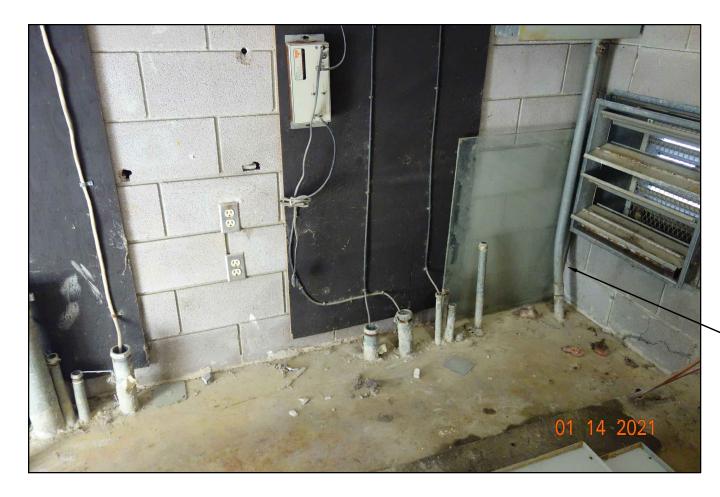
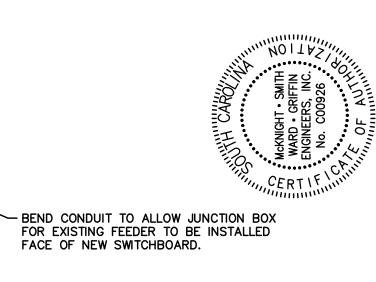


	LIGHTING FIXTURE SCHEDULE													
TYPE	DESCRIPTION	VOLT.	LAMPS						BALLASTS		WATTS	MOUNTING	MANUF. CATALOG NO.	
		VOL 1.	QTY	TYPE	BULB	BASE	TEMP	CRI	LUMENS	QTY	TYPE	WATIS	MOUNTING	WANDI. CATALOG NO.
BS	LED STRIP LIGHT, LOW PROFILE STRIP CHANNEL, FROSTED LENS, 4 FOOT NOMINAL LENGTH, COLD ROLLED STEEL HOUSING, HIGH GLOSS BAKED WHITE ENAMEL FINISH.	277	-	LED	ı	ı	3500 K	-	3000	1	FIXED OUTPUT DRIVER	36	CEILING, SURFACE	LITHONIA #ZL1N SERIES OR APPROVED EQUAL





