved equal.

B. For all devices installed which are exposed to the weather, moisture or where indicated on the drawings, device plates shall be weatherproof. Device plates shall be cast type with gasketing to prevent entrance of moisture when closed.

PART 3 - EXECUTION**3.1 INSPECTION**

- A. Contractor shall examine location where wiring devices and installation components are to be installed and determine space conditions and notify Commissioner in writing of conditions detrimental to proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF WIRING DEVICES AND ACCESSORIES

- A. Install wiring devices and accessories as indicated, in accordance with manufacturer's written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work, including painting, electrical boxes and wiring installations, as necessary to interface installation of wiring devices with other work.
- C. The mounting height of devices is indicated in the legend on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.
- D. Receptacles above countertops shall be installed with major axis horizontal above the backsplash.
- E. Electrical outlets shall be installed vertically unless otherwise noted. Those located on interior columns shall be centered laterally.
- F. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominant building feature, i.e., door frames or countertops.
- G. Install wall switches on the strike side of doors.
- H. Mount switches with the long dimension vertical and the operating handle in the upward position when in the "On" position.
- I. Install wiring devices only in electrical boxes which are clean; free from building materials, dirt, and debris.
- J. Install galvanized steel wall plates in unfinished spaces.
- K. Install wiring devices after wiring work is completed.
- L. Install wall plates after painting work is completed.
- M. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torque requirements are not indicated, tighten connectors and terminal to comply with tightening torque requirements specified in UL Standard 486A. Use properly scaled torque indicating hand tool.

- N. At time of completion, replace items which have been damaged including those burned and scored by faulty plugs.
- O. Where it is not possible to set the switch box flush with the wall, furnish raised edge plates.
- P. Where more than one switch is being installed, provide multiple gang switch plates for number of switches as required.

3.3 PROTECTION

- A. Protect installed components from damage. Replace damaged items prior to final acceptance.

3.4 FIELD QUALITY CONTROL

- A. Testing: Prior to energizing circuits, test wiring for electrical continuity, and for short-circuits. Ensure proper polarity of connections is maintained. Subsequent to energizing test wiring devices and demonstrating compliance with requirements, operate each operable device at least six times.
- B. Test ground fault interrupter operation with both local and remote fault simulations in accordance with manufacturer recommendations.
- C. TABLE 1

RECEPTACLES

Designation (1)	Current Rating Amps	Voltage Rating	Single/Duplex	NEMA Config.	Hubbell Catalog #(3)	Notes
-	20	125	Duplex	5-20R	HBL2162	-
-	20	125	Single	5-20R	HBL5361	-
WP	20	125	Duplex	5-20R	HBL5362WR	Weather-proof (4)
GFI	20	125	Duplex	5-20R	GF20LA	Integral GFI (2)

NOTES

1. Letter designations are used where symbols alone do not clearly designate on plans locations where specific receptacle types are used.
2. Protecting downstream receptacles on same circuit is not acceptable.
3. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Commissioner (ivory, gray, white, etc.).
4. Where required per NEC or local code provide 'WP26M' in-use water-proof cover.

- D. TABLE 2

SNAP SWITCHES/WALL DIMMERS

Designation (1)	Typical Application	Load Rating	Voltage Rating (AC)	Poles	Hubbell Catalog #(4)	Notes
S	Control Lights	20A	120	1	DS120	-
S3	Control Lights	20A	120	3-way	DS320	-

S4	Control Lights	20A	120	4-way	DS420	
Sp	Switch & Pilot Light	20A	120	1	DS1201	(2)
D	Dimmer Switch	1000W	120	1	Vareo Series w/preset	(3)
Swp	Wp Switch & Cover Plate	20A	120	1	1281/1750	

NOTES

1. For snap switches, designation is the same as the symbol used on plans for the device. Type of switch is determined from plan context including type of device or circuit being controlled.
2. Pilot light "on" when switch is "on."
3. Lutron dimmer (refer to 26 05 05 for additional manufacturers). Provide dimmer wattage size to handle load served. Derate dimmer switch per manufacturer's recommendations where dimmers are ganged together.
4. Refer to Section 26 05 05 for additional acceptable manufacturers. Color of device shall be verified with Commissioner (ivory, gray, white, etc.).

END OF SECTION

SECTION 26 28 16**MOTOR DISCONNECTS AND FUSES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections, apply to work of this section.

1.2 SUMMARY

- A. Provide all circuit and motor disconnect switch work including fusing, electrical connections to motors, appliance and mechanical equipment as indicated on the drawings and schedules.
- B. Types of circuit and motor disconnect switches in this section include the following:
 - 1. Equipment disconnects.
 - 2. Appliance disconnects.
 - 3. Motor-circuit disconnects.
- C. Applications of electrical power connections specified in this section include the following:
 - 1. To resistive heaters.
 - 2. From electrical source to motor starters.
 - 3. From motor starters to motors.
 - 4. To lighting fixtures.
 - 5. To grounds including earthing connections.
 - 6. To master units of communication.
 - 7. To panelboards, contactors, time clocks and similar equipment.
- D. All panelboards, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the project.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data on circuit and motor disconnect switches, fuses, and equipment connectors.

1.4 QUALITY ASSURANCE

- A. All equipment shall be in compliance with codes and standards referenced in Section 26 05 02 titled "Electrical Requirements".
- B. "Manufacturers" - Firms regularly engaged in manufacture of the type of equipment required for the application, whose products have been in satisfactory use in similar service for not less than 3 years.
- C. UL Compliance: Comply with requirements of UL 98, "Enclosed and Dead-Front Switches." Provide circuit and motor disconnect switches which have been UL listed and labeled.
- D. Comply with NEC (NFPA 70) for construction and installation of safety and disconnect switches.

- E. Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use with Copper Conductors," including, but not limited to, tightening of electrical connectors to torque values indicated.
- F. NEMA Compliance: Comply with applicable requirements for NEMA Stds Pub/No. KS 1, "Enclosed Switches," and No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)."
- G. ANSI Compliance: Comply with applicable requirements of ANSI C97.1, "Low-Voltage Cartridge Fuses 600 Volts or Less."

PART 2 - PRODUCTS

2.1 CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Furnish and install safety switches as required for motor outlets or other equipment. Switches shall be of size, number of poles, and fused or non-fused, as required for job conditions and the National Electrical Code.
- B. Switches shall be equipped with fuse contacts and jaws which ensure positive fuse and jaw contact by means of reinforcing spring clips or other approved means. All current carrying parts shall be silver-plated. Hinges shall be non-current carrying. Switches shall be so designed that they can be locked in either open or closed position.
- C. All switches shall have switch blades which are fully visible in the OFF position when the door is open. Switches shall have removable arc suppressors, where necessary to permit easy access to line-side lugs. Lugs shall be UL listed for aluminum and/or copper cables and front removable. 30A thru 100A switches shall have provisions for field installed fuse pullers. Switches shall include solid neutral where required.
- D. All safety switches shall be NEMA 1 enclosed Type "HD" (heavy duty) quick-make, quick-break, and have interlocking cover with handle that may either be front or side operating with padlocking provisions. Provide NEMA 3R weather proof enclosures where indicated on the drawings or exposed to exterior or damp locations. Incorporate rejection clips where used with Class "R" fuses.
- E. Handle position shall indicate if switch is ON or OFF. Handle shall have provision for padlock.
- F. Switches shall be rated for voltage, poles, amperes, and horsepower, as required or shown on Drawings. All switches shall be rated for maximum available fault current as required or shown on Drawings.
- G. Fusible Switches: Heavy duty switches, with fuses of classes and current ratings indicated on drawings. See Section "2.3" for Fuse specifications. Where current limiting fuses are indicated, provide switches with non-interchangeable feature suitable only for current limiting type fuses.
- H. Non-fusible Disconnects: Heavy duty switches of classes and current ratings as indicated on drawings.
- I. Double-Throw Switches: Heavy duty switches of classes and current rating as indicated on drawings.

- J. Bolted Pressure Switches: Bolted pressure switches conforming to and listed under UL Standard 977; single or double-throw arrangement as indicated. For fusible units provide fuses as indicated on drawings.
- K. Accessories:
 - 1. Electrical Interlocks: Provide number and arrangement of interlock contacts in switches as indicated on drawings or specified elsewhere in specifications.
 - 2. Special Enclosure Material: Provide special enclosure material as follows for switches indicated on drawings:
 - a. Stainless Steel Type 304.
 - b. Heavy case aluminum.
 - 3. Captive Fuse Pullers: Provide built-in pullers arranged to facilitate fuse removal.

2.2 CONNECTIONS FOR EQUIPMENT

- A. General: For each electrical connection indicated provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, electrical solder, electrical soldering flux, heat-shrinkable insulating tubing, cable ties, solderless wirenuts. All other items and accessories as needed to complete splices and terminations of types indicated.
- B. Metal Conduit, Tubing and Fittings:
 - 1. General: Provide metal conduit, tubing and fitting of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division 26 titled "Basic Materials and Methods" and Section 26 05 33 titled "Raceways" and in accordance with the following listing of metal conduit, tubing and fittings:
 - a. Rigid steel conduit.
 - b. Rigid metal conduit fittings.
 - c. Electrical metallic tubing.
 - d. EMT fittings.
 - e. Flexible metal conduit.
 - f. Flexible metal conduit fittings.
 - g. Liquid-tight flexible metal conduit.
 - h. Liquid tight flexible metal conduit fittings.
- C. Wires, Cables, and Connectors:
 - 1. General: Provide wires, cables and connectors complying with Division 26 titled "Basic Materials and Methods" and "Section 26 05 19" titled "Wires and Cables."
 - 2. Wires/Cables: Unless otherwise indicated, provide wires/cables (conductors) for electrical connections which match, including sizes and rating, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
 - 3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals and are recommended for use by equipment manufacturer for intended applications.
 - 4. Electrical Connection Accessories: Provide electrical insulating tape, heat shrinkable insulating tubing and boots, electrical solder, electrical soldering flux, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

2.3 FUSES

- A. General: Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.
- B. Fuses 0-600 Amperes: Class RK1 dual element time-delay fast acting fuses: Provide UL Class RK1 current limiting time-delay fuses rated 600-volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors and panelboards. Fuses shall have a separate overload and short circuit element. Fuses shall incorporate a spring activated thermal overload element.
- C. Fuses 0-600 Amperes: Class RK5 dual element time-delay fuses: Provide UL Class RK5 current limiting time-delay fuses rated 600 volts, (250 volts where specified), 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit breakers, motors, and transformers.
- D. Fuses 601 to 6000 Amperes: Class L time-delay fuses: Provide UL Class L time-delay fuses rated 600 volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.
- E. A complete set of spare fuses shall be purchased at the same time the initial fuses are purchased. Spare fuses shall consist of a standard carton for 0 to 60 amperes rating, and for above 60 amperes rating provide 10% of each type and rating or a set of three, whichever is greater. Spare fuses shall be placed in one or more spare fuse cabinets as required. The spare fuse cabinet shall be 30. H x 24 in. W x 12 in. D with Key lock door, center shelf and fuse index holder. Include one set of fuse bulletins in the fuse cabinet.
 - 1. Fuses shall be U.L. Class L, time-delay and shall employ "O" rings as positive gas seals between the end bells and the glass melamine fuse barrel. Mounting terminals shall be opened. Fuses shall be time-delay and must hold 500% of rated current for a minimum of 4 seconds and clear 20 times rated current within .01 seconds. Fuse links shall consist of pure copper.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine location where fuses and safety and disconnect switches are to be installed and notify Commissioner in writing of conditions detrimental to proper and timely/completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CIRCUIT AND MOTOR DISCONNECT SWITCHES

- A. Install circuit and motor disconnect switches as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's "Standard of Installation," and in accordance with recognized industry practices.
- B. Coordinate circuit and motor disconnect switch installation work with electrical raceway and cable work, as necessary for proper interface.

