SECTION 26 0500

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. All electrical work shown on the Drawings and specified.

1.2 RELATED DOCUMENTS

A. General Special and Supplementary Conditions.
B. Division 1, Specification Sections.
C. 26 0519 - Wires & Cables.
D. 26 0526 – Grounding.
E. 26 0533 - Raceways.
F. 26 0534 - Boxes.
G. 26 2416 - Panelboards.
H. 26 2726 - Wiring Devices.
I. 26 2816 - Disconnect Switches.
J. 26 5100 - Lighting.

1.3 QUALITY ASSURANCE

A. Qualifications: Qualifications Of Contractor: Provide adequate skilled workmen, properly supervised and sufficient quantities of material and equipment to the end that the general progress of the work shall not be delayed. Employ at all times during the work, a competent superintendent who will be responsible for the correctness of work.
B. Requirements of Regulatory Agencies:
C. Permits: Obtain and pay for all permits and inspection fees required for the execution of electrical contract work. See Supplementary Conditions.
D. Building Codes: All work shall conform to 2014 National Electrical Code (NEC) and all other local enforcing agencies.
E. Tests by independent agencies whose classifications and requirements have general acceptance as regulatory:
   1. Factory Mutual Laboratories (FM).
   2. National Fire Protection Association (NFPA).
   3. Underwriters' Laboratories, Inc. (UL).

1.4 SUBMITTALS.

A. Make in accordance with Division 1 of the Specifications.
B. Product Drawings and Data:
   1. Overcurrent protection.
   2. Panelboards.
   3. Switches.
   4. Relays, contactors, time clocks.
   5. Lighting fixtures.

6. Wiring devices.
7. Device plates.
8. Special system components & accessories.

1.5 JOB CONDITIONS

A. Sequencing, Scheduling:
   1. Conform to construction schedule.
   2. Cooperate with others working on the premises to facilitate progress and to coordinate and integrate all parts of work.

1.6 GUARANTY.

A. Furnish a written guarantee stating that all materials and workmanship are guaranteed against defects for a period of one (1) year after completion and acceptance of work. Defects due to faulty material and workmanship developed during the guarantee period shall be satisfactorily replaced by the Electrical Contractor at his expense.

1.7 DRAWINGS AND SPECIFICATIONS.

A. The Electrical Drawings and Specifications are intended to describe complete systems as shown on the Drawings and as specified in appropriate Section. The Drawings and Specifications are complementary, and work shown but not specified, or specified but not shown, shall be the same as though required by both.
B. Minor items and accessories or devices reasonably inferable as necessary to the complete and proper operation of any system shall be provided for such system whether or not they are specifically shown or specified.
C. Drawings for electrical systems are diagrammatic and illustrate the general arrangements of piping, ductwork, fixtures, equipment, etc. Should rearrangement of systems and components be necessary, the Contractor shall prepare drawings showing the new arrangements and submit the drawings to the Engineer for approval before undertaking the work.

1.8 PERMITS AND INSPECTIONS.

A. Obtain and pay for all necessary permits; arrange and pay for all related governmental inspections. Provide additional materials, parts, etc. and modify the Work as required by governmental inspections and regulations.

1.9 DEFINITION OF "AND/OR".

A. Where "and/or" is used in these Specifications or on the Drawings, it shall mean "that situations exist where either one or both conditions occur or are required and shall not be interpreted to permit an option on the part of the Contractor".

1.10 DEFINITION OF "AS REQUIRED".

A. Where "as required" is used in these Specifications or on the Drawings, it shall mean "that situations exist that are not necessarily described in detail or indicated that may cause the Contractor certain complications in performing the work described or indicated. These complications entail the normal expected coordination activities expected of the Contractor

where multiple trades are involved and existing construction causes deviations to otherwise simplistic approaches to the work to be performed. The term shall not be interpreted to permit an option on the part of the Contractor to perform the end product indicated."

1.11 DEFINITION OF "PROVIDE".

A. Where the word "provide" is used in these Specifications or on the Drawings, it shall mean to "furnish and install".

PART 2 PRODUCTS

2.1 MATERIALS.

A. All materials shall be new and shall be put in place in a complete and workmanlike manner. They shall bear Underwriters' Label where such service is normally provided.

PART 3 EXECUTION

3.1 INSTALLATION

A. Obtain all necessary measurements from other Contractors in order that work will fit other branches of work. Verify all measurements at building to the end that work will properly fit.
B. Confer with Engineer's Representative and other Contractors regarding location and size of conduit, equipment, fixtures, duct openings, switches, ceiling, wall and floor outlets, etc. in order that there may be no interference between the installation or progress of work of any Contractor on the project.
C. In the event that work of this Contractor interferes with the work of other Contractors due to the failure of this Contractor to confer with said other Contractors, then Contractor shall make all necessary changes at his own expense without additional cost whatsoever to Owner.
D. In all cases where ducts prevent locating of outlets in ceiling, provide approved strap hangers from structural members for proper support of conduits and boxes beneath ducts, such work being installed after ducts are in place.
E. Furnish all tools, apparatus, machines, hoists, staging, etc., necessary for the installation of the work.

3.2 NAMEPLATES AND EQUIPMENT DESIGNATIONS

A. In addition to nameplates specified elsewhere herein, furnish and install engraved white core laminated micarta nameplates for all and disconnect switches, safety switches, time switches, magnetic contactors, relays, etc., specified or indicated.
B. Others will furnish nameplates to this Contractor for equipment furnished under their particular branch of work. Electric Wiring Contractor shall install all such nameplates on equipment for which such nameplates are intended.
C. Nameplate designations shall be as later directed by the Engineer.
D. Provide stick-on voltage name tags on all 480 volt and 277/480 volt equipment.
E. On timers, relays, contactors, etc.
F. Provide stick-on name tags on all motor starters giving pump or fan number designation and on timers, relays and contactors indicating their function.

G. All lettering of voltage and motor number designations shall be minimum 1/2 inch high.

3.3 EXAMINATION OF SITE.

A. Visit the site to ascertain the complete scope of all work before submitting bid.

3.4 DEMOLITION WORK IN EXISTING FACILITIES

A. The Contractor shall modify, remove and/or relocate all materials and items so indicated on the Drawings or as required by the installation of the new facilities. The Contractor shall review the architectural demolition drawings and review the existing site to determine the extend of demolition work required. All removals and/or dismantling shall be conducted in a manner so as to produce maximum salvage. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or re-assembly operations shall be repaired and restored to good operative condition. The Contractor may, at his option, and upon approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
B. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with the standards practice of the trades involved.
C. Where items scheduled for relocation and/or reuse are found to be in damaged condition prior to work starting, the Contractor shall call to the attention of the Engineer to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor in a manner acceptable to the Engineer.
D. Service lines and wiring to items to be removed, salvaged or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Engineer. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Engineer. All disconnections or connections into existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Engineer.
E. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection, and in service maintenance of all electrical, plumbing, heating, air conditioning, and ventilating services for the existing spaces.
F. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
G. Where existing construction is removed to provide working and extension access to existing utilities, the Contractor shall remove doors, walls, ceilings, piping, conduit, outlet boxes, wiring, light fixtures, air conditioning ductwork and equipment, etc., to provide this access and shall reinstall same upon completion of work in the areas affected.

3.5 AS-BUILT DRAWINGS

A. See Supplemental General Conditions and General and Special Conditions for information regarding as-built drawings.
B. During the course of construction, Contractor shall keep accurate records of all deviations from work as shown on Drawings and indicate actual installation with colored pencils on a set of blackline prints.
C. Refer to General Conditions.
D. Title Drawings "Project Record Drawings".
E. When revisions are completed, deliver corrected As-Built drawings to Engineer. Wherever possible, As-Built drawings shall be made from corrected shop drawings. Final payment for completed work will not be made until Engineers receive and accept Drawings.