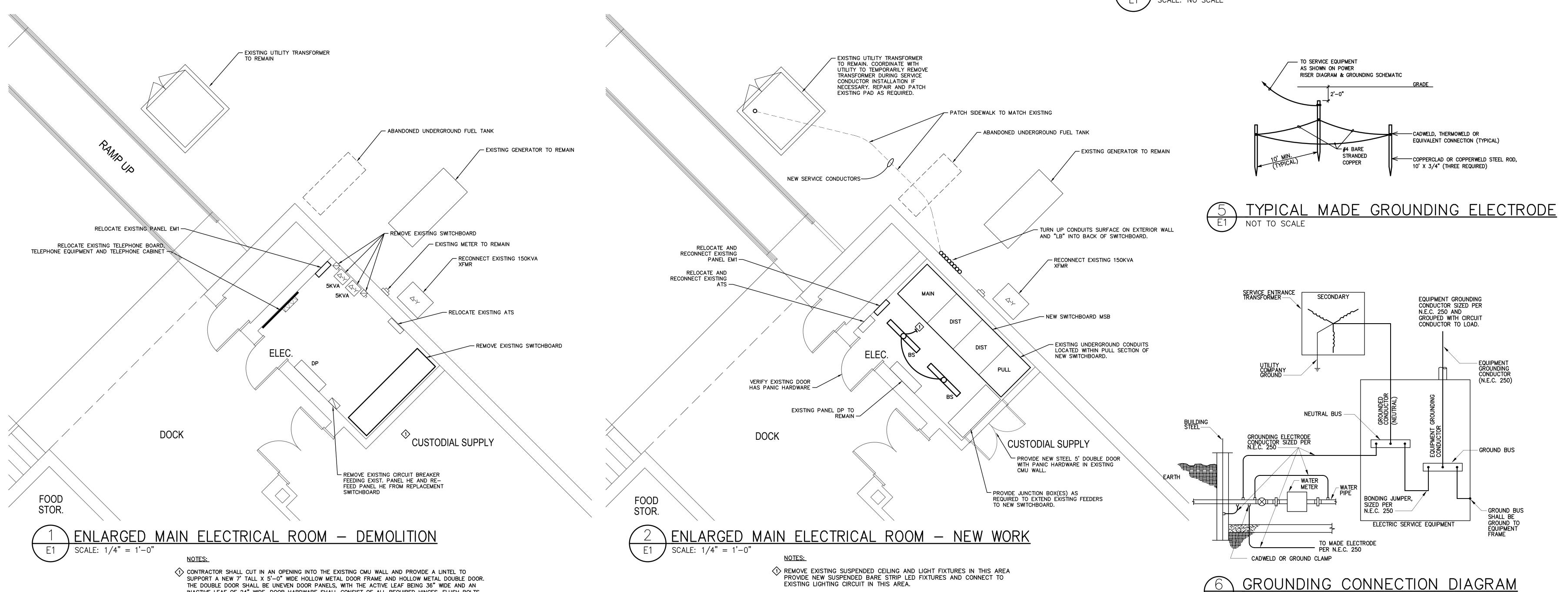


PHOTOS - AREA ABOVE EXISTING SWITCHBOARD

INACTIVE LEAF OF 24" WIDE. DOOR HARDWARE SHALL CONSIST OF ALL REQUIRED HINGES, FLUSH BOLTS,

LEVERS AND LOCKSETS AS REQUIRED. DOOR REQUIRES PANIC HARDWARE AND SHALL BE LOCKABLE. DOOR AND HARDWARE OPERATING MECHANISMS & FORCES SHALL BE COMPLIANT WITH ALL LOCAL AREA BUILDING 4 PHOTOS - RELOCATE PANEL EM1