- C. Install disconnect switches for use with motor-driven appliances, and motors and controllers within sight of controller position unless otherwise indicated.
- D. Provide box with spare set of each size fuse used on job.
- E. Provide nameplate on switch, indicating equipment served.

3.3 INSTALLATION OF EQUIPMENT CONNECTIONS

- A. Install electrical connections in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of installation" to ensure that products fulfill requirements.
- B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.
- C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.
- D. Cover splices with electrical insulating material equivalent to, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.
- E. Prepare cables and wires, by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "nicking" copper conductors while skinning wire.
- F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.
- G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torque tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torque requirements are not available, tighten connectors and terminals to comply with torque values contained in UL 486A.
- H. Provide PVC-coated conduit and fittings for highly-corrosive atmospheres.
- I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.
- J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subjected to one or more of the following conditions:
 - 1. Exterior location.
 - 2. Moist or humid atmosphere where condensation can be expected to accumulate.
 - 3. Corrosive atmosphere.
 - 4. Water spray.

- 5. Dripping oil, grease, or water.
- K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division 26 section titled "Electrical Identification." Affix markers on each terminal conductor, as close as possible to the point of connection.
- L. Provide flexible metal conduit or Type "S" rubber cords, pigtails, caps, etc., as required to constitute an operating system. All flexible cords shall have a grounding conductors. Ground all equipment. See Section 26 05 26 titled "Grounding" for additional requirements.
- M. Prior to roughing-in, refer to all equipment manufacturer's shop drawings for details of equipment connections. Provide receptacles as required to match the cord caps on the equipment furnished. Provide either direct wiring or receptacles for final connection to equipment as required for the particular equipment furnished regardless of the type of outlet shown on the plans.

3.4 INSTALLATION OF FUSES

- A. Install fuses as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC, and NEMA standards for installation of fuses.
- B. Coordinate work including electrical wiring, as necessary, to interface installation of fuses with other trades.
- C. Install fuses in fused switches.
- D. Provide hinged lockable NEMA-1 fuse cabinet in each main electrical switchgear room. Provide spare fuse of size and type for every five (5) fuses installed. A minimum of three (3) spare fuses shall be provided for each size installed.
- E. Contractor shall install Class R fuse rejection kits on all heavy duty safety switches not already fitted for Class R fuses.

3.5 GROUNDING

- A. Provide equipment grounding connections, sufficiently tight to assure a permanent and effective ground for electrical disconnect switches.

3.6 FIELD QUALITY CONTROL

- A. Testing: Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.
- B. Upon completion of installation of fuses, test and inspect system to ensure compliance with requirements.

- C. Final tests and inspections of fuses shall be made prior to energization of the equipment. This shall include a thorough cleaning, tightening and review of all electrical connections and inspection of all grounding conductors.

PART 4 – APPROVED MANUFACTURERS

4.1 For safety and disconnect switches:

- A. Square D
- B. Siemens I.T.E.
- C. Westinghouse
- D. General Electric

4.2 FOR FUSES

- A. Bussman
- B. Cefco

END OF SECTION

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SECTION 26 29 13
MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. Division 26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Extent of motor controller work is indicated by drawings and schedules.
- B. Types of motor controllers specified in this section include the following:
 - 1. Combination.
 - 2. Fractional HP manual.
- C. Work of this section includes wires/cables, raceways, electrical boxes and fittings, as specified in Division 26 sections, and used in conjunction with motor controllers.
- D. Refer to applicable Division 26 sections for wires/cables, electrical raceways, and boxes and fittings required in connection with motor controllers.
- E. All motor controllers, panelboards, disconnect switches, starters, etc., shall be fabricated by same manufacturer throughout the project.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's data and installation instructions or motor controllers.
- B. Shop Drawings: Submit shop drawings of motor controllers showing accurately scaled equipment locations and spatial relationships to associated motors and equipment.
- C. Wiring Diagrams: Submit power and control wiring diagrams for motor controllers showing connections to electrical power panels, feeders, and equipment. Differentiate between portions of wiring which are manufacturer-installed and portions which are field-installed.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualification: Firms regularly engaged in manufacture of motor controllers of types and sizes required, whose products have been in satisfactory use in similar service for no less than 3 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience with projects utilizing motor controller work similar to that required for this project.

C. Codes and Standards:

1. Electrical Code Compliance: Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 220, 250, and 430, as applicable to installation, and construction of motor controllers.
2. NFPA Compliance: Comply with applicable requirements of NFPA 70E, "Standard for Electrical Safety Requirements for Employee Workplaces."
3. UL Compliance: Comply with applicable requirements of UL 486A and 486B, and components which are UL-listed and labeled.
4. IEEE Compliance: Comply with recommended practices contained in IEEE Standard 241, "Recommended Practice for Electric Power Systems in Commercial Buildings," pertaining to motor controllers.
5. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub/No. 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)," pertaining to motor controllers and enclosures.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver motor controllers and components properly packaged in factory-fabricated type containers.
- B. Store motor controllers and components in original packaging and in a clean dry space; protect from weather and construction traffic.
- C. Handle motor controllers and components carefully to avoid breakage's, impacts, denting and scoring finishes. Do not install damaged equipment; replace and return damaged units to equipment manufacturer.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other electrical work including wires/cables, electrical boxes and fittings, and raceway, to properly interface installation of motor controllers with other work.
- B. Sequence motor controller installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.7 MAINTENANCE

- A. Maintenance Data: Submit maintenance data and parts list for each motor controller and component; including "troubleshooting" maintenance guide. Include that data, product data and shop drawings in a maintenance manual; in accordance with requirements of General Conditions.
- B. Maintenance Stock, Fuses: For types and rating required, furnish additional fuses, amounting to one unit for every 10 installed units, but not less than 5 units each.

PART 2 - PRODUCTS**2.1 MOTOR CONTROLLERS**

- A. General: Except as otherwise indicated, provide motor controllers and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for a complete installation.

- B. Combination Controllers: Provide full-voltage alternating-current combination nonreversing controllers, consisting of controller motor circuit protector and disconnect switch mounted in common enclosure, of types, sizes, rating, and NEMA sizes shown on drawings. Each starter shall have a 120-volt, 60 Hz, control power transformer, H-O-A selector switch, red run pilot light, single phase protection and (2) two sets of N.O. and N.C. contacts for the building automation system. Equip controllers with block type manual reset overload relays and with fusible disconnect switches. Provide operating handle for disconnect switch mechanism with indication and control of switch position, with enclosure door either opened or closed, and capable of being locked in OFF position with three padlocks. Construct and mount controllers and disconnect switches in single NEMA Type 1 enclosure; coat with manufacturer's standard color finish. Provide NEMA 3R where installed in an exterior or damp location.
- C. Provide start time delay relay with range 0-300 seconds for all motors 10 HP and larger. Set each relay 4 seconds apart for sequenced start-up after loss and restoration of normal power.
- D. Fractional HP Manual Controllers: Provide single-phase fractional HP manual motor controllers, of sizes and ratings shown on drawings. Equip with manually operated quick-make, quick-break toggle mechanisms; and with one-piece melting alloy type thermal units. Controller to become inoperative when thermal unit is removed. Provide controllers with double break silver-alloy contacts, visible from both sides of controller; green pilot lights, and switch capable of being padlocked OFF. Enclose controller unit in NEMA Type 1 general purpose enclosure; coat with manufacturer's standard color finish. Provide NEMA 3R where installed in an exterior or damp location.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which motor controllers are to be installed, and notify Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF MOTOR CONTROLLERS

- A. Install motor controllers in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of NEC, UL and NEMA standards, to ensure that products fulfill requirements.
- B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers' published torque tightening values for equipment connectors. Where manufacturer's torque requirements are not indicated, tighten connectors and terminals to comply with torque requirements specified in UL Standards 486A and 486B, and the National Electrical Code.

3.3 FIELD QUALITY CONTROL

- A. Prior to energization of motor controller equipment, check with ground resistance tester, phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled.
- B. Prior to energization, check circuitry for electrical continuity, and for short circuits.
- C. Ensure that direction of rotation of each motor fulfills requirements.

3.4 GROUNDING

- A. Provide equipment grounding connections for motor controller equipment. Tighten connections to comply with torque tightening requirements specified in UL Standard 486A to assure permanent and effective grounding.

3.5 ADJUSTING AND CLEANING

- A. Adjust operating mechanisms, where necessary, for free mechanical movement.
- B. Touch-up scratched or marred enclosure surfaces to match original finishes.

3.6 DEMONSTRATION

- A. Upon completion of installation of motor controller equipment and electrical circuitry, energize controller circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

END OF SECTION

SECTION 26 43 13

TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)

PART 1 - GENERAL

1.1 SUMMARY

This specification includes requirements for a high energy transient voltage surge suppression (TVSS) and electronic filtering system used to protect AC electrical distribution from the effects of lightning, utility switching events, and impulses generated internally within a facility.