3.6 COMPLETION PROCEDURES

A. Cleaning Equipment, Completed Work and Premises: After the completion of all installations, each system shall be thoroughly cleaned to remove all paint and oil and other foreign material. Each contractor shall also clean all foreign paint, grease, oil, dirt, labels and stickers, etc., from all fixtures, equipment, piping, ductwork, etc., accumulated from his operation from the premises.
B. Provide all adjustments in the systems.

3.7 TESTS

A. Prior to substantial completion, perform complete operation tests in the presence of the Engineer's representative to prove systems are operating as intended and specified. Make all tests deemed necessary by Engineer, providing all apparatus and material required to make such tests.
B. Upon completion of work, prepare a tabulation of voltage values obtained by actual test:
   1. of all feeders and circuits at main switches or circuit breakers
   2. at each distribution panel
   3. at the last lamp on the longest run from the source.
C. Furnish three (3) copies of tabulation to Engineer.

3.8 INSTALLTION, OPERATING AND MAINTENANCE INSTRUCTIONS

A. Demonstration: At the conclusion of his work and prior to substantial completion, the Contractor shall demonstrate and explain to the Owner's personnel the function, operation and maintenance of all equipment and systems installed by him. This shall include at least one (1) session and shall be of session length as the Engineer may direct.
B. Instruct Owners operating personnel in the proper installation, operation, lubrication and maintenance of all equipment.
C. Where applicable, copies of the National Board Certificates and of the operational test reports shall be bound with the manual.

3.9 REQUIREMENTS FOR FINAL ACCEPTANCE

A. Requirements for final acceptance shall include, but not be limited to accomplishing the following:
   1. Completion of Construction.
   2. Correct all deficiencies found during the review of substantial completion.

3. Submit at least 3 copies of an Owner's Manual for review and acceptance by the Engineer. Each copy of the Owner's Manual shall be bound in a single notebook (i.e., total of 3 notebooks) and contain the following:
   a. System Operating Instructions
   b. System Control Drawings
   c. System Maintenance Instructions
   d. Approved copy of submittals
   e. Manufacturer's, supplier's and subcontractors' names, addresses, and telephone numbers, both local representatives and manufacturer's service headquarters.
   f. Spare parts list
   g. Manufacturer's certification of equipment and installation.
   h. Log of all tests, including City or Utility Inspector reports, conducted.
   i. List of manufacturer's guarantees executed by the Contractor.
   j. Owner's acknowledgment of receipt of instruction on the system and all data contained in the Owner's Manual.
   k. Owner's acknowledgment of receipt of accessories (e.g., panel keys, spare parts, etc.).
4. Record drawings delivered to the Engineer.

END OF SECTION

SECTION 26 0519

WIRES AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cable and wiring.

1.2 RELATED DOCUMENTS CONDITIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical wire and cables specified herein.

PART 2 PRODUCTS

2.1 CABLE AND WIRE.

A. All cable and wire for power and light shall be installed in conduit or duct except as otherwise specified herein and shall be of type as specified hereinafter unless otherwise shown on Drawings.
B. Cable for feeders and service shall be Type THHN/THWN insulated copper. All branch circuit wiring shall be THHN 90°C insulated copper. Aluminum cable is not acceptable.
C. Wire for branch wiring installed in wiring space of fluorescent lighting fixtures shall be Type THHN 90°C., rated 600 volts.
D. All wire shall be pure copper of size noted on Drawings. Copper shall have 98% conductivity.
E. Wire, except as otherwise noted, shall not be less than No. 12 AWG, except No. 14 for control and wire of No. 8 AWG and larger shall be stranded. Wire smaller than No. 8 AWG shall be solid.
F. Stranded wire shall be terminated in solderless compression type lugs.
G. Cable connectors shall be T & G Method Color Keyed Compression type units as manufactured by Thomas and Betts Company for No. 8 AWG and larger conductors. For smaller conductors, connectors shall be Ideal Industries, Inc., 'Wing Nut' Model 452 or 453, "Scotchlok Brand" insulated, as manufactured by Minnesota Mining and Manufacturing Company or approved equal, all of type recommended by manufacturer for wire sizes to be connected. Set screw type connectors will be allowed when terminating cable to a circuit breaker.
H. Splicing tape shall be Scotch Brand No. 33 or No. 88 plastic electrical tape and where required, due to sharp projection of connectors or by Local Code Requirements. Scotch Brand No. 22 rubber electrical tape shall also be applied, both as manufactured by Minnesota Mining and Manufacturing Company, or approved equal. Use No. 99 tape where excessive heating may occur.
I. Color Coding: All conductors shall be color coded of the following colors and markers:

Leg	For 120/240 Volts	For 120/240 Volts	For 277/480 Volts
A Phase	Black	Black	Purple
B Phase	Red	Orange	Brown
C Phase	Blue	Blue	Yellow
Neutral	White	White	White
Ground	Green	Green	Green

J. For wire sizes which are available in black only or in a limited color range, the above specified color code shall be accomplished by application of colored tape applied to the visible portion of wires in junction boxes, pull boxes, panelboards, switchboards, etc. Tape shall be as manufactured by 3M Company, and wire markers shall be as manufactured by Brady.
K. Green shall be used only for grounding wire to meet National Electrical Code requirements.
L. Color as selected for the purpose of identifying circuits shall be applied to insulation. Colors must be fast, fadeless and capable of withstanding cleaning in the event that insulation becomes soiled.
M. Color codes shall be consistent in all control circuits with no spacing of two or more colors within any single lead.
N. All systems of control circuits involving more than five wires shall have each end of every wire, whether it connects to terminals, coils, switches, etc., labeled with the given wire number with Brady or equivalent, gummed tape labels either preprinted or typewritten. In the event that more than one wire of the same number leaves a common terminal or terminal bar, the 'home run" is to carry the given wire number (which is to be closest to the termination of wire), a symbol or indication of the component it is connected to, leaving about 1/2" to 1" gap between these numbers.
O. Identify neutrals in Junction Boxes where more than one neutral is used.

PART 3 EXECUTION

3.1 INSTALLATION

A. Feeders and wiring from distribution panels for power shall be suitable for three-phase, three wire, 208 volt, 60 cycle alternating current distribution.
B. Branch circuits for lighting shall be two, three and four wire color coded as later directed.
C. All lighting shall be distributed between the phases and neutral to balance the load as nearly as possible. Upon completion of work, this Contractor shall submit a tabulation of voltage and ampere values as specified herein before.
D. All conductors comprising a feeder or circuit shall be installed in the same conduit or as noted on Drawings.
E. Where conduits are installed exposed, they shall be run at right angles to or parallel with adjacent construction. They shall be supported from tructural members of building construction by clamps or other suitable devices and from masonry by expansion bolts or sleeves and straps. In the absence of structural members, this Contractor shall furnish and install steel angles, etc., as required for support of conduit and equipment.
F. Where weatherproof wiring is indicated on Drawings, conduit system shall be made watertight, using gaskets at outlets as required.
G. No wire for light and/or power wiring shall be smaller than No.12 AWG. Wires of No. 8 AWG and larger shall be stranded, wires smaller than No. 8 AWG shall be solid unless otherwise noted on Drawings or specified herein.
H. All conductors installed underground or in conduits in slabs under which there is no excavation shall be insulated with moisture resisting insulation approved for installation in permanent moist locations.