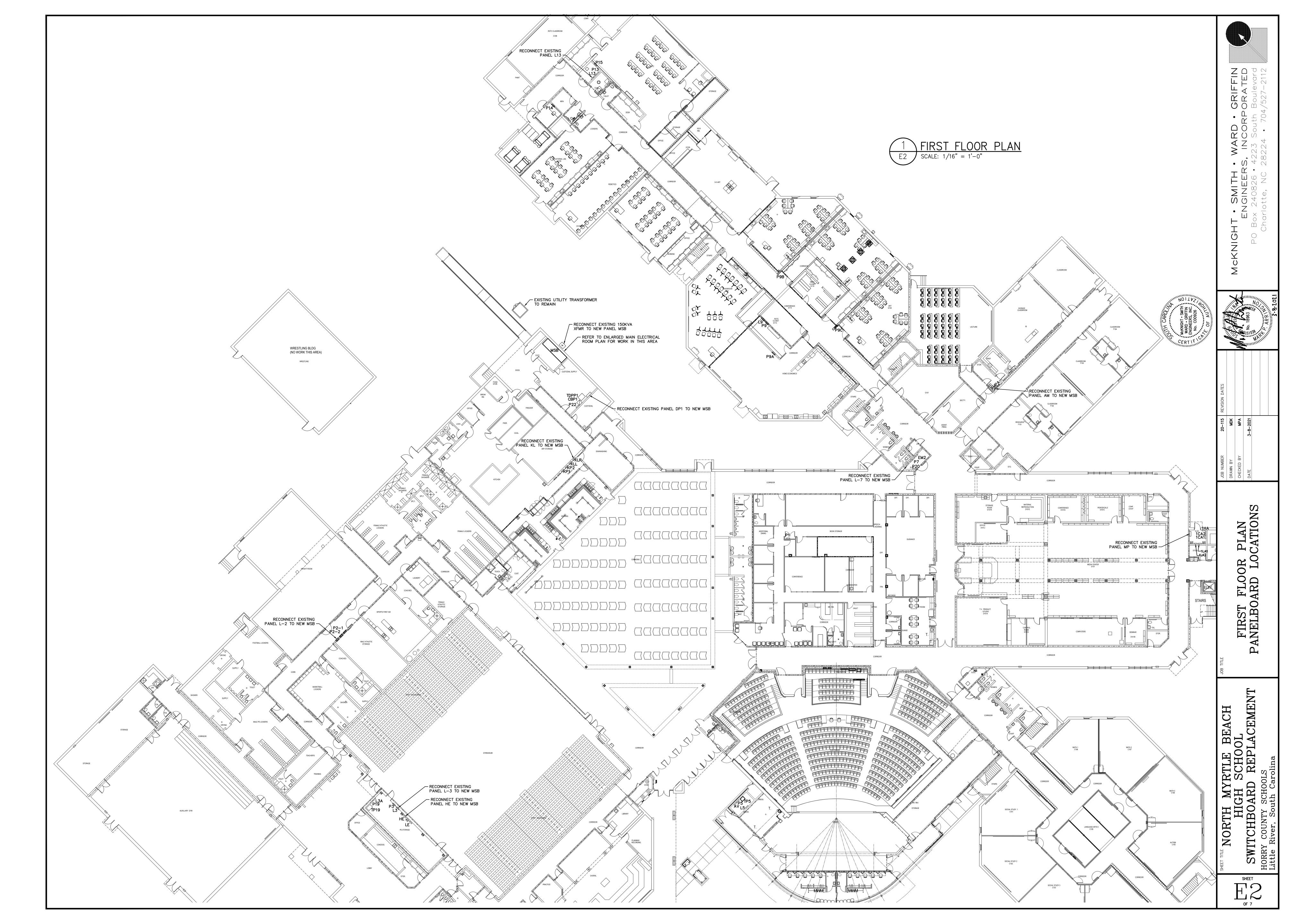
NOT TO SCALE

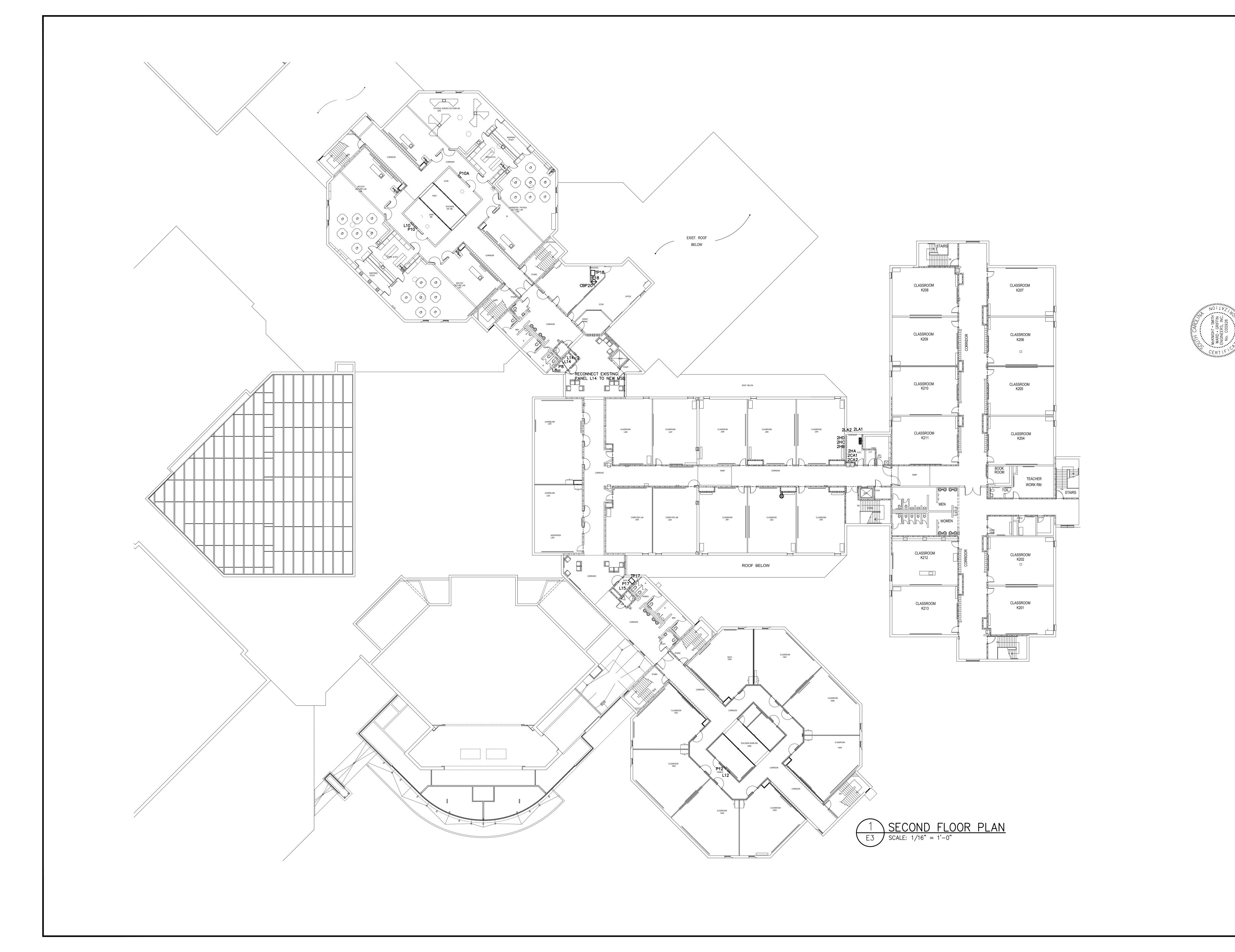


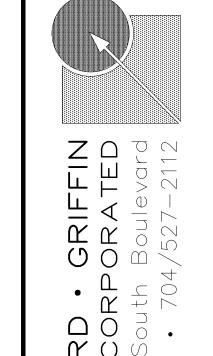
SHET TILE NORTH MYRTLE I HIGH SCHOO SWITCHBOARD REPL.
HORRY COUNTY SCHOOLS
Little River, South Carolina SHEET OF 7