1.2 RELATED DOCUMENTS

The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

ANSI/IEEE C62.41-1991 and C62.45-1992

ANSI/IEEE C62.1 and C62.11

Canadian Standards (CUL)

Federal Information Processing Standards Publication 94 (FIPS PUB 94)

National Electrical Manufacturers Association (NEMA LS1-1992 Guidelines)

National Fire Protection Association (NFPA 70 [NEC], 75 and 78)

Underwriters Laboratories (UL 198, 248-1, 489, 1283 and 1449-Second Edition)

1.3 SUBMITTALS

- A. Product Data: Provide complete product data detailing manufacturer's model number, specifications, features and options. Substitute/alternate products shall only be considered if the **Attachment 1 TVSS Submittal Compliance Form** is fully completed and included in the submittal.
- B. Test Data: Certified documentation shall be provided of the product's UL 1449 Second Edition listing, clamping values (to include ratings with internal disconnects, if applicable), surge current fuse testing, independent test lab single pulse surge current capacity testing, and minimum repetitive surge current capacity testing.
- C. Shop Drawings: Provide electrical and mechanical drawings that include detail on unit dimensions, weights, field connections and mounting provisions.
- D. Installation, Operation and Maintenance Manuals: Provide one copy of the installation, start-up, operation and maintenance data for each unit supplied.

1.4 SUBSTITUTION PRE-APPROVAL PROCEDURES

Manufacturers requesting approval of their products shall identify the full model number and submit product data, specifications and complete the **Attachment 1 TVSS Submittal Compliance Form**.

1.5 WARRANTY

The manufacturer shall provide a ten year limited warranty from the date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

1.6 LOCAL SERVICE SUPPORT

A dedicated support organization shall be located within 150 miles of the project location, and shall have experience supporting at least twenty other projects of similar complexity within the last three years. Personnel shall perform a start-up service to verify correct installation of the filters, perform transient voltage tests for reliability and performance using appropriate surge generating test equipment, and respond on-site to investigate user concerns.

PART 2 - PRODUCTS

2.1 HIGH PERFORMANCE SUPPRESSION SYSTEM

The suppression system shall incorporate metal oxide varistor (MOV) arrays and filtering capacitors. The system shall not utilize gas tubes, spark gaps, silicon avalanche diodes, or other components that might short or crowbar the line, thus leading to power interruption.

2.2 UL 1449 SECOND EDITION

The system shall be UL 1449 Second Edition listed and UL approved as a transient voltage surge suppressor (TVSS).

2.3 UNIT OPERATING VOLTAGE

The operating voltage and configuration shall be 120/208 Volt grounded wye for panelboard locations or as noted on the drawings.

2.4 MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

The MCOV shall be greater than 115 percent (%) of nominal voltage. Test and evaluation shall be as outlined in NEMA LS1-1992, paragraphs 2.2.6 and 3.6.

2.5 PROTECTION MODES

Per the definitions in NEMA LS 1-1992, paragraph 2.2.7, all modes shall be protected (e.g., line-to-line, line-to-neutral, line-to-ground and neutral-to-ground).

2.6 RATED SINGLE PULSE SURGE CURRENT CAPACITY

Calculations for single pulse surge current capacity shall use the component manufacturer's individual component rating multiplied by the respective number of per mode components. Documentation shall be provided with submittals on the **Attachment 1 TVSS Submittal Compliance Form**. Component manufacturer's ratings shall be derived using the ANSI/IEEE C62.41-1991 Category C1 8 X 20/sec, 3000A current waveform. The per mode single pulse surge current rating shall be calculated based upon the component manufacturer's catalog rating for each device. The minimum rated single pulse surge current capacity per mode shall be as follows:

Rated Single Pulse Surge Current Capacity				
Location	L-N	L-G	N-G	L-L
Panelboards	100,000 A	100,000 A	100,000 A	100,000 A

2.7 TESTED SINGLE PULSE SURGE CURRENT CAPACITY

The suppression filter system shall be single pulse surge current tested in all modes at rated surge currents by an industry-recognized independent test laboratory. Units with surge current capacities of 200,000 amps or less shall be tested as a unit, not individual modules. Due to industry test equipment limitations, units with surge current capacities greater than 200,000 amps shall be tested as a unit to 200,000 amps; and certified for surge current ratings above 200,000 amps by testing individual components or sub- assemblies within a mode. Units that sustain any component or overcurrent device failure are unacceptable.

2.8 MINIMUM REPETITIVE SURGE CURRENT CAPACITY

Per ANSI/IEEE C62.41 and ANSI/IEEE C62.45-1992, every mode of the suppression filter system shall be designed to survive multiple Category C3, 20 KV, 10 KA impulses. Test documentation shall detail the unit's ability to survive the following number of events (at one minute intervals) without any performance degradation.

Repetitive Surge Current Capacity - Number of Impulses				
Locations	L-L	L-N	L-G	N-G
Panelboards	>4500	>4500	>4500	>4500

2.9 SWELL VOLTAGE RATING

For unit substation locations only, suppression components shall be capable of withstanding continuous overvoltage events (swells). Based on a source impedance of 0.7 Ohms, the unit shall withstand an overvoltage of 200 percent (above RMS nominal voltage) for at least 60 cycles, without component failure (including fuses).

2.10 HIGH FREQUENCY EXTENDED RANGE FILTER

EMI-RFI noise rejection/attenuation (per NEMA LS-1-1992 and MIL-STD-E220A 50 ohm insertion loss methodology) shall be as follows:

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	50	41	31	35	53

For installations that install multiple downstream filters, the filters shall be coordinated to provide minimum noise rejection/attenuation as follows:

Attenuation Frequency	50 KHz	100 KHz	1 MHZ	10 MHZ	100 MHZ
Insertion Loss (dB)	85	83	68	67	84

NOTE: Insertion loss data shall be based on a minimum of 100 feet of #4 AWG conductor between filters.

2.11 SUPPRESSION VOLTAGE RATING

In compliance with procedures outlined in NEMA LS 1-1992, paragraphs 2.2.10 and 3.10, the maximum suppression voltage rating (with integral fused disconnect) shall be as follows:

System Voltage	Mode	6KV/500A Comb Wave	B3 Ringwave	B3/C1 Comb. Wave	C3 Comb. Wave
120/208	L-N	325	350	425	725
	L-G	325	425	500	800
	N-G	325	375	475	750
	L-L	625	475	825	1200

2.12 REDUNDANT OVERCURRENT PROTECTION

Each suppression element shall utilize individual UL 248-1 recognized, 200 KAIC tested fuses to ensure that the operation of any single fuse does not isolate the filter from the distribution. At service entrance locations only, in the event a catastrophic or swell voltage occurrence causes the failure of all the MOV elements, the fusing for the selenium cells shall be independent to provide redundancy. The filter shall be capable of withstanding the rated single pulse surge current capacity without fuse failure.

2.13 INTERNAL CONNECTIONS

Internal surge current paths shall utilize low-impedance copper bus bar. No plug-in modules or quick-disconnect terminals shall be used in the surge current-carrying paths.

2.14 BUILT-IN FIELD TEST CAPABILITY

The unit shall incorporate an integral test point for off-line diagnostic testing to verify operational integrity of the suppression filter system. Testing shall include injection of an impulse at least two times the nominal system voltage, and provide metering to indicate the resultant clamping voltage.

2.15 ADDITIONAL FEATURES/EQUIPMENT

Advanced Monitoring Feature. A battery-powered audible alarm with event counter displays and two sets of form C dry contacts (N.O. or N.C.) shall be provided. The alarm shall indicate single or multiple phase failure of the filter.

PART 3 – EXECUTION**3.1 INSTALLATION**

The TVSS filters shall be installed within the switchgear as close as possible to the connection point following the manufacturer's recommendations for conductor size and minimal bends.

3.2 EQUIPMENT MANUAL

An equipment manual shall be provided that details installation, operation, and maintenance instructions for the filter. Information shall include unit dimensions, weights, mounting provisions, connection details and a layout diagram.

**ATTACHMENT 1 - TVSS SUBMITTAL COMPLIANCE FORM
(PANELBOARDS)**

Performance/Feature	Specification Requirement	Proposed
Single Pulse Surge Rating Per Mode	<u>100KA</u> L-N <u>100KA</u> L-G <u>100KA</u> N-G	_____ L-N _____ L-G _____ N-G
Single Pulse Surge Rating Per Phase	<u>200KA</u> L-N + L-G	_____ L-N + L-G
Number Of Components Used For Above Rating (Attach Component Manufacturer's Product Data)	L-N: 11, L-G: 11; N-G: 11 Each component rated for 10,000 transient Amps (Manufacturer: Harris Ultra MOV V20E320)	Number of MOV's/Mode L-N _____ L-G _____ N-G _____
Warranty For Damage To TVSS Due To Lightning	5 years	
Dispatch Location For Local Support And Start-Up		
Maximum Continuous Operating Voltage (MCOV) For All Suppression Components	Greater than 115 percent and less than 130 percent	
Protection Modes Provided	L-L, L-N, L-G and N-G	
Category C3 Repetitive Surge Current Capacity	> 4500 impulses	
High Frequency Noise Filtering Attenuation	50 KHz 50 dB 100 KHz 41 dB 1 MHZ 31 dB 10 MHZ 35 dB 100 MHZ 53 dB	50 KHz _____ dB 100 KHz _____ dB 1 MHZ _____ dB 10 MHZ _____ dB 100 MHZ _____ dB
Internal Surge Current Path	Copper Bus Bar	
Built-In Field Test Capability	Required? ____ No <u>x</u> Yes	Provided? ____ No ____ Yes
Low Impedance Internal Disconnect	Required? <u>x</u> No ____ Yes	Provided? ____ No ____ Yes
Dual Disturbance Counters	Required? ____ No <u>x</u> Yes	Provided? ____ No ____ Yes
Microprocessor-Based Diagnostics	Required? ____ No <u>x</u> Yes	Provided? ____ No ____ Yes

END OF SECTION

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SECTION 26 51 00**LIGHTING FIXTURES****PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including general and supplementary conditions, apply to work of this section.
- B. Division-26 Basic Electrical Materials and Methods sections apply to work specified in this section.

1.2 SUMMARY

- A. Extent, location, and details of lighting fixture work are indicated on drawings and in schedules.
- B. Types of lighting fixtures in this section include the following:
 - 1. High-intensity-discharge (HID).
 - 2. Metal halide.
 - 3. Fluorescent.
 - 4. Incandescent and quartz.
 - 5. Other lamps as noted on fixture schedule.
- C. Fixture: A complete lighting unit, including lamps, wiring, controls and parts required to securely support fixture. Exact ceiling construction shall be verified prior to ordering. Minor changes in ceiling construction shall not be an extra cost to the project.
 - 1. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this Contract shall be furnished by the Contractor.
 - 2. Fixtures shall be manufactured in strict conformance with the Contract Drawings and Specifications.
 - 3. Specifications and scale drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary of the work.
 - 4. Minor details, not usually indicated on the drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the drawings.
 - 5. ~~The City of New York shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures.~~ The responsibility of accurately fabricating the fixtures to the fulfillment of this specification rests with the Contractor.
- D. Where a catalog number and a narrative or pictorial description is provided, the written description shall take precedence and prevail.
- E. General Contractor shall provide electrical subcontractor with entire lighting specification (including fixture illustrations and sketches); electrical subcontractor shall provide each specified manufacturer with complete information about the fixtures they will supply.

