SECTION D

SHELBY COUNTY GOVERNMENT

ENGINEERING DEPARTMENT

MECHANICAL, ELECTRICAL & PLUMBING SPECIFICATIONS

SECTION 15010
BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DIVISION 15000 INDEX

DIVISION 15 - MECHANICAL

Section 15010 - Basic Mechanical Requirements
15410 - Plumbing Piping

1.02 SECTION INCLUDES

Comply with all Division 1 Specifications. When Division 15 sections are more stringent, they take precedence. All Division 15 sections are bound by these requirements. In case of conflict, obtain a decision from the Architect/Engineer.

A. Work Included.
B. Prime Contractor Requirements and Drawing Notes.
C. Related Work.
D. Equipment/Items furnished by others and Installed by Division 15.
E. Items to be furnished for Installation by Division 16
F. Job and Job Site Conditions.
G. Intent.
H. Deviations.
I. Quality Assurance.
J. Codes and Standards.
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Q. Warranties.
R. Contract Closeout.

1.03 WORK INCLUDED

A. All labor, materials, tools, and services for a complete installation of mechanical and plumbing equipment and systems contained in the Contract Documents.

B. Principal features of the work included are:

1. Excavate, replace 6" below grade sanitary sewer piping for the East & West wings and backfill.

2. Coordinate with the site utility plans to avoid other work and to time the installation so as to have all work in place prior to any grading work. Comply with materials and methods indicated in civil plans and project manual where they are more stringent.

3. Preparation and submittal of maintenance manuals, shop drawings, product data, and samples.

4. Maintaining a record set of drawings, marking them to indicate locations of concealed items, and deviations made to suit conditions and production of mechanical as-built drawings.

5. Cutting and patching for mechanical work. Providing all support structures as needed for mechanical work.

1.04 RELATED WORK

A. Division 1: General Requirements
B. Division 3: Concrete

1.05 JOB AND JOB SITE CONDITIONS

A. Contractor use of Site:
   1. Limit use of site to cause as little interference or interruption of existing utilities and services as possible.
   2. Schedule work which will cause interference or interruption in advance with the Owner, General Contractor, G.C., authorities having jurisdiction, and all affected trades.
   3. Parking area for Contractor's trucks is allowed only in areas designated by the Owner. Arrangements will be made for delivery of materials and removal of debris in locations designated by the Owner.
   4. Remove all boxes and large debris and place in dumpster on a daily basis. Keep corridors and walkways clear. Do not block exits. Broom cleaning is required on a daily basis.

B. Safety:
   1. Erect substantial barricades, trench and floor opening coverings, and/or fencing sufficient to prevent injury to persons or damage to property. Construct to prevent entry of unauthorized persons.
      a. Construct dust curtains, barriers, barricades, etc., as required to maintain safe working conditions using non combustible materials.
   2. All temporary works required by the Contractor to fulfill his Contract shall at all times comply with local and governing codes and laws and furnish protection to workmen and the public.
      a. Shore all trenches and ventilate all confined spaces as required by governing codes. Use only trained and certified personnel to perform work in trenches and confined spaces.
   3. Do not block or obstruct building entrances or exits.
   4. Provide temporary lifting and hoisting devices and equipment as required to distribute materials and equipment to various locations.
   5. Provide temporary heating as required for the proper protection and drying of all work and for freeze protection of HVAC and plumbing piping.

C. Material Storage: Contractor and subcontractors shall provide and maintain adequate protection and security for materials stored on site. Provide/construct in area only as directed by the Owner.
   1. Provide suitable and sufficient enclosed and covered spaces, with raised flooring, to protect materials and equipment subject to damage by weather or construction.
   2. Provide sheds, as necessary, to suitable store materials and equipment

needing limited protection.

D. Electricity, Natural Gas, and Water for Construction: The Contractor shall pay for electricity, natural gas, and water required for construction purposes. The Contractor shall provide and run the necessary lines, temporary services, standpipes, hoses, extension cords, etc. for construction use.

E. Signage: The Contractor is not allowed to erect signage without the written consent of the Owner.

F. Examine the Contract Documents to determine how other work will affect the execution of mechanical work. Coordinate with affected trades and schedule work as necessary to avoid construction delays.

G. Determine sizes and verify locations of all existing utilities on or near site.

H. Make arrangements for and pay for all necessary permits, licenses, and inspections.

1.06 INTENT

A. The Contract Documents (drawings, specifications and any addenda) describe the work of this project. Any item mentioned in one part shall be as binding as though mentioned in all.

B. The Contract Documents form a guide for a complete mechanical installation. Where an item is reasonably necessary for a complete system, but not specifically mentioned, such as runnout piping, supports or transitions, offsets, drains, wiring, interlocks, linkages, disconnects, starters, etc., provide same at no additional cost.

C. Mechanical layouts indicated on drawings are diagrammatical only. Exact locations of ducts, pipes, and equipment shall be governed by field verification of available space, the drawings of related trades, and adjustments to assure that the new work will fit in available space while maintaining all required service accessibility. Field coordination drawings are encouraged to prevent conflicts. Coordination drawings are required for equipment rooms, outdoor equipment sites and all congested areas to verify the available space and resolve conflicts with other trades. Architect/Engineer reserves the right to make reasonable changes in location of mechanical equipment and appurtenances without affecting the Contract cost.

D. It is the intent of these specifications and the Contract Documents that each and every fixture, piece of equipment, appliance, and any other related articles shown on the drawings or specified herein, as required for proper completion of the work, shall be completely installed, connected, wired, and made satisfactorily operable for the use and service for which it was intended. The manufacturer or vendor of any fixture, equipment or appliance shall see to it that all connections, whether mechanical or wired, are properly built-in or attached to the article when or before it reaches the job site so it will operate. Notwithstanding any omission or failure on the part of suppliers to provide suitable connections, it is the responsibility of the Contractor to install and connect such articles.

1.07 DEVIATIONS

A. No deviations from Contract Documents is allowed without full knowledge and written consent of Architect/Engineer.

B. Should Contractor find during progress of work, that in his judgement, existing conditions warrant a modification of any particular requirement desirable he shall report such item with any applicable recommendation promptly to the Architect/Engineer for decision or instructions.

1.08 QUALITY ASSURANCE

A. Comply with applicable local, state and federal codes and requirements of officials having jurisdiction.

B. Comply with applicable requirements of recognized industry associations which promulgate standards for the various trades. (See individual Sections of Division 15.)

C. Employ only skilled and experienced mechanics for this work. Employ competent, qualified mechanics to supervise the work.

1.09 CODES AND STANDARDS

A. Perform work specified in Division 15 in accordance with codes and standards listed below, and such standards that may be specified in other Sections. When these specifications are more stringent, they take precedence. In case of conflict, obtain a decision from the Architect/Engineer. The most current edition of the following codes shall apply except the building codes shall be the set enforced at the time construction documents are released for bid.

1. NFPA 90A: Air Conditioning and Ventilation Systems.
2. NFPA 101: Life Safety Code.
3. SBCCI Building Code.
4. SBCCI Mechanical Code.
5. SBCCI Plumbing Code.
6. SBCCI Gas Code.
7. SBCCI Fire Code.
8. North Carolina State Building Code, Volume 1-C, General Construction; Handicapped Accessibility Requirements
9. State Energy Code.
10. AGA: American Gas Association.
11. ANSI: American National Standards Institute.
12. ARI: American Refrigeration Institute.
13. ASHRAE: American Society of Heating Refrigeration and Air Conditioning Engineers.
14. ASME: American Society for Mechanical Engineers.
15. ASTM: American Society for Testing and Materials.
16. AWWA: American Water Works Association.
17. ADA: Federal Register, Vol 56, No. 144, Rules and Regulations.
18. MSS: Manufacturer's Standardization Society of the Valve and Fitting Industry.
19. NEMA: National Electrical Manufacturers' Association.
20. NFPA: National Fire Protection Association.
21. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
22. UL: Underwriters' Laboratories, Inc.

23. National Association of Corrosion Engineers Standard RP-01-69 and RP-02-85 for Recommended Practice.

1.10 COORDINATION

Employ and pay for services of a person or firm technically qualified and experienced in field of coordination for the type of work required for this Project.

A. Coordinate work of Divisions 15 with work of Division 16 and other affected Divisions. Check compatibility with equipment, electrical characteristics, and operational control requirements.

B. Visit site and be informed of conditions under which work must be performed. Check field dimensions and clearances and relationship to available space and anchors. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform all work involved.

C. Immediately after notification of contract award meet with affected trades, review shop drawings, product data, and samples for compliance with Contract Documents and for coordination among work of all sections of the Project Manual. Coordination drawings are required for equipment rooms and areas congested with equipment in order to organize installation of Products, for the efficient use of available space, to properly sequence the installation and to identify potential conflicts.
   1. Coordination drawings shall be 1/4" scale on 30"x42" vellum quality tracing paper as a minimum. In congested areas where drawing clarity will be questionable increase the drawing scale and or provide sections and elevations. Note above finish floor elevation (AFF) of pipes, ducts, etc. in plan view drawings. Drafting and lettering shall be located to maximize the readability of the drawings.
   2. When drawings are complete transmit to general contractor for review and approval, then transmit to Architect/Engineer.
   3. Submit coordination drawings after submittal review is complete, but before any work is begun in the equipment rooms. Revise and resubmit package as required, identify all changes made since previous submittal.
   4. After Architect/Engineer review of original and revised documents, pay for, reproduce, and distribute one copy to each to the affected trades.
   5. Coordination documents will form a part of the "As-Built" document set. Division 15 shall maintain documents for the duration of the Work, recording changes due to site instructions, modifications, or adjustments including architectural. Submit Coordination documents to Owner with claim for final Application for Payment.
   6. Store original coordination documents separate from construction documents.