PHOTOS

ELECTRICAL ROOM





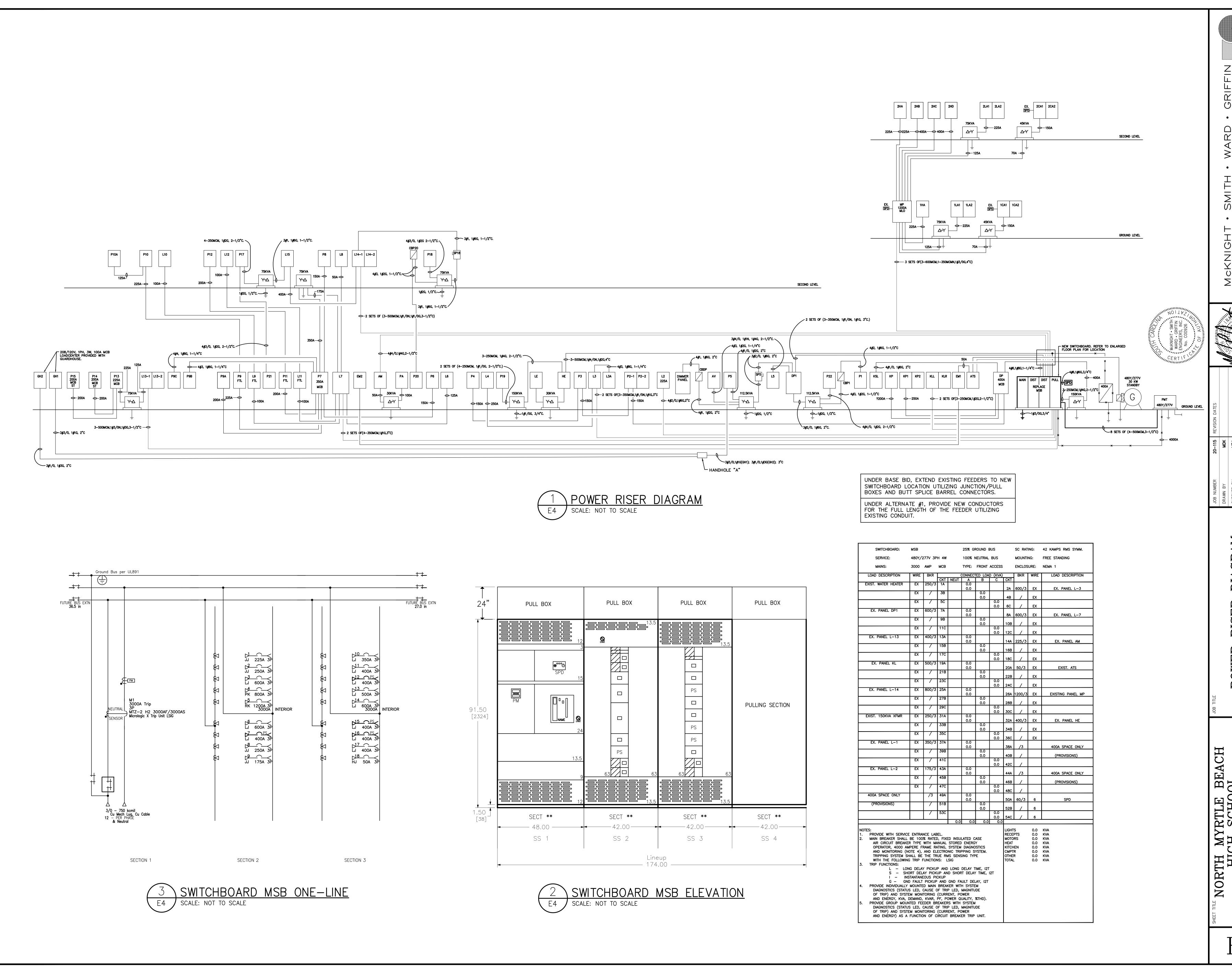


SECOND FLOOR PLAN PANELBOARD LOCATIONS

SHET TILE NORTH MYRTLE BEACH
HIGH SCHOOL

SWITCHBOARD REPLACEMENT
HORRY COUNTY SCHOOLS
Little River, South Carolina

SHEET
OF 7



OWER RISER DIAGRAM SWITCHBOARD SCHEDULE

SHET THE NORTH MYRTLE BEACH
HIGH SCHOOL

SWITCHBOARD REPLACEMENT
HORRY COUNTY SCHOOLS
Little River, South Carolina

SHEET OF 7 1.5 RECORD DRAWINGS

1.7 ELECTRICAL TESTING

1.6 REGULATIONS AND COMPLIANCE

- A. Applicable requirements of the General Conditions of the Contract, Amendments, Supplementary General Conditions, and Special Conditions govern work under this Division.
- B. Work covered by this Division consists of providing all labor, equipment, supplies, and materials; and performing all operations, including trenching, backfilling, cutting, patching, and chasing necessary for the installation of complete electrical systems in strict accordance with these specifications and the applicable drawings.
- C. Minor details not usually shown or specified, but necessary for the proper installation and operation, shall be included in the work, the same as if herein specified or shown.
- D. This Contractor is referred to the General and Special Conditions of the contract which shall form a part and be included in this section of the specification and shall be binding on this Contractor.
- E. Some items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items or equipment as indicated on the drawings, and as required for complete 1.2 DEFINITION
- A. The word "Contractor" as used in this section of the specification refers to the Electrical Contractor unless specifically noted otherwise. The word "provide" means furnish, fabricated, complete, install, erect, including labor and incidental materials necessary to complete in place and ready for operation or use the item referred to or described herein and/or referred to on the Contract Drawings. 1.3 CONTRACTOR'S QUALIFICATIONS
- A.It is assumed that the Contractor has had sufficient general knowledge and experience to anticipate the needs of a construction of this nature. The Contractor shall furnish all items required to complete the construction in accordance with reasonable interpretation of the intent of the Drawings and Specifications. Any minor items required by code, law or regulations shall be provided even if not specified or specifically shown, where it is part of a major system.
- 1.4 CONTRACT DOCUMENTS A. The contract drawings are diagrammatic and are not intended to indicate every detail of construction, or every item of material or equipment required, or exact locations. Indicated locations of outlets,
- equipment, and connections are approximate and shall be verified by reference to related documents. B. The Contractor shall procure complete drawings and specifications on all coincident construction and fit the Electrical work in with it. He shall cooperate with other trades to achieve well-coordinated progress and result; and avoid conflicts with other trades. He shall make minor moves and changes necessary to accommodate other equipment and/or preserve symmetry without claim for extra payment. Should there be any doubt as to the spacing intent, or location of equipment, the Contractor shall have the point clarified by the Architect/Engineer before proceeding with the installation.
- A.During construction of this project, the Contractor shall maintain one complete set of electrical contract drawings, on which shall be recorded all significant changes. This set of drawings shall be used for no other purpose. Upon completion of the work, the Contractor shall submit these drawings to the Architect/Engineer for approval and presentation to the Owner.