- F. The contractor shall include the installation of an additional 20 exit signs (with batteries if no generator) circuited and operational, in the base price for future request for exit signs by the Fire Department or Building Official. Place in field as directed.
- G. Fixture details shown may be modified by the manufacturer provided all of the following conditions have been met:
 - 1. Fixture performance is equal or improved.
 - 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
 - 3. Cost to the City of New York is reduced or equal.
 - 4. Modifications have been reviewed by the Commissioner and have been approved by the Commissioner in writing.

1.3 SUBMITTALS

Submit shop drawings, samples, and prototypes as specifically instructed below.

- A. Shop drawings shall include but not be limited to:
 - 1. Details of construction and finishes.
 - 2. Drawings to Scale.
 - 3. Catalog cuts, without required details not acceptable.
 - 4. Electrical ratings, mounting, ballasts, lenses, and lamps.
 - 5. For standard catalog items with no modifications, submit catalog cut sheets prepared by the manufacturer which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification). If cut sheet shows more than one (1) fixture type, all non-applicable information shall be crossed out.
 - 6. For lamps, submit catalog cut sheets prepared by the manufacturer which clearly shows, manufacturer, CRI, CT, wattage, base type, lumen output, lamp life, and any other pertinent information.
 - 7. For custom fixtures, modified fixtures or linear fluorescent fixtures mounted in continuous rows, submit a reproducible drawing prepared by the manufacturer showing all details of construction, lengths of runs, lamp layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required.
 - 8. For all submittals under paragraphs 1 through 3 above, manufacturer shall provide submittals within two weeks of receipt of order. All submittals shall have project name and fixture type clearly shown.
 - 9. The Commissioner shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request a shop drawing if the fixture cut is insufficient.
 - 10. Maintenance Data: Submit maintenance data and parts list for each lighting fixture, accessory and also include "trouble-shooting" maintenance guide. In addition to the product data and shop drawings, a maintenance manual in accordance with general requirements of General Conditions shall be provided.
- B. Samples:
 - 1. It shall be the responsibility of the Contractor to provide a sample(s) fixture as indicated in LIGHTING FIXTURE SCHEDULES or as stated herein. When samples are called for the manufacturer shall provide two working samples, unless otherwise noted, complete with lamp, ballast (rated for 120 volt operation) and 6' pig-tail 3-prong Edison plug.

2. The sample(s) shall be shipped to a location that is determined by the Commissioner. Shipping and return shipping costs shall be provided as part of the contract.
 3. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample fixtures must be approved prior to fabrication of fixtures for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the City of New York.
 4. Sample fixtures may not be used on the project.
 5. In the event the submissions are disapproved, the fixtures will be returned to the contractor to immediately make a new submission of fixture or fixtures meeting the contract requirements.
 6. All costs associated for samples are to be paid by the Contractor. No additional costs to the City of New York for samples or mockups will be allowed.
- C. Shop drawings and samples requested shall be submitted for approval before fabrication. Any material produced prior to the approval of shop drawings or samples, and not in conformance with the Contract Documents, shall be disapproved with the Contractor bearing full responsibility and cost.
- D. No variation from the general arrangement and details indicated on the drawings shall be made on the shop drawings unless required to suit the actual conditions on the premises, and then only with the written acceptance of the Commissioner. All variations must be clearly marked as such on the drawings submitted for approval.
- E. Mock-ups:
1. It shall be the responsibility of the Contractor to provide a mock-up of the lighting fixture or lighting systems as indicated in the fixture descriptions. The mock-up shall be erected within a time period and in a location that is acceptable to the Commissioner. A minimum of five (5) mock ups are anticipated.
 2. The mock-up installation shall closely conform to the conditions of the actual installation as to: height, distance from ceiling, number and type of lamps, material, color and etc. The Contractor shall submit a written description of each proposed mock-up with drawings in order to obtain the Commissioner's approval prior to commencement of each mock-up.
 3. The purpose of the mock-up will be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color and etc. Final modifications, if any, shall be considered a part of these Specifications and shall be accomplished with no additional cost to the City of New York.
- F. Substitutions: Manufacturers or light fixtures not listed on fixture schedule must be approved. For approval of all manufacturer/fixture substitutions, the bidders shall comply to specifications herein and as outlined below for submitting alternate fixtures:
1. Manufacturer shall have not less than 3 years experience in design and manufacture of lighting fixtures of the type and quality shown. Prequalification submissions must include a list of completed projects and data catalogue pages and drawings indicating length of experience.

2. Request for approval shall be accompanied by working fixture samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the City of New York) of both the specified brand and the proposed substitutes as required to make complete comparison and evaluation. These samples shall be in addition to those required by Lighting Fixture Specification. The above data shall be delivered separately to the Commissioner. The fixture samples shall be furnished and installed at the bidder's expense, at a location selected by the Commissioner. In addition, the bidder shall furnish the Commissioner with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the City of New York, the Architect and the Engineer.
3. Point by point lighting calculations of areas affected by proposed substitution will be done by the bidder for review.
4. The Commissioner shall determine whether the prototype sample complies with the specifications and shall reserve the right to disqualify any bidders.
5. When required and requested by the Commissioner, samples submitted as per above shall be subjected to photometric, thermal, mechanical, electrical or water testing at an independent test laboratory at no expense to the City of New York.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of lighting fixtures of sizes, types and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Installer's Qualifications: Firms with at least 3 years of successful installation experience on projects with lighting fixture work similar to that required for this project.
- C. Codes and Standards:
 1. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 225, 250, 410, and 500 as applicable to installation and construction of building lighting fixtures.
 2. NEMA Compliance: Comply with applicable requirements of NEMA Stds Pub/No's LE 1 and LE 2 pertaining to lighting equipment.
 3. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office lighting. Comply with IES RP-8, 19, 20, and PB-15 pertaining to exterior, parking, and roadway lighting practices and fixtures.
 4. UL Compliance: Comply with UL standards, including UL 486A and 486B, pertaining to lighting fixtures. Provide lighting fixtures and components which are UL-listed and labeled.
 5. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturer's Association standards and carry the CBM label.
- D. Special Listing and Labeling: Provide fixture for damp locations, wet locations, recessed in rated ceilings and walls, hazardous that are UL listed and labeled for specific use.
- E. Materials and Equipment:
 1. Materials, equipment, and appurtenances as well as workmanship provided under this Section shall conform to the highest commercial standards, and as specified and as indicated on drawings. Fixture parts and components not specifically identified or indicated shall be made of materials most appropriate to their use or function and as such resistant to corrosion and thermal and mechanical stresses encountered in the normal application and function of the fixtures.

2. All fixtures shall be manufactured to a consistent level of quality. Size, color, and component parts shall be identical for all fixtures of the same type.
3. Provide lighting fixtures whose performance under specified conditions is certified by the manufacturer.
4. Provide lighting fixtures, ballasts, and lamps produced by a manufacturer listed as an Approved Manufacturer in this section, or noted on the drawings.

1.5 DELIVERY, STORAGE, HANDLING, AND WARRANTY

- A. Deliver lighting fixtures in factory-fabricated containers or wrappings, which properly protect fixtures from damage.
- B. Store lighting fixtures in original packaging. Store inside well-ventilated area protected from weather, moisture, soiling, extreme temperature, humidity, laid flat and blocking off ground.
- C. Handle lighting fixtures carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged units or components; replace with new.
- D. Provide a 5-year warranty of failure in materials, workmanship, ballast, etc., in addition to and not limited to other rights the City of New York may have under the contract documents. A full warranty shall apply for the first year, and a prorated warranty for the last four years.

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways to properly interface installation of lighting fixtures with ceiling requirements.
- B. Sequence lighting installation with other work to minimize possibility of damage and soiling during remainder of construction.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise specified or indicated on the Drawings, all incandescent fixture spinnings and stampings shall be 20 U.S. gauge. All spinnings and stampings shall be perfect and of even bore and gauge, shall be free from dents, scabs, fold or other defects. Incandescent lamp sockets shall have porcelain housings over copper screw base shells, with medium base sockets rated 660 watts at 250 volts. Wiring channels shall be in accordance with the National Electrical Code. All parts of the fixtures shall be accurately and firmly fitted in an approved manner. Where screws are necessary for adjustment, they shall be concealed as far as possible and finished to match the fixtures.
- B. Set screws shall be heavy and of exact bore to fit the stems. Canopy and other set screws shall be large with a bearing of not less than four (4) full threads. All screws in all parts of fixtures shall be brass and of ample and approved size and strength for the purpose intended.
- C. All glassware called for on the Drawings shall be furnished and put in place under this Division. Contractor shall be solely responsible for all glassware furnished by him, until the work has been accepted, and he shall leave the work with all glassware in perfect condition and thoroughly clean. Glassware shall be Opal, Carrara, Alba, Corning, Holophane.

2.2 MANUFACTURERS

- A. The Contractor shall base bid for lighting fixtures on the manufacturer's listed on the fixture schedule.
- B. Alternate manufacturer's identification by means of manufacturer's names is to establish basic features and performance standards. Alternate manufacturer's or substitutions must meet or exceed the standards of the primary manufacturer listed.
- C. Qualifications: The contractor is allowed 60 days after the contract has been awarded to submit independent photometric tests and samples for all alternate fixtures. If these fixtures fail to comply with the specification requirements at that time, the Contractor will furnish acceptable fixtures at no additional cost to the City of New York and with no delay to the project.
- D. Any submittals for cost reduction alternates or value engineering shall include unit prices for the specified manufacturer, the specified equal manufacturer, and the proposed alternates. Refer to Part 1.3 for approval process.