I. Upon completion of work, all temporary wiring shall be removed.
J. No capped outlets will be permitted. Except as otherwise noted, all neutral conductors shall be of the same cross sectional area as phase conductors.

END OF SECTION

SECTION 26 0533

RACEWAYS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Conduit, raceways, and wireways.

B. Fittings and accessories.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical raceways specified herein.

1.3 DESCRIPTION OF WORK

A. Extent of raceway work is indicated by drawings.
B. Types of raceways specified in this section include the following:
   1. Electrical metallic tubing (EMT).
   2. Flexible metal conduit.
   3. Intermediate metal conduit.
   4. Liquidtight flexible metal conduit.
   5. Rigid metal conduit.
   6. Rigid nonmetallic utility duct.
   7. Rigid nonmetallic conduit.
   8. Wireways.

1.4 QUALITY ASSURANCE

A. All raceways shall bear a UL label and the manufacturers name.
B. Acceptable Manufacturers: Subject to compliance with requirements, provide raceway of one of the following manufacturers:
   1. Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing:
      a. Allied Tube & Conduit Corp.
      b. Perma-Cote Industries.
      c. Triangle PWC, Inc.
      d. Wheatland Tube Co.
   2. Flexible Metal Conduit, Liquidtight Flexible Metal Conduit:
      a. Alflex Corp.
      b. Anamet Corp.
      c. Electri-Flex Co.
   3. (PVC) Rigid Nonmetallic Utilities Duct and Conduit:
      a. Carlon.
      b. Condux International, Inc.
      c. Can-Tex Industries.

4. Conduit Fittings and Bodies:
   a. American Electric.
   b. Appleton.
   c. Crouse-Hinds.
   d. O.Z. Gidney.
   e. Raco, Inc.
5. Insert Anchors:
   a. Ackerman-Johnson.
   b. Paine.
   c. Phillips.
6. Conduit Supports and Hangers:
   a. Appleton.
   b. B-Line Systems.
   c. Caddy.
   d. Crouse Hinds.
   e. Thomas & Betts.
7. Reference and Standards:
   a. National Electrical Code (N.E.C.)
   b. Underwriters Laboratories (UL)
   c. National Electrical Manufacturers Association (NEMA)
   d. Joint Industrial Council (JIC)
   e. American National Standards Institute (ANSI)

1.5 SUBMITTALS

A. Submit manufacturer's technical product data, including specifications and installation instructions, for each type of raceway system required. Include data substantiating that materials comply with requirements.
B. Handling and Storage: Handling shall be done to assure that raceways are not crushed or damaged in any way which would restrict cross sectional area or cause oxidation.

PART 2 PRODUCTS

2.1 GENERAL.

A. Provide raceways and fittings of the specified type for each service indicated. Where types and grades are not indicated, provide proper selection determined by the Engineer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways. All conduit size is based on THW insulation and shall not be reduced regardless of the insulation used.

2.2 RACEWAY

A. Rigid Metal Conduit: Hot dipped galvanized rigid steel per ASTM Standard A-153 galvanized after fabrication. All threads to be galvanized after cutting. A uniform zinc coating shall be applied to the inside and outside walls. Meet UL Standard 6, ANSI Standard C80.1, Federal Specs WW-C-581E.
B. Intermediate Metal Conduit: Shall be the same as rigid except thinner wall. Meet UL Standard 1242, ANSI Standard C80.6.

C. Electrical Metallic Tubing: Be made of strip steel. The exterior shall be hot dipped galvanized with a zinc coating applied over the galvanized coating. The interior shall be coated with a silicone epoxy-ester lubricant. Meet UL 797, ANSI C80.3 and Federal Spec. WWC-563.
D. Flexible Metal Conduit: Be made of spirally wound continuously interlocked zinc coated strip steel. Meet UL Standard 1 and Federal Spec. WW-C-566.
E. Liquidtight Flexible Metal Conduit: Be made of spirally wound continuously interlocked zinc coated strip steel with a concentric PVC outer jacket. The PVC jacket shall be UV stabilized. Meet UL Standards.
F. Rigid Nonmetallic Utility Duct: Power and communications duct shall meet NEMA TC6 and TC8, ASTM Standard F-512 for utility duct, UL Standard 651A and shall be used for concrete encased burial only. Straight runs shall be schedule 20 encased burial (EB-20) rated for 90ºC conductors. Bends and angles shall be Schedule 40 PVC rated for 90ºC conductors.
G. Rigid Nonmetallic Conduit: PVC conduits shall be schedule 40, UV stabilized, rated for 90ºC. conductors, and meet NEMA TC-2, Federal Spec WC1094A and UL 651.
H. Wireways: Provide lay-in wireways with cover, knockouts, connectors, and fittings. The wireway shall be constructed in accordance with UL Standard 870 and all components shall be UL listed. The finish shall be ASA-49 gray epoxy. All screws installed towards the inside shall be protected to prevent possible wire insulation damage. Wireways shall be NEMA 1 when located in dry areas and NEMA 3R when located in wet areas. Wireways shall be constructed from minimum 16 gage sheet metal for sizes 4" x 4" and smaller and 14 gage sheet steel for sizes larger than 4" x 4". NEMA 3R wireway shall have knockouts in the bottom only. Provide with wire retainers not less than 12 inches on center.
I. Fittings and Accessories: Die cast fittings are not permitted. Rigid and intermediate metal conduit fittings shall be threaded type made from malleable iron. Provide raintight or concrete tight as required by the installation.
    1. Electrical metallic conduit fittings shall be: Steel set screw type.
    2. Flexible conduit fittings shall be screw-in flex type for 1- inch conduit and smaller, and double screw type for 1-1/4- inch conduits and larger.
    3. Liquidtight flexible conduit fittings shall be the compression ferrule type and shall be watertight for liquidtight flexible conduit.
    4. Rigid nonmetallic duct and conduit fittings shall meet NEMA TC 9 for duct and NEMA TC 2, UL 651 and Federal Spec. WC-109A for conduit.
    5. All fittings and accessories shall mate and match with the raceway being installed and all manufacturers recommendations

2.3 SURFACE RACEWAYS.

A. Manufacturer's standard, architectural grade, surface raceway, as indicated on the drawings.
B. Submit sample of product for approval by Architect.
C. Acceptable Manufacturers: Wiremold, Panduit, Square D, Hubbell..

PART 3 EXECUTION

3.1 INSTALLATION

A. All raceways are to be concealed unless otherwise specifically indicated on the Drawings. When exposed the exact routing shall be confirmed in the field with the Engineer prior to rough-in.
B. Sizing: All wiring shall be in NEC approved raceways sized as shown on the Drawings, or, if not sized on the Drawings, in accordance with the NEC. Wiring of each type and system must be installed in separate raceways.