E. Carefully examine specifications and drawings to be thoroughly familiar with items which require fire protection, plumbing, HVAC connections, control interface, structural support, painting and coordination.

F. Notify other tradesmen of any deviations or special conditions necessary for installation of work. Resolve interferences between work of various Contractors prior to installation. If necessary, remove and properly reinstall, without additional cost to the Owner, work not installed in accordance with specifications and drawings and without proper coordination. Architect/Engineer shall be the mediating authority

in deviation and disputes arising on the project.

G. Where conflicts exist between Contract Documents, Contractor shall refer such conflict to the Architect/Engineer for decision before proceeding with work.

H. Equipment shall be installed in accordance with manufacturer's recommendations. Where conflicts occur between manufacturer's recommendations and Contract Documents, refer such conflicts to Architect/Engineer for decision before proceeding with work.

I. Insofar as it is possible to determine in advance, advise masonry tradesmen to leave proper chases and openings. Place all outlets, anchors, sleeves, and supports prior to pouring concrete or installation of masonry work. Should Contractor neglect doing this, and cutting and/or patching required to be done is at this Contractor's expense.

1.11 SUBMITTALS

A. Apply Contractor's stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

B. The purpose of shop drawing submittals by the Contract Documents is to demonstrate to the Architect/Engineer that the Contractor understands the design concept and that he demonstrates his understanding by indicating the type of equipment and materials he intends to furnish and install and by detailing the fabrication and installation methods to be used.

C. Deviations from the specifications and drawings shall be noted on the shop drawing or equipment brochure. If none are noted it shall be assumed the material fully meets the specified requirements.

D. If deviations, discrepancies, or conflicts between shop drawing or equipment brochures and the Contract Documents are discovered either prior to or after shop drawing submittals are processed, the Contract Documents shall control and shall be followed.

E. Shop Drawings: Submit copy of shop drawings on reproducible vellum quality tracings, including:
   1. Automatic temperature control system.
   2. Layouts of equipment rooms.
   3. Duct, Piping, and other work located in congested areas.

F. Brochures: Submit one copy to the Engineer for approval. The Engineer will issue his comments. Upon submittal approval by the Engineer prepare the number of copies specified under Division 1, but not less than 10, and distribute accordingly, manufacturer's brochures including:
   1. Identify Project, Contractor, Subcontractor or supplier; pertinent Drawing sheet and detail number(s), and specification Section number, as appropriate.
   2. Complete descriptions.
   3. Illustrations.

4. Rating data, accessories, dimensional data, and features as scheduled on drawings and specified herein. Highlight data specific to this project with red or yellow markings so that the unit submitted is clearly identified.
5. Capacities stated in the terms specified.
6. When specified submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing.
7. When specified provide manufacturers' certificate of performance. Certificates may be recent or previous certified test results on material or Product, but must be acceptable to Architect/Engineer.
8. Clearly and completely cross out any features, items, dimensions, options, accessories and descriptions that are not included or pertinent to the equipment offered on this project.

G. Schedule submittal to expedite the Project, and deliver to the prime Contractor for review and distribution.

H. Provide space for Contractor and Architect/Engineer review stamps.

I. Revise and resubmit submittal as required, identify all changes made since previous submittal.

J. Distribute copies of reviewed submittal to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

K. Submit Construction Progress Schedule for Architect/Engineers review.
1. Revise and resubmit as required.
2. Submit revised schedules with each Application for Payment, identifying changes since previous version.
3. Indicate estimated percentage of completion for each item of Work at each submission.

1.12 REINSPECTION FEES

A. Should the Architect/Engineer perform reinspection due to failure of the Work to comply with the claims of status of completion made by the Contractor:
1. The Contractor will compensate the Architect/Engineer for such additional services at the rate of $100/hour, including travel to and from job site.
2. Such compensation will be made direct from the Contractor to the Architect/Engineer.

1.13 RECORD DRAWINGS

A. Keep a record set of Contract Drawings, Specifications, Addenda, Change Orders and other Modifications to the Contract, and Reviewed shop drawings, product data, and samples at the job site exclusively for recording deviations from those drawings which are necessary because of job conditions. Label each document "Project Record". Store Record Documents separate from documents used for construction. Record locations and depths of buried and concealed piping, utilities, and appurtenances by indicating top depths and the distances from fixed, easily identifiable objects such as structural or exterior building walls or columns. Where pipes, utilities, and appurtenances are concealed in walls, indicate distances from building corners or other building features not likely to be disturbed by future

alterations. Mark deviations in colored pencils so that work of various systems can be easily identified. Deliver this set to the G.C. after deviations are recorded on vellums as described herein.

B. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Change Order, Addenda, and Modifications.

C. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Field changes of dimension and detail.
   2. Details not on original Contract Drawings.

D. When work is completed, record all deviations on magnetic media CAD drawings, delete Architect/Engineer seal from all documents, add the notation "As-built" on each sheet, and submit reproducible vellums as well as magnetic media copies of completed record "as-built" drawings to Prime Contractor for review and approval.

E. Forward final approved vellum tracings and magnetic media files to the Architect/Engineer for approval with final application for payment. Revise the files as required by Architect/Engineer and resubmit where any deviations are not included.

1.14 FINAL CLEANING

A. In addition to daily broom cleaning, Contractor will provide final cleaning prior to acceptance of systems for beneficial use.

B. Remove waste and surplus materials, rubbish, and construction facilities from the site. Cleaning and disposal practices must comply with all codes, ordinances, regulations and anti-pollution laws.

C. Building Finished Surfaces and Equipment:
   1. Remove grease, mastic, adhesives, dust, dirt, stains, labels, fingerprints, and other foreign matter from sight-exposed interior and exterior surfaces.

1.15 OPERATING AND MAINTENANCE MANUALS

A. Three sets of the following data are required:
   1. Operating and maintenance instructions.
   2. Spare parts lists.
   3. Copies of approved submittal data.
   4. Equipment warranties.
   5. List showing company name, address, telephone number and local person to contact for service on equipment and systems.

B. Arrange each set of data in an orderly way with section tabs, and bind each set in a premium quality three-post, hard cover binder.
   1. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS", title of project.
   2. Contents: Prepare a Table of Contents for each volume, with each Product or

system description identified.

3. Part 1: Directory, listing names, addresses, and telephone numbers of Architect/Engineer, Contractor, Subcontractors, and major equipment suppliers.
4. Part 2: Operation and maintenance instructions. Including the following:
   a. Significant design criteria.
   b. List of equipment.
   c. Parts list for each component.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.
   f. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
5. Part 3: Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Certificates.
   c. Photocopies of warranties, and bonds.

C. Submit one copy of completed volumes in final form 7 days prior to final inspection. This copy will be returned after final inspection, with Architect/Engineer comments. Revise content of documents as required prior to final payment application.

D. Submit final volumes revised, within 7 days after final inspection.

1.16 WARRANTIES

A. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

B. Provide Table of Contents and assemble in 3-ring premium quality binder.

C. Submit prior to final Application for Payment.

D. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 7 days after acceptance, listing date of acceptance as start of warranty period.

E. A minimum of one year parts and labor warranty is to be provided for the systems installed. Where additional warranty requirements are noted the more stringent shall apply. Where existing systems are affected by this project they are to be included in the one year warranty until proven that any problem they experience is not directly caused by modifications made during this project.

1.17 CONTRACT CLOSEOUT:

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's inspection.

B. Submit final inspection tag to prime contractor.

C. Submit final Application for Payment identifying total adjusted Contract Sum,

previous payments, and sum remaining due.

D. Owner will occupy and have use of all portions of the building.

PART 2 - PRODUCTS

2.01 SECTION INCLUDES

Comply with all Division 1 Specifications. When Division 15 specifications sections are more stringent, they take precedence. In case of conflict, obtain a decision from the Architect/Engineer.

A. Materials and Equipment.
B. Transportation and Handling.
C. Storage and Protection.
D. Demolished and Abandoned Equipment.
E. Basic Materials / Methods.

2.02 MATERIALS AND EQUIPMENT - GENERAL

A. Within the Contract Documents relating to mechanical work, manufacturers' names, catalog numbers, and other proprietary references to materials and equipment are made. Such references are made to establish the standards of quality and type required and not to limit competition. Most known or acceptable manufacturers of competitive products are listed in applicable sections as "approved equals". Reasonable requests for substitution or additions to "approved equals" will be considered, but the Architect/Engineer in concert with the Owner will be the sole judge of acceptability of items proposed as substitutes.

B. Materials and equipment used in carrying out these specifications are to be of domestic manufacture (unless specified to be of a foreign manufacturer), shall bear UL or other recognized testing laboratory label when such labels are available. Contractor may submit for Architect/Engineer approval foreign manufactured material or equipment, including necessary product information, evidence of successful experience with use of product in U.S., and a list of institutions with individual in charge to contact as a reference.

C. Use specified or "approved equal" items as a basis for bidding.

D. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of the Work. Products may also include existing materials or components required for reuse.