2.3 CUSTOM FIXTURES MATERIAL, FABRICATION AND FINISHES (IF REQUIRED)

- A. Provide materials as specified with the following characteristics:
 - 1. Stainless Steel:
 - a. AISI Type 302 or UNS Type S30200 18-8 grade: 18 percent chromium and 8 percent nickel. Austenitic grain structure with excellent corrosion resisters and high strength.
 - b. AISI Type 316: Most resistant to salt spray and industrial fumes for use in these applications.
 - c. AISI Type 430: Most economical Ferritic Chromium Steel, very good corrosion resistance, for use only where specified.
 - 2. Galvanized Steel: Coated steel with zinc by a method of hot dipping or electroplating.
 - 3. Aluminum: A pure metal. Aluminum and aluminum alloys meeting the national standard ANSI H35.1-1982.
 - 4. Bronze: Copper alloy, principal alloying elements are phosphor, aluminum, silicon, and tin.
 - 5. Brass: Copper alloy, principal alloying element is zinc. Wrought brass is of UNS designation C20000, C30000, C40000, C66400 to C69800. Cast brass includes leaded red brass (C83600), leaded semi-red brass (C84400), and yellow and leaded yellow brass (C85200 to C85700).
 - 6. Copper: A pure metal. Copper or high copper alloy containing less than 6 percent alloying elements. Wrought copper has UNS designation C10000. Cast copper has UNS designation C80100 to C82800.
 - 7. Zinc: A pure metal. May be specified as an alloying element in copper and aluminum.
 - 8. Glass: All glass shall be heat strengthened (tempered) clear float glass should conform to the requirements of Federal Specification DD-G-1403B, transmittance not less than 88 percent or laminated safety glass. For exterior fixtures, use Borosilicate glass, tempered, Corning #7740. For fixtures directly exposed to the elements and aimed above horizontal with radiant energy of 4.16 watts per square inch or greater, use Vycor glass.
 - 9. Acrylic: 100 percent virgin acrylic polymer, colorless.
 - 10. Neoprene: All neoprene rubber should be heat resistant to withstand heat generated by lamp operation.
 - 11. Silicone: A plastic based on silicon which is not an organic compound. Suitable for use in a wide temperature range (-80 to +500°F). Used as an additive to plastic to improve adhesion, increase strength, and improve water resistance.

- B. Provide thickness of metal required or as specified so that all fixture are rigid, stable and will resist deflection, twisting, warping or bending under normal installation procedures, loading, relamping, etc.:
 - 1. All steel luminaire housings minimum 20 gauge cold rolled steel.
 - 2. All aluminum extrusion housings minimum 0.125" thick.
 - 3. All spun, hydroformed, or sheet aluminum reflectors fabricated from #12 aluminum sheets, minimum 15 gauge, 0.57" or heavier.
 - 4. All cast aluminum or bronze housings minimum of 0.375" thick.
 - 5. All sheet bronze, steel, aluminum or other metal plate minimum of 20 gauge.
 - 6. Flexible leads shall enter all fixtures at sides only, unless otherwise noted. Ballast compartments shall be well ventilated and ballast shall be firmly secured to conducting metal surface. Ballast screws shall be welded securely to fixture body.
- C. Fasteners shall be manufactured of non-magnetic stainless steel, except in indoor applications where galvanized steel is acceptable in non-visible locations. Provide tamperproof screws in all fixtures mounted below 8' above finished floor.
- D. Refer to other parts of this section for additional material and fabrication requirements.
- E. Fixture finishes shall be applied in a manner that will assure a durable, wear resistant surface.
 - 1. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mold release agents.
 - 2. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
 - 3. Exposed metal surfaces used in interior areas, except chromium plated parts, shall be given an even coat of high grade methacrylate lacquer, or transparent epoxy with a satin finish.
 - 4. All castings, extrusions, and spinings shall be machined, sanded or similarly treated, and given minimum one coat of baked-on clear methacrylate lacquer, unless a painted finish is specified, to provide a consistent texture, color, and finish throughout all exposed surfaces.
 - 5. Exterior metal surfaces such as extruded parts or castings which do not otherwise receive a finishing coating, shall be machined, sanded or similarly treated. All such finished components shall be given a minimum of one coat of baked-on clear methacrylate lacquer, satin finish, unless an alternate finish is specified.
 - 6. Aluminum surfaces exposed to the weather shall receive a duronodic or polyester powder paint or clear methacrylate lacquer finish as specified for corrosion resistance. When in contact with concrete, aluminum shall be coated with bituminous paint, zinc chromate primer, or separated by a layer of plastic or other gasketing material. Creosote and tar coatings should not be used because of their acid contents.
 - 7. For weatherproof and vaportight fixtures, painted finishes and accessories shall be weatherproof enamel using proper primers or galvanized and bonderized epoxy in accordance with the manufacturer's requirements. Unless otherwise specified, all painted surfaces shall have an outdoor life expectancy of not less than 20 years.
 - 8. Sheet steel fixture housings, iron and steel parts, which have not received phosphating treatment ("Bonderizing" or similar process) or are to be utilized in exterior applications shall be made corrosion resistant by zinc or cadmium plating, or hot-dip zinc galvanizing after completion of all forming, welding, or drilling operations. Where aluminum parts come in contact with steel (or other metals), the steel shall be zinc plated or cadmium plated. Minimum thickness of above protective coatings shall be:
 - a. Hot galvanized zinc coating - 0.0005".
 - b. Cadmium plating - 0.00015".
 - 9. Parts operated under temperatures injurious to hot-dipped galvanizing shall be electroplated.

10. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating of Corogard No. 1706 as manufactured by Minnesota Mining & Manufacturing Company.
- F. Completely form painted reflectors before application of primer and enamel color coats. Reflectors and reflector bodies for fluorescent lamp fixtures having baked-on white enamel finish, shall be made of steel of the thickness specified and given a suitable primer and white color coats properly applied to meet all applicable requirements and tests.
- G. When requested by the Commissioner, the Contractor shall submit a sufficient quantity of flat metal panels having the identical primer and color coats applied in the same manner as proposed for the Contract items, for subjection to any one or all of the tests listed herein by an approved independent testing laboratory. Provide panels of suitable size and drilled as necessary for a particular test procedure. The Contractor shall bear the cost of all required tests.
- H. Actual location of fixtures shall be as shown on the architectural reflected ceiling plans, or as directed by the Commissioner. Spaces for fixture insertion will be provided under the Division that installs the ceiling. Plaster and other frames shall be turned over to the Division for General Construction for setting and installation, under another Division of these Specifications. Contractor shall be responsible for obtaining fixtures designed to fit properly into these ceilings. The Contractor's attention is directed to the requirements of the acoustical ceiling, particularly to the need for close coordination between the ceiling construction details and lighting fixture design. The electrical contractor is responsible for coordinating mounted hardware to match ceiling type.
- I. All methods of construction and details of workmanship, where not specifically described or shown on the Drawings, shall be satisfactory to the Commissioner and shall be subject to his approval. All joints between fixture wiring shall be made with Buchanan #2008S or equivalent solderless connectors by Thomas and Betts.
- J. All lighting fixtures on emergency generators or battery circuits shall be provided with a red dot or approved marker. Fixtures with internal batteries shall be provided with test switch and pilot light.
- K. Wire leads to the receptacle or connector of any side-prong incandescent lamp or any "cool-beam" lamp utilizing a dichroic reflector shall be SF-2 (silicone rubber insulated) stranded wire (minimum No. of 18 AWG). Wire within housing entirely covered with flexible woven fiberglass sleeve.
- L. All reflectors shall be finished according to the minimum requirements outlined below.

<u>CLASS</u>	<u>MIN. WEIGHT OF COATING (mg/sq.in)</u>	<u>SERVICE</u>	<u>% MINIMUM REFLECTIVITY</u>	
			<u>SPECULAR</u>	<u>DIFFUSE</u>
MI	0.5	Normal interior service.	83	75
SI	7.5	Medium service, interior industrial, exterior when operated within glass.	82	73
SE	10.0	Exterior industrial or commercial service, exposed to atmosphere. Marine service enclosure.	78	65

- M. All reflector and baffles of modified elliptical contour, with no apparent brightness from above 40° above the nadir, with no lamp image or any part of the lamp visible from above 40° above the nadir.
- N. Cone flange formed as an integral part of the cone and with identical color and finish. Width of the flange covers all ceiling openings without light leaks or hardware visible.
- O. Samples of colored aluminum finishes (black, brass, bronze, etc.) shall be submitted for approval before fabrication.
- P. All glass lenses shall be heat treated (tempered) or sealed with a clear acrylic laminate layer to provide a "safety glass" rating. All lenses which require removal for relamping or normal maintenance shall be attached to the fixture housing by a minimal length of safety chain to prohibit the lens from falling and striking surrounding surfaces. Glass edges exposed during the relamping process gasketed to prevent chipping or cracking. Glass lenses shall be a minimum 0.375" thick.
- Q. Glass lenses specified as translucent or "opal" shall be treated as follows:
 - 1. Sand blasted.
 - 2. Acid etched.
 - 3. White flashed

2.4 MATERIALS AND FABRICATION

- A. Provide thickness of metal required or as specified so that all fixture are rigid, stable and will resist deflection, twisting, warping or bending under normal installation procedures, loading, relamping, etc.
- B. Provide neoprene or silicone gasketing, stops, and barriers where required to prevent light leak or water and water vapor (penetration).
- C. Provide finished product with ground metal edges, tight fitting connections, hinges and closures; clean, neat edges, trims, and frames; continuous welds, ground smooth with sharp corners; all exposed screws countersunk flush.
- D. Provide positive, durable means of connection at all joints as required.

- E. All cast parts, including die-cast members, shall be of uniform quality, free from blow holes, pores, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.
- F. Provide sufficient ventilation for lamps, ballasts and transformers including vent holes where required. Outdoor fixtures shall have corrosion resistant wire mesh screens in the vent holes.
- G. All adjustable fixtures shall be provided with reliable locking device to secure aiming angles of the fixture housing or lamp yoke as well as lamp and lens orientation devices to secure oval beam pattern lamps and/or spread lenses.

2.5 FINISHES

- A. Fixture finishes shall be applied in a manner that will assure a durable, wear resistant surface.
 - 1. Prior to finishing, all surfaces shall be free from foreign materials such as dirt, rust, oil, polishing compounds and mold release agents.
 - 2. Where necessary, surfaces shall be hot cleaned by accepted chemical means and shall receive corrosion inhibiting (phosphating) treatment assuring positive paint adhesion.
 - 3. Provide all ferrous metal surfaces with a protective finish having rest-inhibiting properties. Painted finishes shall be a minimum of 1.5 mils thick and shall have a balance between hardness and bending properties suitable for application. White finishes shall have 87 percent minimum reflectance. Application and cleaning shall be performed so as to prevent any loss of reflectance capability.
 - 4. Finish shall be porcelain or baked enamel, matte white on interiors with minimum tested reflectance of 86%. Manufacturer's standard finish or as specified on plans, on visible exteriors. Base metal shall be thoroughly cleaned and given bonderizing or other approved highly adhesive prime coating. All reflectors shall be of 20 gauge sheet steel with polymerized baked white coating with a reflectance ranging from 85% to 88%.