C. Contractor to install raceway systems where indicated on the Drawings, complete with all J-boxes and pull boxes as necessary and noted on plans.
D. Provide raceway expansion joints for exposed and concealed raceways with necessary bonding conductor at building expansion joints and or structures where required to compensate for raceway or building thermal expansion and contraction.
E. Where raceways pass through fire rated walls or floors an approved fire-stop shall be installed.
F. Wireways installed in hung ceilings shall be placed such that the cover will hinge upward from the side.
G. All empty conduits shall have a nylon pull cord installed.
H. All conduits shall have openings temporarily plugged to exclude plaster or other foreign materials; be reamed after cutting; have joints cut square, and butt solidly into fittings; have the ends terminated in a proper bushed fitting, be rigidly supported so as to prevent undue stress or strain on the couplings and connectors.
I. All threaded conduits shall have bushings installed where they terminate in an enclosure. Bushings shall be of the insulated type.
J. All conduit systems must be installed complete before conductors are pulled. Metal conduit systems shall be electrically continuous throughout. Conduit supported from ceiling, fixture, or mechanical system supports will not be accepted.
K. All conduits shall be installed perpendicular and parallel to the building lines; all breaks and turns in exposed conduit runs shall be made with cast fittings with cadmium or hot galvanized covers. All conduit fittings shall meet or exceed the recommendations of the manufacturer of the conduit. Approval of the Engineer must be obtained for location and aesthetics of each and every run of exposed raceway prior to installation.
L. No conduit smaller than 3/4-inch shall be installed in floor slabs or below grade.
M. Rigid metal conduit shall be used where embedded in concrete slabs, earth, installed exposed outdoors or in crawl spaces, in mechanical and electrical equipment rooms, in exposed interior applications where the raceway is below 8'-0" AFF and for all feeders.
N. Intermediate metal conduit may be used for exposed applications above 8'-0" AFF and for feeders that are installed above accessible ceilings.
O. Electrical metallic tubing may be used for branch circuitry above accessible ceilings and work concealed in walls and for applications greater than 8'-0" AFF. EMT shall not be used in concrete slabs, in crawl spaces, in contact with earth or in areas that are subject to permanent moisture.
P. Flexible and liquidtight flexible metal conduit shall be used for final connections to utilization equipment. Maximum length shall be 6 feet. Liquid-tight shall be used for all exterior locations and any interior location subject to moisture.
Q. Schedule 40 PVC (rigid non-metallic conduit) may be used for buried branch circuits from five feet outside of the building as permitted by the NEC and local codes except where rigid is herein called for. PVC may be used in concrete, on slab on fill or grade construction except that all stub-ups shall transition to rigid steel prior to the elbow.
R. All boxes, fittings, couplings, transition fittings, adhesives and installation procedures recommended by the manufacturer shall be strictly followed. PVC shall not be used within the building envelope except where installed in concrete.
S. Feeders installed underground may be schedule 40 PVC with concrete encasement in lieu of rigid steel.
T. Where threaded conduits enter enclosures, locknuts shall be used inside and outside of the enclosure.
U. All rigid metal conduit installed underground shall be protected by using 0.010 inch thick pipe wrapping plastic tape, field applied with a 50% overlap, or by using conduit with a factory applied protective plastic resin coating.

3.2 CONDUIT SUPPORTS AND HANGERS

A. All conduits shall be securely fastened in place on maximum of 10-foot intervals and within 3 feet of each outlet box, junction box, cabinet or fitting. Hangers, supports or fastenings shall be provided at each elbow and at the end of each straight run terminating at a box or cabinet.
B. Where two or more conduits 1 inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded rods, washers, nuts and galvanized P-1000 Unistrut cross members. These conduits shall be individually fastened to the cross members of every other trapeze hanger with galvanized channel pipe straps, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
C. Hangers shall be made of durable materials suitable for the application involved.
D. On concrete or brick construction, insert anchors shall be installed. In wood construction, round head screws shall be used. In brick, inserts shall be near center of brick, not near edge or in joint. Where steel members occur, same shall be drilled and tapped, and round head machine screws shall be used.
E. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust resisting metal, or approved equivalent.
F. Sleeves, Inserts, Etc.: Lay out and install work in advance of the laying of floors or walls, and furnish and install all sleeves that may be required for openings through floors, walls, etc. Where plans call for conduit to be run exposed, furnish and install all inserts for clamps for the supporting of conduit. If the Contractor does not properly install all sleeves and inserts required, he will be required to do the necessary cutting and patching later at his own expense, to the satisfaction of the Engineer.
G. Coordination: Prior to roughing in, coordinate the installation of conduit and outlets with other trades. To avoid interference, in areas where numerous ducts, pipes, etc., occur.

3.3 INTALLATION OF UNDERGROUND CONDUITS

A. The ground shall be excavated in open trenches to the proper width and depth for the installation of the underground conduits.
B. Where the bottom of the trench is excavated below the necessary elevation, it shall be brought to proper grade by the use of sand or three-eighth inch gravel.
C. No extra will be allowed because of the nature of the ground in which the trench or other excavations are made. All necessary sheathing to prevent cave-ins and barricades shall be provided in accordance with OSHA requirements.
D. Where unstable ground is encountered in the bottom of the trench, it shall be excavated to a depth of at least 12 inches below the line of the duct or slab, and replaced with coarse gravel to the proper height.
E. Where the excavation for its entire depth is in water or wet sand, pump and trench so as to drain it effectively.
F. Backfill trenches with the excavated material unless otherwise specified. It shall be thoroughly compacted to insure a satisfactory job. In surfaced areas, compaction shall be 95% of surrounding undisturbed soil. Sodded areas shall be compacted to 95% up to topsoil. Topsoil shall be lightly compacted then soil mounted to allow for settling.
G. Where conduits pass under existing sidewalks, roads or curbs cut and remove same in order to install the conduit or ducts. All sidewalks, roads or curbs shall be replaced with material equal to those now in place.

H. Underground conduits shall be concrete encased where called for on the drawings and in the following location: When installed under roadways not including parking lots. When PVC conduit is used in lieu of rigid steel for feeders exterior to the building. When containing cables operating in excess of 600 volts phase to phase.

I. Conduit required to be concrete encased shall be mounted on spacers to allow a minimum of 3 inches encasement on all sides a minimum of 3 inches between parallel runs of conduit. Care shall be taken to prevent movement of conduit during pouring.

J. Concrete shall be 2500 PSI, 28 day compressive strength. Maximum aggregate size shall be 3/4 inch.

K. Provide a burial utility tape, over all underground electrical installations that are exterior to the building. This shall include all feeders, branch circuits and communications conduits.
   1. Warning tape over electrical installation under 600 volts shall be red with black lettering stating "BURIED ELECTRICAL LINE".
   2. Tape shall be installed 1 foot to 6 inches below finished grade, 3 inches wide as manufactured by T & B Westline or equal.

END OF SECTION

SECTION 26 0534

BOXES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pull boxes, outlet boxes, and junction boxes.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical boxes specified herein.

PART 2 PRODUCTS

2.1 PULL BOXES AND JUNCTION BOXES.

A. Pull Boxes and Junction Boxes: Code gauge galvanized steel of size required, furnished with two coats of aluminum paint after fabrication at shop. Provide removable blank covers.
B. Concealed Junction Boxes: Galvanized deep box with extension ring and blank cover. Exposed junction boxes shall be cast with threaded hubs.
C. Exterior Exposed Junction Boxes: NEMA 3-R, galvanized steel, unless otherwise indicated.

2.2 OUTLET BOXES

A. Each switch, light, receptacle and other miscellaneous device shall be provided with galvanized, cadmium plated, or sherardized pressed steel outlet box of the knockout type, not less than No. 14 U.S. Gauge, as manufactured by All Steel Equipment, Inc. Conduits shall be fastened with locknuts and bushings and all unused knockouts must be left sealed. There must be sufficient room for wires and bushings and deep boxes shall be installed where required.
B. All ceiling outlet boxes shall be deep type with screw covers and shall have adequate support to carry weight of fixtures. Where boxes and conduits leading to them are embedded in concrete, sufficient support Will be considered as having been provided. Otherwise Contractor shall furnish and install suitable means for fastening box to framing or floor slab.
C. Care must be taken in placing boxes so that fixtures will hang plumb or stand at right angles to wall.
D. This Contractor shall furnish and install all special outlet boxes that may be required to enclose receptacles specified hereinafter.
E. Outlet boxes for vapor proof or weatherproof construction shall be cast, having threaded hubs for conduits and shall be galvanized or sherardized. Boxes shall be provided with gaskets under all covers.
F. Provide a blank cover for each outlet not to be provided with a lighting fixture and for each outlet indicated as capped.
G. Where surface extensions are installed from existing outlets, furnish and install extension rings as required.