E. Do not use materials and equipment removed from existing premises, unless specifically permitted by the Contract Documents.

F. Provide interchangeable components of the same manufacturer, for similar components.

2.03 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to assure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

2.04 STORAGE AND PROTECTION

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Store and protect Products in accordance with manufacturer's instructions, with seals and labels intact and legible. Where that is not practical, provide cover and shielding for all items with protective materials to keep them from being damaged. Store sensitive Products in weather-tight, climate controlled enclosures. Use care in loading, transporting, unloading, and storing to keep items from being damaged.

B. Arrange storage of Products to permit access for inspection. Periodically inspect to assure Products are undamaged and are maintained under specified conditions.

C. Protect nameplates on motors, pumps, pressure vessels and similar equipment. Do not paint or insulate over nameplate data.

D. Protect plumbing fixtures and brass or chromium plated trim, valves and piping from damage. Cover fixtures during work of finishing trades.

E. Keep dirt and debris out of pipes and ducts.

F. Repair, restore, and replace damaged items.

G. Cover factory finished equipment during work of finishing trades, e.g., fan coils, fin tubes, etc.

2.05 DEMOLISHED AND ABANDONED EQUIPMENT

A. All equipment that is removed or functionally abandoned as a part of this contract shall be relocated or disposed of as directed by Owner. Stockpile this equipment in a location as directed by Owner. Take precautions to protect equipment from damage, freezing, corrosion or other adverse conditions which would have a negative effect on the equipment. Repair any damage to equipment caused by the contractor failing to take the aforementioned precautions. After Owner review of equipment, and written summary of equipment he wishes to keep, dispose of all unwanted equipment.

B. The following items are specifically identified as to be turned over to the Owner:
1. None.

PART 3 - EXECUTION

3.01 SECTION INCLUDES

Comply with all Division 1 Specifications. When Division 15 specifications sections are more stringent, they take precedence. In case of conflict, obtain a decision from the Architect/Engineer.

A. Locations.
B. Excavating and Backfilling.
C. Cutting and Patching.
D. Counterflashing.
E. Connection to Equipment Furnished by Owner.
F. Firestopping
G. Service of Systems.
H. Acceptance of Systems.

3.02 LOCATIONS

A. Mechanical layouts indicated on drawings are diagrammatical. Exact locations of ducts, pipes, and equipment may vary because of conflicts with work of other trades and equipment manufacturer deviations. Work out conflicts where relocations will not affect operation or appearance of systems. Where conflicts cannot be worked out between trades, Architect/Engineer will decide. Architect/Engineer reserves the right to make reasonable changes in locations without additional cost.

B. Locate equipment requiring periodic servicing so that it is readily accessible. Don't back up service sides to walls, nor place it too close to other equipment to make service difficult or impractical. Where equipment is above an accessible ceiling locate equipment within 18" of the ceiling so that it may be reasonably service from a standing position on a ladder.

3.03 EXCAVATING AND BACKFILLING

A. Provide trenching, excavating, and backfilling necessary for performance of mechanical work.

B. Trenching and excavation to be unclassified. No extra will be paid in the event that rock is encountered. The contractor shall be responsible for the repair of concealed cables, electrical, piping, structure, plumbing or any utility that is damaged as a result of excavation.

C. Provide sheathing, shoring, dewatering, and cleaning necessary to keep trenches and their grades in proper condition for work to be carried on. Comply with all regulations regarding shoring and workers in trenches. Submit shop drawings of shoring to Architect/Engineer for review where trench depth exceeds 84" depth.

D. Depth of excavation to provide a minimum of 24" cover above top of pipe. Excavation to be carried to a depth of at least 6" below bottom of pipe elevation. Fill below pipe (6"), around pipe, and a minimum of 12" above pipe with sand or Class "B" crushed stone tamped firm and even. Use several layers of backfill, none over 9" deep, compact each layer to 95% Standard Proctor (relative compaction)

Separate top soil during excavation. Final layer of backfill (12" minimum) to be top soil. Trenches to be at least 18" wider than pipe with batterboards placed every 25'. Backfilling shall be done to exclude use of rock or stone above sand or Class "B" crushed stone. In no case shall backfilling contain large rocks, tree roots, organic materials, trash or debris. Backfilling should carefully restore surface to its original condition.

E. Piping through or under foundation walls must be sleeved with schedule 40 pipe or located 6" below footing.

F. Where finished surface is asphaltic pavement or concrete the finished surface shall match adjacent surface and a minimum of 6" concrete shall provide a base for the finished surface. Finished surface shall be by others unless work of Division 15 should occur after the finished surface is in place or if Division 15 work disturbs existing finished surfaces in which case DIV15 will bear full responsibility to restore paving to comply with paving and substrate specifications.

3.04 CUTTING AND PATCHING

A. Includes all cutting, fitting and patching, including attendant excavation, backfill and shoring required to complete the work or to:
1. Make its several parts fit together properly.
2. Uncover portions of the work to provide for installation of ill-timed work.
3. Remove and replace defective work.
4. Remove and replace work not conforming to requirements of Contract Documents.
5. Remove samples of installed work as specified for testing.
6. Provide routine penetrations of non-structural surfaces for installation of piping, ductwork and electrical conduit.
7. Restore surfaces and voids, patch openings and conceal old surfaces left by or uncovered by demolition.

B. Submit a written request to Architect/Engineer well in advance of executing any cutting or alteration which affects:
1. The work of the Owner or any separate contractor.
2. The structural value or integrity of any element of the Project.
3. The integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
4. The efficiency, operational life, maintenance or safety of operational elements.
5. The visual qualities of sight-exposed elements.
6. The temperature of a beam or column. (In general the beam flanges are not to be welded to for attachment of mechanical supports)

C. Inspect existing conditions of the Project, including elements subject to damage or to movement during cutting and patching.
1. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work.
2. Report any unsatisfactory or questionable conditions to the Architect/Engineer in writing; do not proceed with the work until the Architect/Engineer has provided further instructions.
3. Provide adequate temporary support as necessary to assure the structural value or integrity of the affected portion of the work.

4. Provide devices and methods to protect other portions of the Project from damage.
5. Provide protection from the elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water.

D. Execute cutting and demolition by methods which will prevent damage to other work, and will provide proper surfaces to receive installation of repairs.

E. Execute excavation and backfilling by methods which will prevent settlement or damage to other work.

F. Employ the original installer or Fabricator to perform cutting and patching for weather-exposed or moisture-resistant elements and sight-exposed finished surfaces.

G. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

H. Restore work which has been cut or removed; install new products to provide completed work in accord with requirements of Contract Documents.

I. Fit work airtight to pipes, sleeves, ducts conduit and other penetrations through surfaces.

J. Correct unnecessary damage, restore structural integrity and finish surfaces caused due to installation of mechanical work.

3.05 ACCEPTANCE OF SYSTEMS

A. Complete the following before requesting a final inspection;
1. Work required under this division of specifications except as permitted.
2. System balancing.
3. Control system checkout.
4. Furnish required operating instructions and closeout documents.
5. Owner will accept job on basis of tests and inspections. Division 15 Contractor is to furnish necessary mechanics, test & balance, and controls personnel to operate the system, make any necessary adjustments, and assist with final inspection.
6. If directed by Owner/Architect/Engineer, expose concealed work to demonstrate that work has been properly performed and restore work at no charge.
7. G.C. representative must be present and sign off on all testing. Notify Owner 48 hours prior to scheduled testing.

END OF SECTION

DIVISION 16 - ELECTRICAL
SECTION 16010 - GENERAL PROVISIONS

PART 1 - GENERAL

DIVISION 16000 INDEX

1.01 WORK INCLUDED

A. All labor, materials, tools, and services for a complete installation of electrical equipment and systems contained in the Contract Documents. The finished system is to be complete in all details and finished to the best standard of professional installation.

B. Principal features of the work included are:

1. Provide new outdoor lighting panel, lighting contactor, photocell and time clock for outdoor lighting control.

2. Provide new pole mounted and wall mounted site lighting.

3. Remove wall mounted light fixtures, raceways and conductors. Schedule and coordinate removal of MLGW leased outdoor lighting with MLGW.

4. Provide all associated raceways, wiring, panelboards, supports, interlocks, terminations, connections, equipment, gear, lugs, fuses, feeders, circuit breakers, disconnects, relays, instrumentation, enclosures and accessories for a complete and operable system.

C. Provide temporary electrical service where required for construction and to maintain normal use of the facility by the occupants during construction. Note: All interruptions (of any duration) in power shall be coordinated with the Owner at least two weeks in advance.

D. Penetrations, excavation, backfill and restoration of disturbed area for electrical work.

E. Seismically restrain all new work to SBCCI Standard Building Code requirements.

1.02 RELATED WORK REQUIRED UNDER THIS DIVISION

A. Flashing of conduits into roofing and outside walls.

B. Cutting, trenching, backfill and patching for electrical work.

1.03 OWNER'S REPRESENTATIVE

A. Where the term "Owner's Representative" is used throughout this specification it shall be interpreted to be the Engineer.

1.04 QUALITY ASSURANCE

A. Comply with applicable local, state, and federal codes.

B. Electrical work shall be guaranteed against faulty material or workmanship for a period of one year from the date of final acceptance. If the project is occupied or the systems placed into operation in several phases at the request of the Owner, then the guarantee of each system or piece of equipment used, shall begin on the date each system or piece of equipment was placed in satisfactory operation and accepted as such, in writing, by the Owner. The use of building equipment for temporary service and testing does not constitute the beginning of the warranty.