2.6 WIRING

- A. All wiring shall comply with the following:
 - 1. All wiring devices within lighting fixtures or from the fixture to the splice with the project branch circuit wiring shall be as specified below.
 - 2. Wiring between fluorescent lampholders and associated operating and starting equipment shall be of similar or heavier gauge than the leads furnished with the approved types of ballasts with equal or better insulating and heat resisting characteristics.
 - 3. Wiring shall be protected with tape or tubing at all points where abrasion may occur.
 - 4. Wiring shall be concealed within the fixture construction except where design or mounting dictates otherwise.
 - 5. Connections of wires to terminals of lampholders and other accessories shall be made in a neat and workmanlike manner and electrically and mechanically secure with no protruding or loose strands. The number of wires extending to or from the terminals of a lampholder or other accessory shall not exceed the number which the accessory is designed to accommodate.
 - 6. Individual fixture wiring shall be not less than #16 gauge and shall be limited to insulations with rated maximum operating temperature of 150 ☐ C or higher.
 - 7. Where branch circuit wiring calls for two-level lighting, three-and- four-lamp fixtures shall be circuited in a manner so that outer lamps can be switched separately from inner lamp(s), unless otherwise indicated on Drawings.
 - 8. Joints in wiring within lighting fixtures and connections of the fixture wiring to the wiring of the building shall be specified in General Conditions.
 - 9. Wiring channels and wireways shall be free from projections and rough or sharp edges throughout, and all points or edges over which conductors must pass and may be subject to injury or wear shall be rounded and bushed.

10. Insulated bushings shall be installed at points of entrance and exit of flexible wiring.
11. Junction boxes attached to lighting fixtures shall be manufactured in accordance with the National Electrical Code and approved for the number of conductors indicated on the drawings. Supplementary junction boxes shall be installed where required to comply with Code.
12. When exposed, all junction boxes and conduit to be painted as per the Commissioners' direction at no additional cost to the City of New York.
13. Cord types shall be suitable for application and be fitted with proper strain relief and watertight entries where required by application.
14. Furnish code approved wiring in ceiling cavities forming air plenums.

2.7 MARKING OF FIXTURES

- A. Fixtures designed for voltages other than 110-125 volts shall be marked with operating voltage.
- B. Fixtures equipped for operation of rapid start lamps shall be clearly marked "USE RAPID START LAMPS ONLY."
- C. Fixtures designed for operation of lamps below the rated enclosure maximum shall be clearly marked "Lamp Watts Not to Exceed" to maintain the design energy load.
- D. Where catalog numbers are listed, they shall be considered only as a guide. Contractor is cautioned to take care that where fixtures are ordered by catalog numbers these fixtures must incorporate all the general and particular requirements mentioned in the specification, even though it may be necessary to modify the manufacturer's standard fixture corresponding to the designated type or catalog number.

2.8 SOUND TRANSMISSION

Sound transmission through the light fixture units, when spaced as indicated on drawings, shall be sufficiently attenuated to maintain speech privacy between adjoining spaces. Contractor to provide insulating battens around the fixtures where sound transmission levels are unacceptable.

2.9 THERMAL PROTECTORS

- A. Provide thermal protectors as required by the N.E.C., or as required by local Code, to prevent operation of lighting fixtures in enclosed spaces or adjacent to combustible materials at temperatures at or above 90°C (194°F).
- B. Fixtures approved for operation in fire-resistant material at temperatures up to 150°C (302°F) shall be plainly marked.
- C. All incandescent fixtures shall be provided with thermal protectors except where otherwise indicated or where approved for operation without such protectors by the N.E.C. and by the local building authority.

2.10 LAMPS

- A. Provide lamps as shown in the fixture schedule or as modified in reviewed shop drawings.
- B. Lamps as specified for the individual luminaries or lighting equipment shall be delivered and installed in fixtures and lighting equipment leaving these completely lamped and in normal operating condition.

- C. Hot cathode fluorescent lamps, unless otherwise designated, shall be of the rapid start type and deliver not less than 2,900 initial lumens for straight lamps. Fluorescent lamps are triphosphor, color temperature 3500°K, with a color rendering index of not less than 85, unless noted otherwise. Refer to light fixture schedule for details.
- D. Provide all incandescent lamps inside frosted, unless noted otherwise. Refer to light fixture schedule for details.
- E. High intensity discharge lamps, unless noted otherwise, shall be color corrected, phosphor coated, mogul base metal halide lamps. The mogul base color rendering index (CRI) shall not be less than 80 and a color shift not exceeding $\pm 400^\circ\text{K}$, unless otherwise specified. All medium base metal halide lamps to have a CRI of not less than 80 and color shift not exceeding $\pm 200^\circ\text{K}$. Refer to light fixture schedule for details.
- F. A complete set of new lamps shall be installed in each fixture at the completion of the work. Fluorescent lamps shall be of the energy savings type, cool white or warm white, unless otherwise noted in Schedule, or directed. All fluorescent lamps shall be T-8, 1" dia., SP35, 3500°K unless otherwise noted.
- G. Lamps shall be by the same manufacturer and produced by the following acceptable manufacturers:
 - 1. General Electric Lighting
 - 2. Osram Sylvania, Inc.
 - 3. North American Philips Lighting
 - 4. Venture Lighting International, Inc.
 - 5. Others only where specified.

2.11 LAMP HOLDERS

- A. Lamp sockets shall be rigidly attached to fixture enclosure or husk.
- B. Incandescent and high intensity discharge lamp sockets shall be made of heavy duty heat-resistant porcelain.
- C. Plastic or metal sheet sockets are not to be used.
- D. Fluorescent lamp sockets operated with an open circuit voltage in excess of 300 volts shall be of the safety type, and open the supply circuit when the lamp is removed from the sockets.
- E. Provide nickel plated brass or nickel and silver plated contacts in all lampholders for tungsten halogen lamps, lamps in outdoor fixtures, and mogul base incandescent, metal halide or mercury vapor lamps.
- F. All lamp sockets shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all lighting fixture components. All adjustable sockets shall be preset at the factory for lamp specified.

2.12 FLUORESCENT AND HIGH INTENSITY DISCHARGE LAMP BALLASTS

- A. All fluorescent and high intensity discharge lamp ballasts shall conform to the following:
 - 1. All ballasts shall be "Class P" indicating approved integral ballast protection. Fuses in the primary leads shall be provided in addition to the "Class P" ballast.
 - 2. All ballasts shall be of the electronic high power factor type, energy saving, "super low heat" as manufactured by Universal, Motorola or approved equal.

3. All fluorescent ballasts shall be electronic, capable of maintaining a constant light output on all rapid start fluorescent lamps over operating range of 90V to 145V (120V ballast). The total harmonic distortion (THD) of the ballast shall be less than 10 percent of the full light output current level. The ballast shall have a sequenced start progression which first heats cathode filaments and then ignites the lamp. The ballast shall withstand line transients as defined in ANSI/IEEE C62.41, category A; crest factor less than 1.4; power factor greater than 95% and operating frequency of 20KHZ or greater without a visible flicker. The case temperature shall not exceed 25°C temperature rise over 40°C ambient. Ballasts shall comply with FCC regulations Part 18, Class A.
 4. All HID ballasts to be encapsulated and have maximum crest factor 1.6.
 5. All HID ballasts shall meet U.L. standards for "Class H" operations (180°C).
 6. U.L. and ANSI specifications with labels and/or symbols of approval by the U.L. and of certification by the Certified Ballast Manufacturers (C.B.M.) as tested by the E.T.L.
 7. The component parts shall be designed, fabricated, and assembled in accordance with the latest requirements of the N.E.C.
 8. Ballasts shall provide safe and reliable operation of the specified lamps.
 9. Whenever possible, provide two-lamp ballasts for fixtures with two fluorescent lamps or multiples of two lamps.
 10. Identical ballasts shall be installed within each fixture type.
 11. Fixture design, fabrication, and assembly shall be such as to prevent overheating or cycling of lamps and ballasts under normal operating temperature variations.
 12. Provide the lowest sound rating available for the lamps specified and clearly show their respective sound ratings. Ballasts found by the Commissioner to be unduly noisy shall be replaced without charge prior to acceptance of the work.
 13. Dimming ballasts shall be provided where dimming controls are required per the drawings, notes and schedules. Dimmer type ballasts shall be of a design recognized and approved under the U.L. component program. These ballasts must coordinate with the dimming control devices specified for the particular application.
 14. Ballasts intended for outdoor use shall have a minimum lamp starting temperature of 0°F, except as noted otherwise.
 15. Where ballasts are remote from fixture housing, provide suitable enclosure for installation with the conduit and wire from the ballast to the lamp socket clearly marked "Caution," "High Voltage." All remote ballasts to be installed within the recommended distance from the lamp socket as per the manufacturer with access plates for maintenance and on neoprene pads for sound absorption.
 - a. All ballasts shall be high power factor (over 95%) of the "Watt Reducer" type and shall have ETL-CBM certification. All ballasts shall be sound-rated and shall have manufacturer's lowest sound level rating. Ballasts shall be 120 volt 60 Hz, depending on the voltage applied in individual branch circuiting. The ordering of fixtures with the appropriate ballast voltage shall remain the Contractor's responsibility.
 16. At conclusion of the work, deliver to Commissioner a written certificate guaranteeing all fluorescent and HID lamp ballasts for a full two years after job acceptance date. Guarantee shall also cover the cost of replacing the defective ballast and installing new ballast, as well as the purchase cost of the ballast.
 17. Ballast for T5 HO lamps or smaller shall have end of live sensing circuits.
- B. Ballasts manufactured by the following are acceptable:
1. Motorola/GE
 2. Advance
 3. Universal
 4. Osram Sylvaria
 5. Lutron (for dimming ballasts)

6. Approved Equal

- C. Contractor to coordinate ballast line side voltage with branch circuit voltage as shown on Contract Drawings.