PART 3 EXECUTION

3.1 INSTALLATION

A. All exposed pull and junction boxes shall be secured to building or equipment with proper size machine bolts. Secure anchor and hanger rods in an approved manner.
B. Pull boxes shall be installed where shown and wherever necessary for each installation of conduits, cables or wires. They shall be of size shown and as required for size and number of conduits, cables and wires to be accommodated as well as for the conditions responsible for installation of same.
C. All unused open knock outs shall be properly sealed, utilizing approved caps.
D. Prior to final project completion, all cover plates shall be installed and all boxes properly sealed.
E. Identify panel and circuit numbers on cover plates for all boxes located above accessible or lay-in acoustic ceilings. Utilize a permanent black marker to identify the panel and circuit information with letters ½" high.

3.2 INSTALLATION OF OUTLET BOXES

A. In installation of outlet boxes, no shallow ceiling boxes or plates shall be used. Use of handy boxes or similar outlets for exposed work will not be permitted.
B. On brick and concrete walls or ceiling, exposed outlets shall be fastened with two Paine-Phillips, Ackerman-Johnson or approved equal screw anchors and round head machine screws.
C. On structural members, exposed outlets shall be fastened with no less than two machine screws. Where no structural members are available for support of outlet boxes, furnish and install steel members as required and in a manner as approved.
D. Carefully lay out all outlets and check with other Contractors so that outlets are not blocked, hidden or rendered inaccessible on account of piping or equipment of these trades passing under, over, across or in close proximity to same, or to cause the devices or fixtures in or on these outlets to be inaccessible for use or maintenance.
E. Outlets and fixtures under fans, ducts, etc., where shown and as required shall be independently supported so as to provide adequate support for fixtures.
F. Where more than one (1) switch, wall receptacle, etc., occurs at the same location, install gang boxes and plates suitable for the combination of devices required to be accommodated.

END OF SECTION

SECTION 26 2416

PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Electrical panelboards with overcurrent protection.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical circuit breakers specified herein.

PART 2 PRODUCTS

2.1 PANELBOARDS.

A. General: Panelboards shall be one section panels and shall be of the automatic circuit breaker, dead front type, and shall be in accordance with UL "Standard for Panelboards", and "Standard for Cabinets and Boxes" and shall be so labeled. Panelboards shall be designed and approved for voltage and phase as scheduled.
B. Cabinets: The cabinets shall be of sufficient size to provide ample gutter space in accordance with the National Electrical Code and in no case less than 4" on all sides. All recessed cabinets installed in masonry walls shall be of sufficient depth to accommodate all conduits and have a minimum clearance of 1" from the face of the finished wall to the conduit. Gutters shall be increased in size as required by the conductor splice for connections to mechanical lugs on the circuit breakers. Fronts shall have indicating or self-aligning trim clamps and doors equipped with flush type combination lock and catch. Cabinets shall be of the flush or surface type as scheduled. Cabinets shall be NEMA 1, NEMA 4-X, or NEMA 3-R as scheduled. Cabinets shall have hinged front covers with locks.

2.2 CIRCUIT BREAKERS

A. General: Circuit breakers shall be of the automatic, dead front type, and shall be in accordance with UL requirements. Breakers shall be bolt on type or snap in type and be completely compatible with the panelboard installed. Provide space covers as required to protect any exposed electrical parts from casual access through the front of the panel.
B. Breakers: Circuit breakers shall be quick make and quick break on manual operation. Automatic tripping (overload and short circuit) shall be clearly indicated by the operating handle assuming a neutral (center) position. Multi-pole circuit breakers shall be of the common trip type. Breakers shall be UL approved for the panelboard voltage and thermally compensated to carry rated load at 40ºC ambient with 45ºC rise. Breakers shall be bolted type or plug in. Circuit breakers shall have interrupting capacity as scheduled, but shall in no case be less than 10,000 Ampere symmetrical. Locking type breakers or guards shall be provided where indicated on the

Drawings for circuits supplying lights controlled by light control relays which may cause confusion or inconvenience if inadvertently de-energized.

C. Directory: Each panelboard circuit breaker shall be identified by a separate number. Numbering of poles will not be acceptable. Panelboard directory shall be typed.
D. Acceptable Manufacturers: Cutler-Hammer, GE, Square D, Siemens.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with the National Electrical Code.
B. Test installation upon completion of work.
C. Within four (4) weeks of the end of the warranty period, re-torque all lugs and wire connections on a holiday or weekend day, acceptable to the Owner.

END OF SECTION

SECTION 26 2726

WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Light switches, electrical convenience receptacles, and wall plates.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical wiring devices specified herein.

PART 2 PRODUCTS

2.1 WALL SWITCHES.

A. With switches shall be located as indicated on Drawings, arranged single or in gangs, at height 48" centerline, or indicated, and shall have approved plates and furnish as specified hereinafter.
   1. Single pole wall switches shall have capacity of 20 amperes at 277 volts alternating current and shall be Pass & Seymour (P&S) No. 20AC-1-GRY, or approved equal.
   2. Three way wall switches shall have a capacity of 20 amperes at 277 volts alternating current and shall be P&S No. 20AC-3-GRY, or approved equal.
B. Where pilot lights are indicated, furnish and install lamp receptacle for installation in outlet box, complete with lamp, plate and ruby jewel. Where pilot lights are associated with wall switches, they shall be in gang with same.
C. Where two or more phases of a 277 volt system enter a single switch box, metal barrier plates shall be used to separate the phases in the switch box.
D. Device color shall be “gray”.

2.2 WALL RECEPTACLES

A. Duplex receptacles for general purpose shall be side wired grounding type with double binding screws, having bakelite bodies and grounding terminals and shall be NEMA 5-20R, 20 amp rated, or approved equal. Mounting height shall be 15" to bottom above floor unless otherwise indicated.
   1. Interior Duplex Receptacles - Isolated Ground: P&S No. IG-6300, orange in color.
   2. Interior Duplex Receptacles – Normal: P&S No. 5352-GRY, gray in color.
   3. Ground Fault Circuit Interrupters: P&S No. 2091-SHG-GRY-WR.
B. Power receptacles for single phase, 208 volt, shall be single, three wire plastic body and shall be Bryant or approved equal with collar or plate fitting snugly around receptacle to close space between same and floor box where used.
C. All receptacles shall be of a “gray” color. Submit color chart to Engineer for approval.

2.3 PLATES FOR WALL SWITCHES AND RECEPTACLES

A. Weatherproof Receptacles. Specification grade, while in use type, vertical, heavy duty gray thermoplastic; Pass & Seymour Model WIUC10-GL-GRAY.
B. Weatherproof Toggle Switches. Specification grade, stainless steel, vertical to fit toggle switch; Pass & Seymour Model WP-1.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wiring devices in accordance with the National Electrical Code.
B. Test installation upon completion of work.

END OF SECTION

SECTION 26 2816

DISCONNECT SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Safety type disconnect switches.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section.
B. This section is a Division 26 Basic Electrical Materials and Methods section, and is part of each Division 26 section making reference to electrical disconnect switches specified herein.