C. Equipment and material provided under this Division shall be periodically inspected and serviced by competent mechanics. This function becomes the responsibility of the Owner when the system is accepted by the Owner. The one year material and workmanship guarantee is not intended to supplant normal inspection or service and shall not be construed to mean the Contractor will provide free service for normal maintenance items such as periodic lubrication and adjustment due to normal use, nor to correct without charge, breakage, maladjustment, and other trouble caused by improper maintenance.

D. Any electrical equipment provided under this division shall be turned over to the Owner in lubricated, tested and ready to use condition. Instructions on care and maintenance of equipment shall be included in the operating instructions.

1.05 STANDARDS

A. Perform work specified in Division 16 in accordance with standards listed below. Where these specifications or local codes are more stringent, they shall take precedence. In case of conflict, obtain a decision from the Engineer.

1. NFPA-101 (2000).
2. NFPA-70: National Electrical Code. (1999).
3. NFPA-72: National Fire Alarm Code. (1999).
4. Local Electrical Code. Local Ordinances pertaining to electrical work.
5. ANSI Handicapped Code-A117.1. (1998).
6. State Energy Code. (Applicable edition date).
7. SBCCI Building Code. (1999).

1.06 SUBMITTALS

A. Within 14 days after the award of contract, submit for review to the Engineer complete list of materials, equipment, accessories and alternates submitted as

equals by vendors proposed for use on the project together with costs for an evaluation to select supplier. This review shall be conducted prior to submission of shop drawings and product data.

B. Brochures: Based on manufacturers selected under foregoing paragraph, contractor is to submit complete descriptions, illustrations, specification data, etc., of all materials, fittings, devices, fixtures, special systems, etc., as required by the individual sections of this chapter.

C. When specifications list more than one manufacturer and do not say "or approved equal", furnish one of the manufacturers named.

D. Shop drawing submittal and review are intended to show that the Contractor understands the design concept. Submittals demonstrate that the Contractor understands the materials and fabrication and construction methods to be used. Submittals are not intended to modify or change the contract documents.

E. Shop drawings and submittals shall bear the stamp or approval of the Contractor as evidence that they have been checked by him and certified as to having met the contract documents. Submittals without this stamp of approval will not be considered and will be returned for proper resubmission. If the submittals show variances from the requirements of the contract documents, the Contractor shall make specific mention of such variation in his letter of transmittal in order that, if acceptable, suitable action may be taken for proper adjustment; otherwise the Contractor shall not be relieved of the responsibility for executing the work in accordance with the contract documents.

F. Shop Drawings: In addition to the above, submit four copies of shop drawings for major materials where called for or when requested by the Engineer for the following:
   1. Panelboards, transformers and switchgear.
   2. Dimensioned layout of each electrical room, drawn to scale, with equipment location shown therein. Show all required clearances. Show complete details of connections with elevations at wireways to verify panel lug requirements, top/bottom feed and to assure that the finished installation is as professional as is practical in each space.

G. Arrange each set of data in an orderly way, provide tabs for the individual sections and bind each set in a separate 3-ring, hard-cover binder.

1.07 DELIVERY AND STORAGE

A. Insofar as possible, deliver items in manufacturer's original unopened packaging. Where this is not practical, cover items with protective materials to keep them from being damaged. Use care in loading, transporting, unloading, and storage to keep items from being damaged.

B. Store items in a clean dry place and protect from damage.

1.08 RECORD DRAWINGS

A. Keep a set of drawings prints at the job site exclusively for recording deviations from the drawings which are necessary because of job conditions. Record locations and depths of buried and concealed conduits from fixed, easily identifiable objects, such as building walls. Where conduits are concealed in walls, indicate distances off of building corners or other building features not likely to be disturbed by future alterations. Mark deviations in colored pencils so that work of various systems can be easily identified.

C. The Architect/Engineer will provide magnetic media floor plans for use by the Contractor. The Contractor shall revise the magnetic media floor plans to depict "as-built" conditions and provide the Owner with both magnetic media and reproducible vellum plots with all deviations from the original plans depicted.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

B. All materials and equipment used in carrying out these specifications to be American made unless approved otherwise (by Owner) and to be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, or catalog numbers of materials and equipment to be used as "standards". Proposals shall be based on "standards" specified. The "standards" shall not be construed as limiting competition. Contractor may, subject to Engineer approval, use any materials and equipment equivalent to that specified.

C. Equipment and materials furnished shall be listed by UL or other nationally recognized testing laboratory where available. When listing is not available for a piece of equipment, it will be accepted provided it is furnished in accordance with drawings and specifications and is approved by the authorities having jurisdiction.

D. Specifications and drawings indicate name, type and/or catalog number of materials and equipment to establish standards of quality. Submittals shall be based on the standards specified. The standards should not be construed as limiting competition.

PART 3 - EXECUTION

3.01 COORDINATION

A. Visit site and be informed of conditions under which work must be performed. No subsequent allowance will be made because of error or failure to obtain necessary information to completely estimate and perform work involved.

B. Examine specifications and drawings to be familiar with items which require electrical connections and coordination. Electrical drawings are diagrammatic and shall not be scaled for exact sizes.

C. Equipment shall be installed in accordance with manufacturer's recommendation. Where conflicts occur between Contract Documents and

these recommendations, a ruling shall be requested of the Engineer for decision before proceeding with such work.

3.02 CUTTING AND PATCHING

A. Repair any damage caused by cutting or trenching in the performance of work under this Division.

B. Correct damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.

C. Holes cut through existing floor slabs to be core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs between floors to be sealed, fire proofed and water proofed.

D. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.

E. Where raceways 1-1/4" through 4" trade size pass through one-hour fire-rated gypsum board walls, limit annular space to 1/4", fill annular space with 3M CP-25 firestop caulk and seal with a 1/4" bead of 3M CP-25 firestop caulk around perimeter (UL System 147A). If raceway is 1" or smaller, limit annular space to 3/16".

3.03 FOUNDATIONS AND PADS

A. Foundations and pads are required for equipment and shall be provided under this Division unless indicated otherwise on plans. Proper size and location of foundations, pads, and anchor bolts shall be determined under this Division. Minimum of 3.5" thick concrete pad with welded wire reinforcing and a #4 bar offset 4" the full perimeter of the pad. Extend pad 6" beyond footprint of equipment and radius tool or chamfer 1" the top edge of curb. Rub out any voids and remove any spillage for a smooth and finished appearance.

3.04 TESTS

A. On completion of work, installation shall be completely operational and entirely free from grounds, short circuits, and open circuits. Perform a thorough operational test in presence of Engineer. Furnish all labor, materials and instruments for above tests.

B. Furnish the Owner, as a part of closing file, a copy of such tests including identification of each circuit and readings recorded, also the main service ground resistance test as described in Section 16450 of these specifications. Test information to be furnished to the Owner includes ampere readings of all panels and major circuit breakers and insulation resistance reading of motors.

C. Prior to final observation and acceptance test all electrical systems and equipment shall be in satisfactory operating condition including, but not limited to the following:

1. Electrical distribution system.

2. Electrical safety devices.
3. Electrical control systems.
4. Lighting fixtures and lamps.

3.05 FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.06 IDENTIFICATION OF EQUIPMENT

Identify all equipment within the area where work is awarded (Base Bid plus any Alternates) and identify devices on branch circuits only where new devices are added under this work.

A. Identify all electrical equipment (new and existing) that is tagged with an identifier in the Construction Documents. Switchgear, transfer switches, panelboards, safety switches and disconnects, individually mounted circuit breakers, and relays, shall be marked with permanently attached phenolic plates with 1/4" white engraved lettering on the face of each attached with two sheet metal screws or rivets. Starters and relays connected under this Division shall be identified whether furnished under this Division or under other Divisions of this contract. Engraved tag shall indicate equipment served or designation of panel, panel and circuit number of source of service, and voltage e.g. "PANEL 2A, FED FROM EPH2:7,9,11, 480Y/277" or "AHU 6B, FED FROM H32:14,16,18, 480V/3Ph". Black background on normal power, red background on emergency power.

B. Within every panel provide a typed directory with the area/equipment served by each circuit. Where spares are provided provide adhesive tags beside the appropriate circuit breakers labeled "spare".

C. Provide an adhesive tag on the cover plate of all receptacles and switches. Tag shall have a clear background with black numbers 1/8" tall identifying the panel & circuit, e.g. A:17. On receptacles the tag shall be on the exposed side of the cover plate near the bottom. On wall switches the tag shall be on the concealed side of the cover plate. In exposed locations the tag should be only as long as the text and shall be installed horizontal centered below the lowest receptacle and the edge of the cover. Rub on tightly for a bubble free and secure seal. Remove and replace any labels which are not applied thus.

D. Circuits which operate above 480VAC shall be labeled at every pull point, disconnect, starter, switch, transformer, motor terminal box and 20' O.C. along the raceway. The label shall be an adhesive backed vinyl with 2" tall black letters on a yellow background identifying the nominal voltage between phase conductors. e.g. 4160VAC, 12,470 VAC.

END OF SECTION

SECTION 16110
RACEWAYS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide a complete raceway system with associated couplings, connectors, fittings, hangers and supports.

C. Raceways to be mechanically and electrically continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes. All nonmetallic raceways shall have a continuous grounding conductor.