2.13 TRANSFORMERS (COLD CATHODE, NEON)

- A. All transformers shall be sized to accommodate the intended load and utilized to operate lamps in a method approved by Underwriter's Laboratory and acceptable by code and shall not exceed the following:
1. Neon: 9,000 volts, 30 ma.
 2. Cold Cathode: 150 ma.
- B. Transformers for non-dimming installations shall be high power factor type, voltage as specified in LIGHTING FIXTURE SCHEDULE. Transformers for dimming installations shall be 120 Volt, 60 hertz, low (normal) power factor type. Fixture manufacturer shall confirm compatibility of transformer with dimming system manufacturer. Secondary voltage shall be as required by lamp footage, cold weather usage and dimming. Transformers shall be UL listed, self-contained steel enclosure equipped with a disconnect switch which shall automatically disconnect the primary when the wiring compartment cover is removed. Transformers shall be installed in accessible and ventilated area (100°F maximum ambient temperature) with air circulation on all sides to dissipate full wattage rating of the transformer. Each transformer shall be installed as close to the lamp as possible in order to keep the secondary feeds as short and equal in length as possible. Wiring compartments shall be accessible if mounted above ceilings, in partitions, or in any location other than electrical closets.
- C. Provide self contained, U.L. listed transformers in 16 gauge steel housing with secondary and primary wiring compartments, mount all transformers securely to the fixture housings (if integral) or to the building structure (if remote) with neoprene pads to isolate vibration and noise.
- D. Provide all transformers with secondary overcurrent protection and a primary disconnect switch, which will automatically disconnect the primary switch when the wiring compartment cover is removed.
- E. All transformers shall be installed in an accessible and ventilated location with a maximum 100°F, ambient temperature with air circulation on all sides.
- F. All winding type transformers will be high power with a maximum crest factor of 1.6.
- G. All regulating transformers shall be tested to have an output regulated to +/-3 percent for input variations of 15 percent to 25 percent, less than 3 percent distortion with a minimum load efficiency of 85 percent, and operating temperature of -20°C to 70°C.

2.14 REFLECTORS

- A. All reflectors shall be of glass or metal of the type required by the drawings and of the size recommended by the manufacturer for the lamp rating indicated. In all cases, holders shall be made so as to support the reflector in proper relation to the lamp filament
- B. Reflectors and reflecting cones or baffles shall be as follows:
1. Absolutely free of any tooling marks including spinning lines, indentations caused by riveting or other assembly techniques.
 2. No rivets, springs, or other hardware visible after installation.
 3. First quality polished, buffed and anodized finish, "Alzak" or approved equal.

4. Specular finish color as selected by the Commissioner or as specified in the fixture schedule.
- C. Other aluminum reflectors shall be as follows:
1. Formed and finished as noted on the Drawings and elsewhere in the Specification.
 2. Reflectors free from blemishes, scratches, or indentations which would distort their reflective function.
 3. Finished by means of the "Alzak" process or approved equal unless otherwise noted.

2.15 LENSES AND DIFFUSERS

- A. All lenses secured by positive means with neoprene or silicone gasketing or washers as required to hold the lens tight within a frame or attach to a housing.
- B. All glass lenses shall be heat treated (tempered) or sealed with a clear acrylic laminate layer to provide a "safety glass" rating. All lenses which require removal for relamping or normal maintenance shall be attached to the fixture housing by a minimal length of safety chain to prohibit the lens from falling and striking surrounding surfaces.
- C. Acrylic lenses shall be 100 percent virgin acrylic polymer and colorless and shall be guaranteed for 15 years against crazing or warping. Lens shall be (.156") thick.
- D. The quality of the raw acrylic material must exceed IES, SPI, and NEMA Specifications by at least 100 percent which, as a minimum standard, shall not exceed yellowness factor of 3 after 2,000 hours of exposure in the Fade-o-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
- E. All plastic diffusers shall be given an approved destaticizing treatment prior to installation, and instructions shall be left with Commissioner for similar destaticizing after cleaning. Diffusers must be put up with no finger or dirt-marks. Use white gloves, if necessary.

2.16 LOUVERS

- A. All louvers shall be fabricated of the specified material.
- B. All fluorescent light fixture louvers shall be parabolic and shall be rated at 90 percent or over on the VCP index.
- C. Louver finishes shall be provided as specified.
- D. All plastic parabolic louvers shall be destaticized before and after fabrication to insure minimum maintenance.
- E. All metal louvers shall be coated with anti-rust material and electrostatically painted.
- F. All louvers shall be heat tested to withstand lamp operating temperatures with no deformation of shape, paint blistering or discoloration.

2.17 FIXTURE TRIMS

- A. Fixtures shall have finish trim designed for the following types of ceiling systems: Ceiling Type Trim Type
 - 1. Recessed Incandescent, Fluorescent, or Metal Halide Fixtures
 - a. Plaster - Overlap Trim.
 - b. Concrete - Overlap Trim.
 - c. Tile - Overlap Trim.
 - d. Gypsum - Overlap Trim.
 - e. Metal Pan, Concealed M - Modular, Fit-in Support.
 - f. Lay-in - Modular, Tile with Flush Fit-in.
- B. Provide trim details as shown on the Drawings or as specified, which are indicative of appearance and dimensional requirements. The trim finish and dimensions subject to the approval of the Commissioner.
- C. Mitered corners shall be continuously welded and smoothed before shop finish is applied. No lapping of trim metal for all flush mounted ceiling trims for rectangular or square recessed fixtures.
- D. Provide a mounting frame or ring with lock recessed or semi-recessed light fixture to secure the mounting frame to the ceiling and support any reflectors, trims, or lenses. Ring shall be compatible with the ceiling and of sufficient strength to rigidly support the fixture and any stress applied in relamping.

NOTE: Catalog numbers are included for reference. Provide all accessories and design features described herein regardless of whether such features are included in catalog reference including, mounting hardware, louvers, lenses, filters, transformers, etc.

2.18 LIGHTING FIXTURE TYPES AND CATALOG NUMBERS

- A. General: Various fixtures types required are indicated on drawings fixture schedule. Fixtures must comply with minimum requirements as stated herein. Review architectural drawings and specifications to verify ceiling types, modules, suspension systems appropriate to installation.

2.19 SUPPORTS FOR SUSPENDED FIXTURES

- A. Provide separate and isolated suspension for all fixtures required by the Local Building Department and seismic requirements. This may include rod hangers, hook hangers, or single stem hangers.

2.20 EMERGENCY LIGHTING UNITS

- A. Provide 90-minute battery pack emergency lighting fixtures with two lamp heads for all mechanical equipment rooms, electrical equipment room, generator area, etc. Battery units shall be self-contained, self diagnostic, sealed, maintenance free, lead-acid type with 10-year normal life warranty.
- B. Light produced by these emergency fixtures shall provide one foot-candle maintained have chargers and wire guards.
- C. Where battery back-up is required for linear fluorescent sources, provide 1400 lumen output battery packs, for a 4ft. lamp length and equivalent efficiency on shorter lamp lengths, operation shall be for a continuous 90 minutes.

- D. All metal halide fixtures connected to an emergency circuit shall have a quartz restrike and a time delay relay to illuminate the space for emergency purposes. Quartz lamps shall remain on until 50% of metal halide lamp output is achieved. Quartz wattage shall be equivalent to the metal halide lamp.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION OF LIGHTING FIXTURES

- A. Contractor to coordinate exact quantities and critical dimension with field conditions.
- B. Contractor to verify and coordinate that appropriate framing, support structures, mounting brackets, and other required structural connections are provided by the General Contractor or other trades to insure a timely, neat installation of all luminaries.
- C. Contractor to coordinate and provide any associated mounting hardware, conduit connections, or associated appurtenances to effectively install the luminaries. Provide each light fixture with complete installation instructions. All light fixtures to be installed in strict conformance with manufacturer's recommendations and instructions.
- D. Coordinate space conditions with other trades.
- E. In Mechanical Equipment Room modify locations and mounting to suit conditions as directed.
- F. Install lighting fixtures in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's "Standard of Installation," NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- G. Exact locations of all lighting fixtures including mounting heights and plan dimensions are as per the Architectural Drawings. Any ambiguities or conflicts in this dimensional information to be identified to the Commissioner prior to installation.
- H. Provide fixtures and/or fixture outlet boxes with hangers to properly support fixture weight. Submit design of hangers, method of fastening, other than specified herein, for review by Commissioner.
- I. Install flush mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.
- J. Provide plaster frames for recessed fixtures installed in other than suspended grid type acoustical ceiling systems. Brace frames temporarily to prevent distortion during handling.
- K. Fasten fixtures securely to structural supports, and ensure that pendant fixtures are plumb and level. Provide individually mounted pendant fixtures longer than 2 feet with twin stem hangers. Provide stem hanger with ball aligners and provisions for minimum one inch vertical adjustment. Mount continuous rows of fixtures with an additional stem hanger greater than number of fixtures in the row.

- L. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified on UL Stds. 486A and 486B and the National Electrical Code.
- M. Provide support cable for pendant fixtures with stems over 2 feet long.
- N. Fasten electrical lighting fixtures and brackets securely to indicate structural supports, including poles/standards, and ensure that installed fixtures are plum and level.
- O. Rigidly align all continuous rows of fixtures for true in-line appearance.
- P. Do not install exposed fixtures, reflectors or trims until all plastering and painting that may mar fixture finish is completed. Replace blemished, dented, damaged or unsatisfactory fixtures as directed.
- Q. Support all fixtures independent of ductwork or piping.
- R. Install rows of fixtures in straight lines, except as noted. Install fixtures so that fixture doors open from same side.
- S. Pendant mount fixtures where indicated, and provide all mounting hardware.
- T. Mount fixtures in accordance with manufacturer's installation details and applicable codes. Provide all required accessories.
- U. Install reflector cones, baffles, aperture plates, and decorative elements after completion of ceiling tiles, painting and general clean-up.

3.3 FIELD QUALITY CONTROL

- A. Replace defective and burned out lamps for 3 months following the Date of Substantial Completion.
- B. At Date of Substantial Completion, replace lamps in lighting fixtures which have been operational over 400 hours and have a lamp life of less than 4,000 hours.
 - 1. Refer to Division-1 sections for the replacement/restoration of lamps in lighting fixtures, where used for temporary lighting prior to Date of Substantial Completion.
- C. Furnish stock or replacement lamps amounting to 5%, but not less than 4 lamps in each case, of each type and size lamp used in each type fixture. Deliver replacement stock as directed to City of New York's storage space.
- D. Upon completion of installation of lighting fixtures, and after building circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- E. Certify that the equipment has been properly installed, adjusted, and tested.

F. For sloped ceilings:

1. Provide sloped ceiling adapters for all fixtures in sloped ceilings.
2. Contractor shall coordinate with architectural details for degrees of slopes, mounting details, etc.

3.4 AIMING AND ADJUSTMENT

- A. All adjustable lighting units shall be aimed, focused, locked, etc., by the Contractor under observation of the Commissioner. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc., required shall be furnished by the Contractor. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely. The aiming and adjustment of luminaires must take place after the projects amenities have been completely installed. These amenities shall include but are not limited to plantings, furniture, artwork, graphics and signage.
- B. Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing, aiming shall be accomplished at night.
- C. Provide positive locking devices to preclude mis-focus during relamping.