PART 2 PRODUCTS

2.1 SAFETY SWITCHES.

A. General: Where shown on Drawings or as required and as specified else where, furnish and install externally operated safety switches enclosed in NEMA 1, NEMA 3-R, or NEMA 4-X steel cabinets.
B. Safety Switches: Service and motor disconnect switches shall be "Heavy Duty" type for 200 amps and greater, horsepower rated, fusible or non fusible of the size and type indicated on the drawings, or as required by the motor or device served.
C. Rating: Switches shall be rated 250 Volts AC for use on the 120/208 Volt system and 600 Volts AC for use on the 277/480 Volt system. Switches shall be rated for a minimum of 20,000 Amperes RMS interrupting rating.
D. Features: Switches shall be designed for locking in ON or OFF position, UL approved for duty shown, and be of the NEMA class for the location required. Switches shall be provided with cover interlock. Switches indicated on the Drawings by specific type and manufacturer shall be furnished as noted. Paralleling of fuses per phase will not be acceptable.
E. Acceptable Manufacturers:
   1. Cutler-Hammer
   2. General Electric
   3. Siemens
   4. Square D.

2.2 FUSES

A. One time dual element, current limiting low peak as manufactured by Bussmann Manufacturing Company. All fuse contacts shall be silver plated. Provide one (1) set of spare fuses for each size and type used. Fuses shall be Class RK-1 unless otherwise indicated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install disconnect switches in accordance with the National Electrical Code.
B. Test installation upon completion of work.

END OF SECTION

SECTION 26 5100

LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Exterior lighting fixtures.
B. Mounting hardware and accessories.
C. Lamps.

1.2 RELATED REQUIREMENTS

A. General, Special and Supplementary Conditions.
B. Division 1, Specification Sections.
C. 26 0500 - General Requirements for All Electrical Work.
D. 26 0519 - Wires and Cables.
E. 26 0533 - Raceways.
F. 26 0534 - Boxes.

1.3 DESCRIPTION OF WORK

A. Furnish and install a lighting fixture of the type indicated by number at each location shown on the drawings. Where multiple fixtures in a room are of the same type, the type may be indicated only once.

B. 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.

1. 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.

2. The Engineer 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.

1.4 SUBMITTALS

A. Shop Drawings

1. Manufacturer's dimensioned scale drawings showing in complete detail the fabrication of all lighting fixtures including overall and detail dimensions, metal gauges, glass thickness, type, fabrication methods, support method, ballasts, transformers, sockets, switches and types of wiring, electrical and mechanical connections, welds, fasteners, joints, end conditions, targeting and locking devices for adjustable fixtures, type of shielding, reflectors, trims, hinges, gaskets, provisions for re-lamping, and all other information to show compliance with the Contract Documents. Indicate type and extent of inert insulating materials to prevent electrolytic corrosion at junctions of dissimilar materials. Clearly indicate work performed by others, and materials adjacent to or abutting work of this section.

2. Installation instructions clearly indicating work performed by others and materials adjacent

to work of this section.

3. All drawings shall clearly indicate the Contract Drawing number of fixture details used as referenced in the development of the shop drawings and the name of the project, the specific location of the detail and the manufacturer's contact information.

4. Accurate color chart indicating the actual color of fixtures finishes available. In lieu of a color chart, it will be acceptable to submit an actual sample fixture of the color desired.

1.5 QUALITY ASSURANCE

A. Materials, equipment and appurtenances as well as workmanship provided under this Section shall conform to the highest commercial standards, and as specified and 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.

B. All fixtures shall be manufactured to a consistent level of quality. Size, color, and component parts shall be identical for all fixtures.

1.6 REFERENCE STANDARDS

A. All fixtures and components shall be made in accordance with the National Electric Code (NEC), and bear the Underwriter's Laboratories (UL) or Factory Mutual label.

1. All fixtures shall be fabricated, wired, and installed in compliance with applicable Local, State, or Federal codes, regulations and building inspection standards. Contractor to certify and provide all required labels indicating compliance with above standards, affixed to each fixture in a position concealing it from normal view.

2. All fixtures shall comply with the Certified Ballast Manufacturers Association (CBM), Illuminating Engineering Society (IES), and the American Society for Testing and Materials (ASTM).

1.7 QUALIFICATION OF BIDDERS

A. Manufacturers listed in the fixture schedule shall be assumed capable of supplying the listed fixtures unless exceptions are set forth in their quotations. Any such exceptions shall immediately be brought to the attention of the Engineer. Manufacturers not listed as an "acceptable manufacturer" must be pre-qualified to bid as follows:

1. Manufacturer shall have a minimum of five years experience in design and manufacture of lighting fixtures of the type and quality shown. Pre-qualification submissions must include a list of completed projects and dated catalog pages or drawings indicating length of experience.

2. Manufacturer shall also submit a prototype sample or detailed shop drawings of each fixture for review by the Engineer. Prototype samples or shop drawings shall be sufficiently detailed and operational to allow evaluation of compliance with the salient features of the specification. Preliminary design or incomplete catalog cut sheets will not be accepted in place of the information required.

3. The fabricator-installer shall have a minimum of five years experience in fabricating and installing specialty lighting components and fixtures.

B. The Engineer shall be the sole judge in determining whether the proposed fixture complies with the specifications, and shall reserve the right to disqualify any manufacturers.

1.8 GUARANTEE

A. The Contractor shall guarantee the fixtures, finishes, component parts, and materials for one (1) year in accordance with the General Conditions of this specification. Ballast shall be guaranteed for five (5) years in accordance with the general specifications.

1.9 LIGHTING PRODUCT OPTIONS AND SUBSTITUTIONS

A. The Contractor shall base bids for lighting fixtures on the manufacturers listed in the specification and the lighting fixture schedule on the drawings.

B. Alternate fixtures shall be considered only if submitted in accordance with the requirements of the General Conditions. Refer to Sections 01630 and 01631 for requirements for Substitutions.

C. Any submittals for cost reduction alternates or value engineering shall include unit prices for the specified manufacturer, the specified equal manufacturer, and the proposed alternate.

D. All bids for alternate fixtures shall include unit prices for each specified fixture. Fixtures can be added or deleted for the indicated unit price.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handle all lighting fixtures and accessories carefully to avoid damage. Store in original protective packaging, tagged and marked as to type and location. Store under cover, out of contact with the ground, in clean, dry areas.

PART 2 - PRODUCTS

2.1 GENERAL

A. Lighting Fixtures: As described in the lighting fixture schedule. Lighting fixtures manufacturers' catalog numbers or model descriptions indicate quality, type, and style, but may not cover special required design details. Provide lighting fixtures having special details as noted in the fixture descriptions and drawings.

B. Fixtures, in general, have been specified for the particular condition where they are being installed. Verify the ceiling system, wall, and pavement construction types and provide lighting fixtures, fittings, hangers, clamps, brackets, yokes, plaster flanges, and miscellaneous devices as required for a complete installation.

C. Poles: Poles shall be tapered aluminum poles complete with hand holes, base cover, anchor bolts, and all accessories and fittings required for a complete installation. Aluminum for poles shall be cast or extruded of Type 6063-T6 aluminum alloy with base of alloy 356. Poles shall be rated to withstand 100 MPH continuous wind, with all fixtures attached, plus a 30 MPH gust. Submit information on effective surface areas that the pole is rated for. Submit bolt templates to the construction site to assist in placement of bases.

2.2 MATERIALS

A. Fixtures: Provide completely factory-assembled, wired, and equipped with necessary sockets, ballasts, wiring, shielding, reflectors, channels, lenses and other parts and appurtenances necessary to complete fixture installation.

B. All fixture submittals shall clearly state all material components, including alloys of each component and their respective characteristics relative to fixture performance and durability.