D. Raceway application schedule:

Rigid Galvanized Steel, RGS:
1. Installations exposed in equipment rooms, and less than 7'-0" AFF.
2. Outdoors in wet, damp or dry locations.
3. Within floor slabs and/or buried locations.
4. Service entrance raceways at changes in direction and at all exposed locations.
5. Within all AHUs, plenums and similar areas.
6. All applications exceeding 480 VAC nominal voltage.

PVC Conduit:
1. Within floor slabs, in crawlspaces or buried locations protected by concrete cover.
2. Service entrance raceways, both primary and secondary, for straight runs in buried locations protected by concrete cover.
3. Buried locations serving site lighting and/or signage without concrete cover.
4. Buried locations used as telecommunication duct banks with concrete cover. RGS required at changes of direction

Electrical Metallic Tubing, EMT:
1. Indoors in dry locations unless noted otherwise within Contract Documents.

Flexible Metal Conduit: (Indoors in dry locations)
1. Final 72" connection to recessed ceiling mounted light fixtures.
2. Across expansion joints with a bonding jumper.
3. Not permitted for final connection to control or fire alarm devices in exposed locations.
4. Final 16" connection to control and fire alarm devices/appliances in above ceiling concealed locations.

5. Final connection to motors, generators, transformers and HVAC equipment. 16" max length for sizes up to 2", 36" max length for sizes over 2".
6. Not permitted on exit or emergency fixtures unless concealed above ceiling.
7. In raised accessible floor systems a maximum of 36" length is allowed for final connection to raised floor mounted devices. EMT required to be anchored to the subfloor.

Liquidtight Flexible Metal Conduit: (In wet, damp and all outdoor locations)
1. Final connection to motors, transformers and HVAC equipment. 16" max length for sizes less than 2", 36" length max for sizes over 2".
2. Final 16" connection to HVAC control and fire alarm devices/appliances in exposed locations in all equipment rooms

E. Empty raceway system for data, communication, generator controls and telephones. Provide device box and raceway system as shown on the drawings and as indicated in the project manual. Leave a pull cord/rope in all empty raceways. Extend raceway to an accessible ceiling through the hollow spaces of walls, ceilings, floors and as necessary by routing under slab-on-grade or crawl spaces.

1.02 RELATED WORK

A. Section 16190: Supporting Devices and Hangers.

1.03 SUBMITTALS

A. Submittal of products furnished under this Section is not required.

PART 2 - PRODUCTS

2.01 RIGID GALVANIZED STEEL, RGS, CONDUITS AND FITTINGS

A. Rigid Steel Conduit, ANSI C80.1/UL6, NEC Art. 346, hot dipped galvanized, or electro galvanized interior and exterior, including threads. Standard threaded galvanized couplings. Ericson series 675 couplings are allowed where neither adjacent section can be rotated.

B. Associated couplings, connectors and fittings shall be all steel as manufactured by Thomas and Betts Corp., O.Z. Gedney Co., EFCOR or approved equal.

C. Intermediate Metal Conduit, UL 1242, NEC Art. 345, is permitted where RGS is indicated unless noted otherwise.

2.02 ELECTRICAL METALLIC TUBING (EMT)

A. EMT, ANSI C80.3, NEC Art. 348, electro galvanized steel interior and exterior.

B. Connectors and couplings for EMT shall be all steel, T&B 5000 series or approved equal and shall be raintight compression or concrete tight set screw type. Diecast connectors and indention tool connectors are not allowed.

2.03 POLYVINYL CHLORIDE (PVC)

A. Polyvinyl chloride (PVC) conduit, Schedule 40, NEC Art. 347, and associated couplings, connectors, and fittings. PVC conduit to be UL listed and 90 degrees C. UL rated.

B. Associated couplings, connectors and fittings shall be PVC solvent welded. Convert to RGS for ells.

2.04 FLEXIBLE METAL CONDUIT

A. Flexible Metal Conduit, "Greenfield", NEC Art. 350, UL1, ANSI C33.92, galvanized steel.

B. Fittings UL 514, ANSI C33.84

2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

A. Liquid-tight flexible metal conduit, NEC Art. 351, UL360, galvanized steel, flexible PVC outer jacket.

B. Fittings UL 514, ANSI C33.84

PART 3 - EXECUTION

A. Minimum size of conduits shall be ½" above grade and 3/4" below grade. Use 3/4" for empty wall boxes used for data, thermostats, etc.. Size conduits as indicated on plans. Where sizes are not indicated select sizes based on NEC requirements for THW insulated conductors and as needed to hold pulling forces below manufacturers recommendations.

B. Conceal conduits unless noted otherwise. Conduit joints shall be cut square, threaded where applicable, reamed smooth, and drawn up tight so conduit ends will butt in couplings, connectors and fittings.

C. Make bends or offsets with standard ells or field bends with an approved bender. Telephone, data and communication raceways used for fiber optics require 24" radius bends.

D. Run conduits in direct line with long sweep bends or offsets. Run conduits parallel to and at right angles to building lines. Group multiple conduit runs in banks. In general run conduits at one elevation range of +/- 4" in the above ceiling space just above and just below the bottom chord of the bar joists. Coordinate raceway installation to avoid conflict with other trades and accommodate their space requirements. Remove and reinstall raceway as needed to avoid conflicts with work of these other trades.

E. Secure EMT and flexible metal conduits to all boxes and cabinets with locknuts and/or bushings so system will be electrically continuous from service to all outlets.

F. Cap ends of conduits to prevent entrance of water and other foreign material during construction.

G. Complete conduit systems before pulling conductors.

H. Support conduits as specified in 16190.

I. Provide cable supports in conduits rising vertically in accordance with the National Electrical Code, Article 300-19.

J. Provide 250 lb. test nylon cord in all empty conduits and install plastic caps on open ends.

K. Conduits which pass through floor slabs (except ground floor) shall be sealed with concrete grout. Seal around conduits or other wiring materials passing through partitions, which extend to the underside of the slab above, and those passing through fire rated floors/walls. Use UL listed fire stop caulk in full accordance with manufacturers' recommendations to prevent passage of smoke or fire.

L. Conduits which enter below grade or weather exposed shall be grouted-in and waterproofed to prevent passage of water. Any service entrance conduit shall be closed with flexible duct seal where it enters the building disconnecting means.

M. Where RGS conduit is installed in a cabinet, junction box, pull box or auxiliary gutter, conductors shall be protected by an insulated bushing.

N. In areas where enclosed and gasketed fixtures and weatherproof devices are specified, where rigid conduit enters a sheet metal enclosure, junction box and outlet box, and not terminated in a threaded hub, a steel, or malleable iron nylon insulated Bullet Hub, complete with recessed Sealing "O" Ring, shall be used, series 370-379. DO NOT use die cast material.

O. Provide seal-off fitting in all conduits entering hazardous areas and seal with a hard set epoxy labeled for this purpose. Seal any conduits entering isolation rooms or cold temperature areas such as air handling units, freezers and refrigerators. Do not use epoxy hard set sealant in non-hazardous areas, use flexible duct sealant.

P. When connecting to a generator, switchgear or motor controller coordinate all penetrations carefully with the equipment manufacturer. Penetrate housing in approved locations and route conductors only in approved locations.

Q. In concrete slabs block up conduit from forms and securely fasten in place. All conduits in slabs shall have a minimum of 1-1/2" concrete coverage above and below. Conduits shall be minimum 3/4" when installed in concrete slabs.

R. Where conduits running overhead pass through building expansion joints they will be connected by flexible metal conduit of same size with sufficient slack to allow conduits on either side of expansion joint to move a minimum of 3" in any direction. A bonding jumper is required. Provide supports as required on each side of expansion joint, all in accordance with seismic requirements of specific area.

S. Conduits for feeders and branch circuits shall be terminated directly into panelboard enclosure without the use of pull boxes, junction boxes, wire ways, or auxiliary gutters, unless the panelboard enclosure does not provide sufficient surface area for all conduits. Where such cases exist, the contractor shall notify the Engineer. In no case will splices in such boxes, wire ways, etc. be permitted.

T. Failure to route conduit through building without interfering with other equipment and construction shall not constitute a reason for an extra charge. Equipment, conduit, and fixtures shall fit into available spaces in building and shall not be introduced into building at such times and manner as to cause damage to structure. Equipment requiring servicing shall be readily accessible. In general raceways shall be routed as high as possible in concealed spaces which also serve HVAC, sprinkler and plumbing piping/duct/equipment. Coordinate with other trades to avoid interferences. Offset raceways as necessary to avoid interferences with other trades. Relocate any raceways which block service access to equipment of other trades.

U. Do not route any raceways in elevator hoistways, stairs, fire pump room or mechanical spaces except those raceways which serve equipment in these spaces.

V. Provide grounding bushings on all feeder conduits.

W. Underground PVC raceways shall change direction using galvanized rigid steel elbows. Support all under ground raceways with chairs for uniform separation and concrete coverage, 5 foot on center. Encase primary and secondary service entrance raceways in 3" of concrete, tint red with chalk. Provide 6" wide continuous red plastic tape 12" above all buried raceway "Buried Electrical".

X. Telecom and data raceways 2" and larger require a minimum bend radius of 24".

Y. No PVC shall emerge from the ground or concrete slab, transition to RGS below grade. PVC is allowed in crawlspace on straight runs.

Z. Make bends in PVC with standard ells or with an approved bender.

AA. Provide a flexible final connection between equipment that is motorized and the EMT or RGS raceway that connects to this equipment.