3.5 CLEANUP

- A. Clean lighting fixtures of dirt and construction debris upon completion of installation. Clean fingerprints and smudges from lenses. Two weeks prior to substantial completion, re-clean all fixtures for dust, fingerprints, smudges from all visible parts of the fixture.
- B. Protect installed fixtures from damage during remainder of construction period.
- C. At the time of final acceptance by the Commissioner, all lighting fixtures shall have been thoroughly cleaned with materials and methods recommended by the manufacturers, all broken parts shall have been replaced, and all lamps shall be operative.

3.6 GROUNDING

- A. Provide equipment grounding connections for lighting fixtures as indicated by branch circuitry. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.7 DEMONSTRATION

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

END OF SECTION

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SECTION 26 51 01**OCCUPANCY SENSORS AND INSTALLATION COMPONENTS****PART 1 - GENERAL****1.1 GENERAL REQUIREMENTS**

- A. This Section is coordinated with and complementary to the General Conditions and Supplementary General Conditions of the Work, wherever applicable to Mechanical Work.
- B. Section 23 05 01 - Mechanical and Electrical Coordination shall apply.
- C. Section 26 05 01 - Mechanical and Electrical Coordination shall apply.

1.2 DESCRIPTION OF WORK

- A. The work includes the providing of all labor, materials, equipment, accessories, services and tests necessary to complete and made ready for operation by the City of New York, all occupancy sensors in accordance with drawings and specifications.

1.3 QUALITY ASSURANCE

- A. "Manufacturers" - Firms regularly engaged in manufacture of occupancy sensors and installation components, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. Provide occupancy sensors and installation components produced by a manufacturer listed as an Approved Manufacturer in this Section.
- C. Provide equipment whose performance under specified conditions is certified by the manufacturer.
- D. All equipment shall be U.L. listed.

1.4 SUBMITTALS

- A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination shall apply and submit shop drawings. Shop drawings shall include occupancy sensors, control units, relays, etc.

1.5 GUARANTEE

- A. Refer to Section 23 05 01 - Mechanical and Electrical Coordination.

PART 2 - PRODUCTS**2.1 MATERIAL**

- A. Ceiling and Wall Dual Technology Sensors:
 - 1. Sensors shall be ceiling or wall mounted as indicated on plans.
 - 2. Sensor shall have a microprocessor and utilize adaptive technology to optimize the sensor behavior to fit occupant usage patterns and adjust sensitivity and time delay to changing conditions.

3. Sensor shall not require any manual adjustment at the time of installation or during operation.
4. Sensor shall adapt automatically to changing room conditions.
5. Sensor shall utilize either passive infrared and ultrasonic technology to detect motion. Sensor shall not react to noise or ambient sound.
6. The sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.
7. Sensor's microprocessor shall monitor PIR background levels and automatically make corresponding adjustments.
8. Sensor shall incorporate a dual element pyrometer and 12-element cylindrical Fresnel lens.
9. Sensor shall be provided with a variety of mask inserts for PIR rejection to prevent false tripping.
10. Sensor's microprocessor shall monitor ultrasonic frequency changes and automatically make corresponding adjustments.
11. Sensor's microprocessor shall automatically adapt to a continuous airflow situation.
12. Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
13. Sensor shall have an ultrasonic frequency of 32kHz or 40kHz.
14. Sensor coverage shall range from 0 to 2000 sq. ft. depending on model.
15. Sensor shall be available with either a 110 degree, 180 degree, or 360 degree field of view, as specified on drawing.
16. Sensor shall recognize, as a false on, the failure to detect motion 6 seconds after motion is detected initially (turning on the lighting). The sensor shall decrease the sensitivity in response to the false on.
17. Sensor shall feature an 8-second time out install test mode, which will automatically revert to standard time out one hour after being put into test mode.
18. Sensor shall have manual controls and override switches to force manual adjustments.
19. Sensor shall have controls behind a cover to resist tampering. All controls shall be accessible from the front of the sensor.
20. Sensor shall have timer that can be adjusted manually from 8 to 30 minutes.
21. Sensor sensitivity shall be adjustable from 0% to 100%
22. Sensor shall have a control knob that sets the minimum setting for the timer in automatic mode.
23. Sensor shall have control knobs for setting the initial automatic sensitivity adjustments.
24. Sensor shall have a switch to restore factory settings.
25. Sensor shall have real time motion indicator LED's visible from the front of the unit. Red = Infrared, Green = Ultrasonic.
26. Sensor shall operate at universal voltages 100 - 277VAC; 50/60Hz, with each relay able to operate on a different voltage.
27. Sensor shall accept Class 2 wiring.
28. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
29. Sensor shall be ETL listed (Conforms to UL STD 508 Certified to CAN/CSA STD C22.2 NO.14).
30. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
31. Sensor shall have a standard 5-year warranty.
32. Sensor shall be available in White.

B. Wall Switch, Dual Technology Occupancy Sensor:

1. Sensor shall be two self-contained, dual technology motion sensing type. Unit can be mounted to any standard single or two gang outlet box.
2. Sensor shall be capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.

3. Sensor shall not react to acoustic noise or ambient sound.
4. Sensor shall adapt automatically to changing room conditions.
5. Sensor's microprocessor shall monitor PIR background levels and/or ultrasonic frequency changes and automatically make corresponding adjustments.
6. Sensors utilizing passive infrared detection technology.
7. Sensors utilizing passive infrared detection technology shall incorporate a dual element pyrometer and 12-element cylindrical impact resistant Fresnel lens.
8. Sensors utilizing ultrasonic detection technology shall have an ultrasonic frequency of 40 kHz.
9. Sensor shall operate at universal voltages 100 - 277VAC; 50/60Hz, with each relay able to operate on a different voltage.
10. Sensor shall have no minimum load requirement and shall be capable of switching 0 to 1000W Ballast or 1/6HP @ 100/120VAC, 50/60 Hz; 0 to 1800W Ballast or 1/6 HP @ 230/277VAC, 50/60 Hz.
11. Sensor shall have line and load control wires plus a ground wire for safety. Sensor shall not require a neutral.
12. Sensor shall have automatic-ON or manual-ON operation adjustable with DIP switch.
13. Sensor shall have a user accessible ON/OFF control for each circuit.
14. When the sensor is in the 5-sec test time out mode, depressing the push button reverts the unit to standard time out mode.
15. Sensor shall retain all learned adjustments and programmed modes of operation even after power loss.
16. Sensor shall close the relay at zero crossing to protect the contacts.
17. Sensor shall recognize the lighting turning off exactly 1 timeout period as a false on. In response to the second false on, sensitivity settings are adjusted accordingly.
18. Sensor shall automatically determine and calibrate the ambient light level set point (10 - 500 fc) when put into daylight mode.
19. Sensor shall have a mode which turns lights off during periods of occupancy if ambient light levels increase sufficiently to illuminate the area.
20. Sensor shall have a hallway algorithm, that when enabled reduces false tripping of the lights associated with hallway traffic outside the room where the sensor is controlling the lights.
21. Sensor shall have a adaptive reset switch, that when enabled resets the sensor's adaptive timer and sensitivity settings.
22. Sensor shall have configuration switches that are only accessible with fascia cover removed.
23. Sensor shall have a safety air gap disconnect switch.
24. Sensor shall have an automatic timer mode of 4-30 minutes which self adjusts based on occupancy.
25. Sensor shall have a fixed timer mode of 4, 8, 15 and 30 minutes.
26. Sensor shall have a 5-sec time out test mode, which reverts to standard timeout after pressing any button or automatically after one hour.
27. Sensor shall have a minimum 4-min time out (standard).
28. Sensor shall feature a walk-through mode, where lights turn off three minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.
29. To avoid false on activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
30. Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 degree.
31. Each sensing technology shall have a LED indicator that remains active at all times in order to verify detection within the area to be controlled.
32. Sensor shall be able to control incandescent, magnetic low voltage, electronic low voltage, and fluorescent loads.
33. The Dual Technology wall switch sensor shall be a completely self contained control system that replaces a standard toggle switch.

34. To ensure quality and reliability, sensor shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
35. Sensor shall have standard 5-year warranty.
36. Sensor shall be ETL listed (Conforms to UL STD 508 Certified to CAN/CSA STD C22.2 NO.14).

C. Power Packs and Relays:

1. Power pack shall be a self-contained transformer and relay module.
2. Power pack shall have primary universal voltage inputs of 100-277VAC, 50/60Hz.
3. Power pack shall have dry contacts capable of switching 20 amp ballast and incandescent load @ 120 VAC, 60Hz.
4. Power pack shall provide a 24 VDC, 150mA output.
5. Power pack shall provide overload protection. A momentary or continuous short of any of the control wires will not damage the device.
6. Power pack shall provide Zero Arc Point Switching to protect from the effects of inrush current and increase product life.
7. Power pack shall be capable of parallel wiring without regard to AC phases on primary.
8. Power pack can be used as a stand alone, low voltage switch, or can be wired to sensor for auto control.
9. Power and auxiliary relay packs shall be suitable for use in plenum applications.
10. For ease and speed of installation, power and auxiliary relay pack shall have 1/2" snap-in nipple for 1/2" knockouts and shall mount on the outside or inside of enclosure.
11. Power and auxiliary relay packs shall have a 5 year warranty.
12. Power and auxiliary relay packs shall be UL and CUL listed.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor shall examine locations where wiring devices and installation components are to be installed and determine space conditions and notify Commissioner in writing of conditions detrimental to proper and timely completion of the work.
- B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install occupancy sensors and installation components where shown, in accordance with manufacturer's written instructions, and with recognized industry practices, to ensure that installation complies with requirements and serves intended purposes.
 1. Locate switches near doors at the strike side of doors as finally hung.
 2. Install devices only after wiring is completed.
- B. Provide tape masking of sensors as required to prevent unintentional sensor activation by walking past an office with an open door.
- C. Set dip switches on all sensors as specified.
- D. Coordinate with other work as necessary to interface installation of occupancy sensors and installation components.
- E. Installation shall comply with the requirements of NEC and NECA, "Standard of Installation".

- F. At time of completion, replace items which have been damaged.

3.3 FIELD QUALITY CONTROL

- A. Upon completion of installation of occupancy sensors and installation components, and after connection to power source, test devices and installation components to demonstrate compliance with requirements. When possible, field correct malfunctioning units, and then retest to demonstrate compliance. Replace units which cannot be satisfactory corrected.
- B. Test devices and installation components to ensure electrical continuity of grounding connections.

PART 4 - APPROVED MANUFACTURERS

- A. For Occupancy Sensors:

1. Hubbell
2. Watt Stopper
3. Douglas
4. Lutron
5. Leviton
6. Honeywell.
7. Lightolier

END OF SECTION

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