2.3 FABRICATION

A. Fabricate fixtures free of unnecessary knockouts, holes, and other gaps.

B. Provide thickness of metal required or as specified so that all fixtures are rigid, stable and will resist deflection, twisting, warping or bending under normal installation procedures, loading, re-lamping, etc., or no less than as follows:

1. All steel luminaire housings minimum 20 gauge cold rolled steel for surface or suspended fluorescent fixtures, 22 gauge ribbed for recessed fluorescent fixtures, 18 gauge for incandescent and High Intensity Discharge (HID) fixtures.
2. All aluminum extrusion housings minimum 0.090" thick.
3. All acrylic lenses shall be minimum 0.1875" thick.
4. All glass lenses shall be minimum 0.375" thick.
5. All cast aluminum or bronze housings minimum of 0.375" thick.
6. All sheet bronze, steel, aluminum or other metal plate minimum of 22 gauge.
7. Provide neoprene or silicone gasketing, barriers, and stops where required to prevent light leaks or water and water vapor penetration.

C. Provide finished product with ground metal edges, tight fitting connections free of light leaks, hinges and closures; clean, neat edges, trims, and frames; continuous welds, ground smooth; all exposed screws countersunk flush if exposed fasteners are allowed.

D. Provide positive, durable means of connection at all joints as required.

E. Fabricate fixtures with a minimum number of joints. Make unexposed joints by acceptable method such as welding, brazing, screwing or bolting. Soldered joints are unacceptable. Do not use blind metal tapping methods or rivets for fastening parts, which must be removed during service, or for fastening electrical components and supports.

F. All cast parts, including die-cast members, shall be of uniform quality, close grained, rigid, true to pattern, free from blow holes, pores, discoloration, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.

G. Housings for fluorescent and HID fixtures: Fabricate so electrical components are easily accessible and replaceable, without removing fixture body from mounting.

H. 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 feet above finished floor. Use concealed hardware, unless noted otherwise.

I. 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 spread lenses, as specified.

2.4 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. Exposed metal surfaces used in interior areas, except chromium plated and stainless steel parts, shall be given an even coat of high grade methacrylate lacquer, or transparent epoxy with a satin finish.

4. All castings, extrusions, and spinning shall be machined, sanded or similarly treated, and given a minimum of 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. The final finish shall be polyester power coat finish.

5. Exterior metal surfaces such as extruded parts or casings, 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. The final finish shall be polyester power coat finish.

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. The final finish shall be polyester power coat finish. 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. Sheet steel fixture housings, iron and steel parts, which have not received phosphating treatment 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". ASTM A525, G90

    b. Cadmium plating - 0.00015".

8. Polyester Coatings. Equivalent to Landscape Forms' Pangard II finishing process that includes a rust inhibitor primer and topcoat finish of polyester polyurethane that is U.V., chip and flake resistant.
    a. Color: Selected by the Engineer from the specified manufacturer offerings.
    b. Dry Film Thickness: As indicated, but not less than 3 mils for polyester topcoat and 4 mils total with primer.

B. Cadmium plate screws, bolts, nuts and other fastening and latching hardware in accordance with ASTM F1135. After plating, chase and finish threads intended to receive holding screws to ensure easy installation and removal of knurled-headed screws.

1. Parts operated under temperatures injurious to hot-dipped galvanizing shall be electroplated.

2. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating guaranteed in accordance with the general requirements to prevent electrolytic action between the two metals.

C. 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 the following requirements and tests:

1. Initial reflection factor is not less than 86 percent.

2. After 100 hours of exposure to a fade-o-meter, reflection factor is not less than 85 percent and finish shows no visible color change.

3. Exposure to 100 percent humidity at 110°F for 100 hours (Cook Box Test) shows no blistering or other effects.

4. Salt spray (20 percent sodium chloride) for 150 hours causes no breakdown of film.

2.5 WIRING

A. All wiring shall comply with the following:

1. 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-resistant characteristics.

2. 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. Wire within housing shall be entirely covered with flexible woven fiberglass sleeve.

3. Wiring shall be protected with tape or tubing at all points where abrasion may occur. Wiring shall be concealed within the fixture construction except where design or mounting dictates otherwise.

4. Minimize splices. Make splices with approved mechanical insulated steel spring type connectors, suitable for temperature and voltage conditions to which splices are to be subjected.

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.

6. 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.

7. Insulated bushings shall be installed at points of entrance and exit of flexible wiring.

8. 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.

9. All exposed wire shall be jacketed with a flexible woven fiberglass sleeve or similar flexible metallic or armored cable (BX) or EMT type conduit.

10. When allowed to be exposed, all junction boxes and conduit to be painted as per the Engineer’s request.

2.6 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 265 MA or 325 MA rapid start lamps shall be clearly marked to indicate the appropriate lamp type.

C. Similarly, fixtures equipped for operation of instant start or other type lamps shall be clearly marked "USE INSTANT START LAMPS ONLY", or as appropriate for other types as required. Clearly mark multi-level output ballasts as such, and indicate proper terminals for various outposts. Markings shall be clear and located to be readily visible to service personnel, but invisible from normal viewing angles when lamps are in place.

D. 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.

2.7 SOUND TRANSMISSION

A. 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.

2.8 THERMAL PROTECTORS

A. Provide thermal protectors as required by the NEC and other regulatory agencies in accordance with section 01060 of the General Conditions. Thermal protectors shall prevent operation of lighting fixtures in enclosed spaces or adjacent to combustible materials at temperatures at or above 90°C (194°F).

2.9 LAMPS

A. Provide electric lamps as shown in specifications or as modified in reviewed shop drawings plus 10 percent additional spare lamps of all types. All incandescent or quartz tungsten halogen lamps shall not be operated other than for testing prior to final inspection. Use inexpensive A-lamps during construction for all incandescent fixtures having medium base sockets.

B. Lamps as specified for the individual luminaires or lighting equipment shall be delivered and installed in fixtures and lighting equipment leaving these completely lamped with new lamps and in normal operating condition.

C. Tungsten halogen (quartz) lamps: Use lamps and lighting fixtures with compatible temperature ratings.

2.10 LAMPHOLDERS

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 over copper screw shells.

C. 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 light fixture components. All adjustable sockets shall be preset at the factory for lamp specified.

2.11 HIGH INTENSITY DISCHARGE LAMP BALLASTS

A. All high intensity discharge lamp ballasts shall be suitable for electrical characteristics of supply circuits to which connected, and 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. Install fuses readily accessible and easy to replace. Provide smallest acceptable fuses.

2. All ballasts shall be of the high power factor type, energy saving, "super low heat" as manufactured by Universal, or approved equal.

3. All HID ballasts to be encapsulated and have a maximum crest factor of 1.6.

4. All HID ballasts shall meet UL standards for "Class H" operations (180°C) and shall be constant-wattage autotransformers (CWA) type, unless noted otherwise.

5. UL and ANSI specifications with labels and/or symbols of approval by the UL and of certification by the Certified Ballast Manufacturers (CBM) as tested by the ETL

6. The component parts shall be designed, fabricated, and assembled in accordance with the latest requirements of the NEC

7. Ballasts shall provide safe and reliable operation of the specified lamps.

8. Identical ballasts from the same manufacturer shall be installed within each fixture type.

9. Provide the lowest sound rating available for the lamps specified and clearly show their respective sound ratings. Ballasts found by the Engineer to be unduly noisy shall be replaced without charge prior to acceptance of the Work. Inform Engineer in writing if ballasts with sound rating "A" are not available.

10. Ballasts intended for outdoor use shall have a minimum lamp starting temperature of 20°F, except as noted otherwise.

11. Where ballasts are remote from fixture housing, provide suitable enclosures for installation with the conduit and wire from the ballast to the lamp socket clearly marked "Caution", "High Voltage". All remote ballasts shall 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.