BB. Pendent type industrial fixtures shall be supported by RGS.

CC. Where flexible metal raceway is installed outdoors or is exposed to continuous or intermittent moisture, conduit shall be liquid tight, UL type UA.

DD. Where fittings for liquid tight flexible conduit are brought into an enclosure with a knock-out, a gasket assembly, consisting of one piece "O" ring, with Buna-N sealing material, T&B series 5200, shall be installed on outside of box. Fittings shall be made of either steel, or malleable iron only, and shall have insulated throats or insulated bushings.

EE. In dry locations, where final connections to motors and other equipment may be made with flexible metal conduit, fittings shall be of steel or malleable iron only

with insulated throats or insulated bushings, and shall be of wedge and screw type having an angular wedge fitting between convolutions of conduit.

FF. A copper ground wire is required inside of all flexible conduit to assure a continuity of ground to transformers, equipment, controls and other utilization equipment.

GG. All suspended and recessed lighting fixtures shall be connected with flexible metallic conduit from outlet box to fixture.

HH. Install liquid tight flexible conduit in such a manner as to prevent liquids from running on the surface toward fittings.

II. Allow sufficient slack in flexible conduit to reduce the effect of vibration.

JJ. Conceal raceways wherever possible in walls, floors or ceiling cavities. Route exposed only in equipment rooms.

KK. Flexible metal conduit shall not be used for final connection to control devices exposed in equipment rooms.

END OF SECTION

SECTION 16121
CONDUCTORS - 600 VOLTS AND BELOW

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide a complete system of conductors and terminations for all lighting, receptacles, motors, HVAC equipment, switchgear, generators, generator controls, equipment, alarms, and grounding.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Provide 98% conductivity copper conductors with 600-volt insulation. For all conductors No. 10 AWG and larger, provide stranded type THHW-THHN. For all conductors No. 12 AWG and smaller, provide solid type THHN. Provide type SA at connection to lighting fixtures.

B. Conductors shall be by Anaconda, Cyprus, Rome, Triangle, Southwire or approved equal.

C. Connectors shall be by AMP, T&B, Burndy or approved equal.

D. Provide white or gray colored neutral conductors; provide black, color coded phase conductors.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All conductors to be continuous from origin to panel or equipment termination without splices. Where splices and taps are indicated or are required, they shall be made in splice boxes.

B. Install pull boxes in circuits or feeders over 100' long indoors, 200' outdoors.

C. Use only pulling compound approved by conductor/cable manufacturer to lubricate conductors.

D. Deliver all conductors to jobsite new and in original wrapping, package or reel.

E. All conductors and connections shall test free of grounds, shorts, and opens.

F. Provide No. 10 wire in lieu of No. 12 wire for the entire length of any branch circuit that has a one way conductor length in excess of 100'.

G. Use Ideal wing nuts, Scotchlok Type Y, R, G, or B, or approved equivalent connectors for fixture connections at outlet boxes.

H. Make feeder taps and joints with O. Z. Gedney type T, PT, PM, or PTS, or approved equivalent clamp connectors as manufactured by Kupler, or with approved compression sleeves. Wrap connectors with No. 10 electro-seal or approved equivalent plastic filler and vinyl tape or varnished cambric and linen tape with two coats of glyptal or approved equivalent insulating varnish applied overall. Heavy gauge, water tight, heat shrink sleeves are required over connectors outdoors.

I. Leave a minimum of 8" slack wire in every outlet box whether it be in use or left for future use.

J. Minimum size branch circuit conductor shall be #12.

K. Derate conductor ampacity in accordance with NEC Art. 310 when more than three current carrying conductors are in a single raceway. (Two conductors for single phase systems.) Do not combine more than nine current carrying conductors in a single raceway. (80% of rated Ampacity with 4-6 current carrying conductors, 70% of rated Ampacity with 7-9 current carrying conductors)

L. Use compression lugs on all splices and terminations #1/0 and larger. Motor terminations #3 and larger shall be T&B type MSC.

M. Select conductors with ampacity at 75 degC to equal or exceed rating of over current device or as indicated on drawings, whichever is larger. Advise Engineer if a voltage drop exceeding 3% is anticipated on any branch or 2% on any feeder.

N. Color code conductors as follows:

	120/208 Volt	277/480 Volt
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Gray
Ground	Green	Green

O. Use factory color coded conductors where commercially available. If not available, use black conductors and band with color tape. For isolated ground conductors use green jacket with an orange stripe.

P. Size conductors based on the overcurrent protection device rating as follows:

C/B OR FUSE RATING AMPS	PHASE SIZE	NEUTRAL SIZE	GROUND SIZE	
20	12	12	12	
30	10	10	10	
40	8	8	10	
50	6	6	10	
60	4	4	8	
70	4	4	8	
80	3	3	8	
100	1	1	6	
125	1	1	6	
150	1/0	1/0	6	
175	2/0	2/0	6	
200	3/0	3/0	6	
225	4/0	4/0	4	
250	250M	250M	4	
300	350M	350M	4	
400	600M	600M	3	

Round up the OPD setting if it is not listed herein.

Q. These above sizes are a minimum. Increase to account for derating factors and longer runs of conductors exceeding 100 linear feet. The neutral shall be sized to match the phase conductor(s). The ground shall be sized to match the phase conductor's current rating and may be larger than shown if the phase conductor size is increased above that shown in the table due to derating or voltage drop.

1. Increase one standard size where circuit one way length equals or exceeds the following at the noted voltages:
   a. 100 LF for 120 VAC single phase.
   b. 200 LF for 208-240 VAC single or three phase.
   c. 250 LF for 277 VAC single phase.
   d. 400 LF for 480 VAC single or three phase.

2. Where the length exceeds twice the distance noted above the conductors shall be increased two standard sizes.

3. Any length of 500 LF shall have conductor size determined by the Engineer.

4. Refer to NEC derating tables for reductions due to ambient temperature.

END OF SECTION

SECTION 16130
OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide each fixture, switch, receptacle, and other wiring device with an outlet box of appropriate size and depth for its particular location and use unless indicated otherwise.

C. Provide pull and junction boxes of appropriate size and depth as indicated on the drawings and as specified hereinafter.

1.02 RELATED WORK

A. Section 16190: Supporting Devices and Hangers.
B. Section 16110: Raceways.
C. Section 16121: Conductors
D. Section 16140: Wiring Devices

1.03 SUBMITTALS

A. Submittals of products furnished under this Section is not required unless specifically noted.

PART 2 - PRODUCTS

A. Pull, outlet, conduit bodies and junction boxes shall be Hubbell, National, Arrow-Hart, Appleton, Raco, G.E., Steel City or approved equal.

B. In-floor outlet boxes shall be equal to Hubbell #B-2519 with #S-3925 cover or equal matched to the flooring materials, tile, concrete or carpet. Submittals required.

C. Outdoor outlet boxes shall be cast aluminum, equal to Appleton "Unilet", suitable for wet location use. Submittals required.

D. For interior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4" flanges, screw covers, etc.

E. For exterior work, provide galvanized sheet metal boxes of code thickness with lapped and welded joints, 3/4" flanges, bolted covers with full gaskets forming a completely raintight assembly.

F. For exterior below grade work provide non-metallic pull boxes in landscaped areas. Quazite or equal.

G. Pull boxes shall have solid tops, bottoms and sides. No factory knock-outs are allowed.

H. Conduit bodies shall be galvanized malleable iron with gasket and steel cover.

PART 3 - EXECUTION

A. Locate outlet boxes to prevent moisture from entering or accumulating within them.

B. Support outlet boxes independently of conduit per NEC.

C. Provide 4" x 1-1/2" octagonal ceiling outlet boxes. For increased cubic capacity, provide 4" x 2-1/8" octagonal, 4" x 1-1/2" square or 4" x 2-1/8" square ceiling outlet boxes.

D. Where required to hang a specified fixture, provide a fixture stud of the no-bolt, self-locking type on ceiling outlets.

E. Provide 2-1/2" x 3-3/4" one gang masonry boxes for switches and receptacles installed in concrete block walls not plastered. For increased cubic capacity, provide 3-1/2" x 3-3/4" one gang masonry boxes. Where more than two conduits enter the box from one direction, provide 4" square boxes with square cut device covers not less than 1" deep specifically designed for this purpose. Use round edge plaster rings only if the block walls are to be plastered. Use sectional or gangable type outlet boxes with square edge openings that extend through the gypsum wall board in drywall construction.

F. Provide double gang device boxes for telephone and other communications system outlets with a plaster ring reducing to accept a single gang cover plate. Provide high capacity masonry boxes for nurse call system devices.

G. Provide fittings with threaded hubs for screw connections and with the proper type covers for switches and receptacles served by exposed conduit. Use pressed steel outlet only for ceiling fixture outlets.

H. Provide conduit bodies with threaded hubs and covers and with proper configurations for all changes of direction of exposed conduits. Standard conduit ells may be used if they do not interfere, damage, or mar the appearance of the installation in the opinion of the Engineer. Galvanized malleable bodies required where RGS is specified.

I. Use boxes of sufficient cubic capacity to accommodate the number of conductors to be installed. See Article 370 of the National Electric Code.

J. Effectively close unused openings in boxes with metal plugs or plates.

K. Set boxes so that front edges are flush or immediately recessed at the finished surfaces. Comply with NEC regarding the allowable recess. Covers shall fit tight to finished wall with no gap.