B. Electronic Ballasts, Additional Requirements

1. Physically interchangeable with electromagnetic ballasts in new or existing fixtures.

2. Operate lamps at frequencies between 25 and 40 KHz from 60 Hz input source with less than 10% flicker, at ambient temperature of 50°F to 105°F with 60°C maximum case temperature during operation.

3. Maximum light regulation ±5% with ±10% input voltage variation.

4. Solid-state consisting of rectifier, high frequency inverter, power control and regulation circuitry, in steel case, marked with manufacturer's name, part number, supply voltage, sound rating, power factor, open circuit voltage, RMS current draw, input watts, starting current, crest factor, efficiency and UL listing.

5. Ballast life to be unaffected by lamp failure.

6. Minimum ballast factor of 95%.

7. Maximum current crest factor of 1.7.

8. Maximum total harmonic distortion of 10%.

9. Minimum power factor of 90%.

10. Withstand line transients per IEEE 587, Category A.

11. Rated life of 30,000 hours based on 10 hours per day.

12. Submit with shop drawings a certified test report from an independent test laboratory demonstrating conformance with specified requirements.

C. Except where noted otherwise, rigidly mount ballasts to inside top of fixture housing, with ballast surfaces and housing in complete contact for efficient conduction of ballast heat. Secure ballasts with removable fasteners (screws or bolts) instead of rivets.

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

2.13 REFLECTORS

A. 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.
4. Low iridescence for fluorescent sources.
5. Specular finish color as selected by the Engineer.
6. All reflectors 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.
7. Cone flange formed as an integral part of the cone and with identical color and finish, unless specified otherwise. Width of the flange covers all ceiling opening without light leaks or hardware visible.

2.14 LENSES

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. Glass edges exposed during the relamping process shall be gasketed to prevent chipping or cracking.

C. Acrylic lenses shall be 100 percent virgin acrylic polymer, colorless, as manufactured by Rohm & Haas, DuPont or equal unless noted otherwise.

2.15 FIXTURE TRIMS

A. Provide trim details as shown on the Drawings or as specified, which are indicative of appearance and dimensional requirements. The trim finish and dimensions shall be subject to the approval of the Engineer.

B. Provide a mounting frame or ring with lock at recessed or semi-recessed light fixtures 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 re-lamping.

2.16 SUPPORTS

A. Comply with all applicable codes requiring independent support for lighting fixtures.

B. Provide plaster frames and mounting frames for fixtures as required, appropriate for ceiling construction in which installed.

C. Provide formed, rolled, or cast metal attachment devices including brackets, plaster rings, saddle hanger and tie bars, of rigidity and strength to maintain continuous alignment of installed fixtures.

D. Provide necessary hardware including stems, plates, plaster frames, hangers, and similar items, for safe support of fixture.

E. Provide fastening devices of positive locking type, not requiring special tools to apply or

remove. Do not use tie wires in place of fastening devices.

F. Provide fixture supports adequate to support the weight of fixture.

1. Provide supporting members; primed or paint-dipped to resist corrosion.

2. Finish exposed hanging devices to match fixture finish unless indicated otherwise.

2.17 ACCEPTABLE MANUFACTURERS

A. LED & HID Lighting Fixtures – Pole Mounted:
1. Lithonia
2. Approved equal

B. Ballasts & Drivers:
1. Advance
2. Magnetek
3. Lutron
4. Motorola
5. Valmont
6. Prescolite.
7. Sylvania

C. Lamps:
1. General Electric Co.
2. Osram/Sylvania
3. Phillips
4. Westinghouse.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Setting and Securing: Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved shop drawings. Conform to the requirements of NFPA 70.

B. Mounting: Mounting heights specified or indicated are to bottom of suspended and ceiling mounted fixtures and to center of wall-mounted fixtures.

C. Support: Recessed and semi-recessed fixtures may be supported from suspended ceiling support system ceiling tees if the ceiling system support rods or wires are provided with a minimum of four rods or wires per fixture and located not more than 6 inches from each corner of each fixture.

D. Coordination: Coordinate with work specified in other sections as appropriate to properly interface installation of lighting fixtures with other work.

E. Install all lighting fixtures as shown on the Drawings at heights indicated, and in accordance with the fixture manufacturer’s written instructions.

F. Fixtures in exposed structure areas shall be provided with channels, pendants, and other accessories required to mount fixtures.

G. Replace all high intensity discharge (H.I.D.) fixture ballasts and LED drivers

during construction period.

3.2 GENERAL

A. Install fixtures complete with lamps and with equipment, materials, parts, attachments, devices, hardware, hangers, cables, supports, channels, frames and brackets necessary to make a safe, complete, and fully operative installation.

B. Do not install reflector cones, apertures, plates, lenses, diffusers, louvers, and decorative element of fixtures until completion of wet work, plastering, and general clean up in area of fixtures.

C. Mount fixtures at heights and locations indicated on Drawings or as directed by the Engineer. Fixture locations indicated on Electrical Drawings are generalized and approximate. Carefully verify locations with the lighting plans and other reference data prior to installation. Check for adequacy of headroom and non-interference with other equipment, such as ducts, pipes or openings. Bring conflicts to the Engineer before proceeding with work and ordering fixtures.

D. Adequately protect housing of recessed lighting fixtures during installation by internal locking or framing to prevent discoloration of sides, and discoloration of threaded lugs; maintain perfect lug alignment and match corresponding holes in frames and rims. Insert holding screws freely without forcing, easily removable for servicing.

E. Upon completion of installation, lighting fixtures and lighting equipment shall be in first class operating order and free from defects in condition and finish. At time of final Inspection, all fixtures and equipment shall be clean, fully lamped, and complete with required lenses; replace damaged diffusers, reflectors, side panels and other parts prior to final inspection.

F. Support Services:

1. Lighting Control System Startup: Provide technician to confirm proper installation and operation of system components.

2. Training: Provide training of Owner's personnel in operation and programming of lighting control.

3. Programming: Provide following manufacturer's system programming on floppy disk or CD compatible with central PC:

    a. Wiring documentation.

    b. Operating schedules.

3.3 COORDINATION

A. Give ample notice of special openings required for placing equipment in building; avoid cutting completed work.

B. Furnish materials and labor for work under this Section in ample time, and in sufficient quantities so work may be installed in proper sequence to avoid unnecessary cutting of floors and walls.

C. Coordinate and schedule work with work of others, including Utility Company and Telephone Company, to avoid delay in proper installation and completion of respective work.

D. Coordinate the sizes of any banners to be mounted with the Owner so that height makes for a snug installation.

3.4 ACCESSIBILITY

A. Install equipment such as junction and pull boxes, fixture housings, transformers, ballasts, switches and controls, and other apparatus that must be reached periodically for operation and maintenance, easily accessible.

3.5 ADJUSTMENTS

A. Perform final focusing and adjustment, in presence of the Engineer of adjustable fixtures as required.

3.6 CLEANING

A. Immediately prior to occupancy, clean reflector cones, reflectors aperture plates, lenses, louvers, lamps and decorative elements. De-staticize lenses after cleaning, install free of finger and dirt marks. Lamp shall also be clean and free of dust upon completion.

3.7 FIELD QUALITY CONTROL

A. Tests: Upon completion of installation of lighting fixtures, and after building circuits have 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.

B. Replacement Lamps: At the time of substantial completion and prior to field tests, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing.

C. Touch-Up Paint: Prior to substantial completion, review the conditions of all poles, bollards and other fixtures and touch-up paint all scratches, chips or defects. Along with substantial completion, turn over to the Owner not less than one (1) gallon of touch-up paint that exactly matches the finish of each type.

END OF SECTION