L. Secure boxes to surfaces upon which they are mounted or embed boxes in concrete masonry. Support boxes from structural members with approved braces.

M. Install blank device plates on outlet boxes left for future use.

N. Provide bushings in holes through which cords or conductors pass.

O. Install outlet boxes so that the covers will be accessible at all times.

P. Electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings occur on one side only in each framing space and that openings do not exceed sixteen square inches. All clearances between such outlet boxes and the gypsum board shall be completely filled with joint compound or approved fire-resistive compound. The wall shall be built around outlet boxes larger than sixteen square inches so as not to interfere with the wall rating. Do not install boxes back-to-back in common wall, but offset boxes a minimum of 24". Coordinate with the General Contractor.

Q. Locate wall switch boxes such that switch center is 46" AFF unless noted otherwise.

R. Locate receptacle boxes such that receptacle center is 18" AFF unless noted otherwise. At counters and other millwork locate receptacle center 4" above counter or splash unless noted otherwise. Refer to architectural plans for exact locations. At drinking fountains locate receptacle as required by fountain manufacturer to conceal receptacle within fountain housing.

S. Provide coverplates for all junction and pull boxes. Blank covers are required on empty boxes.

T. Where multiple switches/receptacles are adjacent to one another they shall be ganged together. Provide gang plates with suitable openings.

U. Provide single gang box for thermostats 46" AFF to centerline. Refer to mechanical drawings for locations.

V. Provide an empty 3/4" raceway from telephone, data, video, security equipment, thermostat and other empty device boxes to the above ceiling space in an accessible location and turn open end of conduit horizontal. In some locations the walls do not extend up directly to the ceiling and the raceway shall be run horizontally and/or below the floor until it reaches an accessible ceiling. Install a plastic bushing in the open end of the conduit. An accessible ceiling is defined as a lay-in suspended acoustical tile ceiling. All control raceways for emergency power systems shall be continuous.

W. Provide junction boxes where required, sized according to number of conductors in box or type of service to be provided. Minimum junction box size 4" square and 2-1/8" deep. Provide screw covers for junction boxes.

X. Use minimum 16 gauge steel for pull boxes and provide with screw cover.

Y. Install boxes in conduit runs wherever necessary to avoid excessive pulling force requirements or bends in excess of code allowances. Do not exceed 100' runs between pull boxes indoors. Do not exceed 200' runs between pull boxes outdoors. In exposed locations use conduit bodies in lie of pull boxes in 1" and smaller raceways.

Z. Rigidly secure boxes to walls or building structure. Conduit runs will not be considered as adequate support.

AA. Install boxes with covers in accessible locations. Size boxes in accordance with Articles 370 and 373 of the latest edition of the National Electric Code.

BB. Do not install pull or junction boxes for joint use of line voltage and signal or low voltage controls unless all conductors are insulated for the highest voltage being used in the same box.

CC. Install quazite type boxes in a concrete base 2" above finished grade and 12" wider than pull box. Provide an open bottom with the base being 9" thick of 1" or larger gravel for drainage.

DD. Label box covers with an indelible black marker to indicate the circuits fed through each box.

END OF SECTION

SECTION 16134
PANELBOARDS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide circuit breaker type panelboards as indicated on drawings and as specified hereinafter.

1.02 RELATED WORK

A. Section 16450: Grounding.

B. Section 16190: Supporting Devices and Hangers.

1.03 SUBMITTALS

A. Submit product data for Engineer approval as required by Section 16010.

PART 2 - PRODUCTS

A. Panelboards shall be Square "D", G.E., ITE or Westinghouse.

C. Provide panelboards of circuit breaker, dead-front safety type, UL labeled and meeting all applicable requirements of the National Electrical Manufacturers Association.

D. Provide panelboards with 75C or higher rated lugs (both main lugs and branch circuit lugs) suitable and UL approved for both aluminum and copper conductors.

E. Provide electrically isolated factory installed neutral bus.

F. Provide separate, ground bus complete with lugs or connectors on bar. Where noted provide an additional electrically isolated ground bus.

G. Provide panelboards with distributed phase bussing for: 120/208 volts wye, 277/480 wye, or 480 volts as noted. All bus to be tin plated copper.

H. Provide panel doors equipped with chrome-plated locks and catches, all keyed alike. Provide two keys for each lock. Provide fronts with adjustable indicating trim clamps. Provide a separate pad-lockable hasp and install on all panels using 1/8" zinc plated steel rivets. Hasp may be omitted in selected locations as directed by the Owner, verify prior to installation

I. Provide bolt-on, thermal magnetic circuit breakers, inverse time delay and instantaneous circuit protection. Wiring connections shall be rated at 75C or higher. Circuit breakers shall be calibrated to carry 100% rated current in a 40 degrees C ambient and shall be self derating in higher temperature

environments to properly protect the conductor. Breakers to be quick-make, quick-break type with trip indication shown by handle position other than ON or OFF and with a common trip on all multi-pole breakers.

J. The interrupting rating of the circuit breakers shall be at least equal to the available short circuit current at the line terminals of the circuit breaker and shall conform to UL listed integrated short circuit current rating specified for the panelboards and switchboards. Branch circuit breakers to be "bolt-on" style and 10,000 AIC rated for 240 VAC and lower potentials, 14,000 AIC for 277 to 480 VAC potentials unless higher AIC is noted otherwise. The service entrance breakers and breakers which serve as any panel main overcurrent protection shall be 42,000 AIC rated for 240 VAC and lower potentials, 35,000 AIC for 277 to 480 VAC potentials unless a higher AIC is noted otherwise. Series rating in accordance with UL is allowed to meet this requirement.

K. Refer to drawings for numbers of branch circuits, their ratings, number of poles, arrangements, etc. Panel schedules indicate spaces where bus provisions are to be provided.

L. Panelboards for 240/120 or 208Y/120VAC, 3-phase, 4-wire service to be Square "D" NQOD type or approved equivalent. Provide breakers with trip ratings and interrupting ratings as noted on the drawings. Panelboard shall be equipped with circuit breaker integral to panel or remotely located and UL listed. Panels shall be Square D I-Line or an approved equivalent when the panel rating exceeds 600 amps.

M. Panelboards for 480Y/277VAC, 3-phase, 4-wire service shall be Square "D" NF or approved equivalent. Provide breakers with trip ratings and interrupting ratings as noted on the drawings. Panelboard shall be equipped with circuit breaker integral to panel or remotely located and UL listed. Panels shall be Square D I-Line or an approved equivalent when the line to ground voltage exceeds 277 volts or the panel rating exceeds 600 amps.

N. NEMA 1 construction indoors. NEMA 3R construction outdoors.

PART 3 - EXECUTION

A. Ground separate ground bus to the main service entrance ground bus or step down transformer as applicable with a grounding conductor sized as shown installed in the same conduit as the phase and neutral conductors. Dedicated Isolated ground panel shall have a separate ground conductor which extends to the main building grounding array. See Section 16450 - Grounding.

B. Install all circuits using a common neutral in accordance with the latest edition of the National Electrical Code, Article Nos. 100, 210-4, 210-5, 220-4d, and 310-11, note 11. Balance all circuits to achieve not greater than 10% unbalanced neutral current in panel feeders.

C. Provide typed directory cards under plastic on the doors of lighting and branch circuit panelboards. Directories to indicate devices being served including space numbers or space names in which devices or fixtures are located.

D. Panelboards shall be labeled with a 1/4" text engraved lamcoid nameplate which identifies the panel by name and general area served. System labels shall be black for normal power panels and red for panels which have an emergency power feed. Attach to the panel with rivets. On distribution panels, MCCs and switchboards provide individual nameplate at each overcurrent device. Glue is NOT acceptable. See 16010 for additional labeling requirements.

E. Conduits for feeders and branch circuits shall be terminated directly into panelboard enclosure without the use of pull or junction boxes, wireways, or auxiliary gutters unless the enclosure does not provide sufficient surface areas for all conduits. Where such cases exist, the Contractor shall notify the Engineer. In no case will splices in such boxes, wireways, etc., be permitted.

F. Provide spare raceways for all panels that are installed flush. Raceways are to extend from the top of panel to an accessible ceiling space and have a pull cord where the conduit is more than 10' long. Each panel section with a bus rating of 225A or less to receive 4 @ 3/4" and 1 @ 1" spare. Panel sections with a bus rating of 250 - 600A to receive 4 @ 3/4" and 2 @ 1-1/4" spare.

END OF SECTION

SECTION 16190
SUPPORTING DEVICES AND HANGERS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide a system of supporting devices, strut and hangers to insure secure support or bracing for conduit, electrical equipment, including safety switches, fixtures, panelboards, transformers, outlet boxes, junction boxes, cabinets, etc.

C. Seismically restrain all equipment installed or reused under this project. This requires bracing of existing switchgear and transformers that are reused.

PART 2 - PRODUCTS

2.01 HANGERS/FASTENERS

Provide appropriate supporting devices and hangers for electrical equipment from the below list of Caddy Fasteners as manufactured by Erico Products, Inc., Steel City, Minerallac, or approved equivalent.

A. Vertical flange clamps (beam clamps).
B. "Z" purlin clips.
C. Conduit clips.
D. Universal clamps (beam clamps).
E. Beam clamps (set screw type).
F. Combination push-in conduit clips.
G. Combination conduit hanger clamps.
H. Flexible conduit clips.
I. Special combination conduit clips.
J. One hole steel straps.
K. Minerallac conduit hangers.

2.02 EQUIPMENT PADS

Fabricate pads of concrete with 10 GA 6X6 welded wire reinforcement, and "J" Bolts positioned for securing equipment to pad. Pad height as noted, or 3.5" if not noted. All floor mounted equipment to be provided with a pad or approved structural steel support frame. Extend pad 6" beyond footprint of equipment. Chamfer top edge of pad 1" on all sides. Finish grout and rub for a smooth void free surface. Refer to drawings for any applicable details. All equipment requires bolting to pad or slab structure to resist movement during seismic activity. Dowel pads to existing slab with 1/2" rebar 6" long, minimum 4 per pad or 1 per 5 SF of pad whichever is greater.

2.03 STRUT

G. Pre-galvanized or hot dip galvanized steel strut, fitting and accessoried. Painted strut and fittings are not allowed. Sizes and pre-punched openings shall be selected to minimize field drilling and to rigidly support the raceways and equipment that is attached to it. B-line numbers are used for reference, equal by Grinnell, Unistrut or Engineer approved equal may be used. No strut less than 14 gauge. Comply with manufacturers load rating and anchoring recommendations.

A. For simple rack mounting on rigid building structure, #B54.

B. Fabricated equipment supports, 14 gauge #B24 or heavier.

C. Provide compatible pregalvanized fittings connectors and accessories for a complete galvanized finish system. Paint any welds and cut edges with zinc rich paint.

PART 3 - EXECUTION

A. Secure conduits to within 12" of each outlet box, junction box, cabinet, fitting, etc., and at intervals not to exceed ten feet (10') in accordance with currently effective edition of the National Electric Code. All counties in Tennessee west of the Tennessee River shall be installed to resist movement during seismic activity. In these seismic zone counties, support conduits 2.5" and larger with transverse restraints at 30 foot intervals and longitudinal restraints at 60 foot intervals and at each end of conduit run. Seismic restraints are not required if the raceway is rigidly mounted with clamps or all-thread rod with a free distance 12" or less from support to top of raceway. In exposed locations below 9' AFF where raceway is 1" or smaller, support conduit with 2-hole straps at 5' intervals and within 18" of each outlet box, J-box, cabinet and fitting.

B. Install clamps secured to structure for feeder and other conduits routed against the structure. Use drip rods and hangers or racks to support conduits run apart from the structure.

C. Provide and install suitable strut, angle iron, channel iron or steel metal framing with accessories to support or brace electrical equipment including safety switches, fixtures, panelboards, etc. All equipment shall be rigidly supported to prevent toppling. Unless noted otherwise supports shall be galvanized steel strut. All strut, braces, joints and connections shall be made using B-line strut systems or equal by Unistrut, or Grinnell

D. Paint all supporting metal not otherwise protected, with rust inhibiting primer and then with a finish coat to match the surrounding surfaces.

E. Use of chains, perforated iron, baling wire, or tie wire for supporting conduit runs will not be permitted.

F. For support of low voltage wiring not required to be in conduit, contractor shall bundle cables together in a neat manner using approved nylon tie wraps. Bundled cables shall be supported with "J" hooks a minimum of five feet on centers.

G. Secure floor mounted equipment at the top and bottom to building structure. Size supports to resist the full weight of equipment. 1/2" x 4" expansion bolt at each corner as a minimum. Provide strut extending from the top of the equipment as necessary to connect to structural building elements.

END OF SECTION

SECTION 16450
GROUNDING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. The entire system of raceways and equipment to be grounded in accordance with Article No. 250 of the National Electrical Code and any local regulation or governmental governing authority.

PART 2 - PRODUCTS

A. Ground clamps: OZ Electrical Manufacturing Company Type "OG", or equal by Steel City or Appleton.

B. Raceways, conductors, outlet boxes, pull and junction boxes, etc., to be furnished in accordance with applicable sections of these specifications.

C. Grounding electrode rods shall be copperclad, 10' length and 3/4" diameter minimum, designed for use as grounding electrode.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Clean all conductive surfaces on equipment to be grounded, to assure good electrical continuity.

2. Effectively bond all grounding conductors to grounding electrodes, equipment enclosures and ground busses, except for grounding conductors in isolated ground systems. These shall be bonded only to the isolated ground bus, and shall be kept electrically isolated from the equipment enclosure/raceway system. In isolated ground systems, a second, separate grounding conductor shall be installed for grounding of equipment.

3. Locate all grounding attachments away from areas subject to physical damage. Provide protective covering as required.

B. Main Switchboard/Building Ground:

Main grounding electrode system shall be as shown on the drawings. Additional driven ground rods shall be installed if required to achieve 10 ohm effective resistance to earth. Maintain access to ground rod termination points using PVC pipe and threaded caps.

C. Feeder/Branch Circuits:

1. Feeder circuits to panels and equipment loads to have a separate green grounding conductor in conduit sized as shown. Grounding conductor shall be kept electrically isolated from the metallic raceway ground at all points.

2. All branch circuits to have a separate green grounding conductor installed in same conduit as phase and neutral conductor from panel ground bus to device. The grounding conductor to be sized in accordance with Table 250-95 of the National Electrical Code. Three single phase branch circuits may share a ground conductor.

3. Flexible conduit will not be approved as achieving continuity of ground. All flexible conduit to have a separate ground wire sized to ampacity of branch breaker and to be connected to conduit system on both ends; this applies to feeders, motors, expansion joints.

4. Isolated ground circuits shall not share a ground wire with other circuits.

3.02 TEST

A. Ground on main service to be tested to obtain no greater than 10 ohms using test equipment similar to a "Biddle" test. Test data to be submitted to Owner for approval and such approved test data to become a part of the final O&M brochure.

END OF SECTION

SECTION 16510

LIGHTING AND LAMPS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. All work specified in this section shall comply with the provisions of Section 16010.

B. Provide labor, material, equipment and services necessary to provide all lighting fixtures, necessary hangers and lamps. Fixtures include all interior fixtures plus all exterior fixtures and signage.

C. Fluorescent fixtures shall be designed in such a manner that all electrical components may be replaced without disturbing fixture in or on ceiling.

1.02 SUBMITTALS

A. Submit for approval prior to purchasing fixtures, a complete list of fixtures proposed to be used. Include cuts of both specified fixtures and proposed equivalent fixtures. See Section 16010 for submittal requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Fixtures are scheduled by Manufacturer and Model number on the project drawings in order to define the type, performance, and quality required. Equal fixtures to be one of the following Approved Manufacturers: Cooper Lighting, Thomas Lighting, Columbia, Prescolite, Moldcast, Hubbell, Williams, Lithonia, Visa and Halo. Others may be considered subject to Owner Approval.

B. Fluorescent lamps shall be General Electric, Sylvania, Osram, Phillips, or an Engineer approved equal.

C. Incandescent and HID lamps shall be General Electric, Sylvania, Phillips, Venture or an Engineer approved equal as recommended by fixture manufacturer.

D. Ballasts shall be energy-saving electronic, high power factor type. Magnetek, Advance, Bodine, Motorola, GE or Engineer approved manufacturer. Electronic ballasts for all fluorescent lamps shall have less than 10% Total Harmonic Distortion. Power factor above 0.99. Crest factor below 1.5.

2.02 Spare Lamps

A. Provide 5% spare lamps to replace any lamps which burn out during the initial operation of the fixtures. Replace any burned out lamps immediately before Owner occupancy. Return three months after Owner occupancy and replace

any additional lamps that have burned out. Turn over any remaining lamps for the Owner's inventory.

PART 3 - EXECUTION

A. All fixtures shall be securely mounted as required by NEC and as specified herein.

B. Fixtures mounted in a suspended ceiling shall be secured to the structure above with four wires extending from each corner to the building structure. Typically two wires extending diagonally across the fixture through a single suspension point overhead will meet this requirement.

C. Recessed fixtures in dropped ceiling areas shall be connected using Greenfield and No. 16 THHN wire. Standard 6' whips meet this requirement. Greenfield shall be connected to fixture and outlet box. Each piece of Greenfield to have installed in it a separate insulated green grounding conductor not smaller than No. 16 AWG for grounding continuity between fixture and conduit system. Grounding conductor shall be mechanically connected in a permanent and effective manner to fixture and conduit system and to be electrically continuous. No conduit shall enter a recessed fixture directly as this would prevent removal of fixture without disturbing balance of circuit.

D. Outdoor fixtures shall be fully rated for wet locations. Penetrations through walls and roof shall be sealed weathertight. Aiming and/or socket position adjustment of all HID fixtures shall be adjusted until approved by Architect/Engineer. Allow for evening work as necessary.

E. Outdoor poles and pole-mounted fixtures shall be as scheduled with substitution subject to Owner and Engineer approval. Pole lighting systems shall be rated for 150 percent of maximum effective fixture projected area for design wind of locale.

O. In mechanical spaces the locations must be adjusted to provide full use of the light output from every fixture to illuminate the space. Coordinate with the other trades and adjust fixture locations to meet this requirement. Relocate fixtures as directed by the Engineer which, in the opinion of the Engineer, are not properly located. Where possible mount to wall brackets to avoid hanging supports exceeding 3 feet.

P. Provide seismic restraints on all fixtures when the site is in a seismic zone. Comply with local and state authority requirements.

END OF SECTION