- A. The requirements of the International Building Code, the National Electrical Code, and of all other State and Local codes, ordinances, regulations and interpretations by authorities having jurisdiction are binding upon this Contractor, and nothing contained in, or inferred by, these specifications or the applicable drawings may be construed as waiving those requirements. The latest edition of the National Electrical Code, referred to herein and on the drawings as "N.E.C.", forms a part of these specifications; and under no circumstances may the installation fail to meet the minimum requirements therein.
- B. This Contractor shall secure and pay for all permits, fees, inspections and licenses required. It is the responsibility of the contractor to notify the local electrical inspector to schedule the required
- inspections. Upon completion of the project and prior to his request for final payment he shall present to the Architect/Engineer a certificate of inspection and approval from the inspection authorities. C. The Contractor shall include in his work, without extra cost to the Owner, any labor, materials, service, apparatus, drawings, in order to comply with all applicable laws, ordinances, rules and regulations,
- whether shown on drawings and/or specified.
- D. All materials furnished, and all work installed shall comply with the National Fire Codes of the National Fire Protection Association, and with the requirements of all governmental departments having
- E. All materials and equipment shall bear the approval label, and shall be listed by the Underwriters' Laboratories, Inc. or any other third-party listing organization acceptable to the AHJ.
- A. Conduct full scale tests with all lights, equipment and appliances in operation; and prove the electrical system satisfactory for operation and free from defects. Pay attention to the balancing of the
- single-phase loads on the three-phase system. Promptly remedy all defects. B. All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance, continuity, and accidental grounds. This shall be done with a 500-volt megger. The procedures listed below shall be followed:
- 1. Minimum reading shall be one million or more ohms for #6 AWG wire and smaller, 250,000 ohms or more for #4 AWG wire or larger, between conductors and between conductor and the grounding reading between the neutral bar and the grounded enclosure. If this reading is less than 250,000 ohms, the contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low reading is found. The contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
- 3. At final inspection, the contractor shall furnish a megger and show that the panels comply with the above requirements. He shall also furnish a hook-on- type ammeter and voltmeter to take current and voltage readings as directed.
- C.Upon completion of installation of the electrical grounding and bonding systems, the ground resistance shall be tested with a ground resistance tester. Where tests show resistance-to-ground is over 25 ohms, appropriate action should be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting).
- D. All tests specified shall be completely documented indicating time of day, date, temperature and all pertinent test information.
- E. All required documentation of readings indicated above shall be submitted to the engineer prior to, and as one of the prerequisites for, final acceptance of the project. 1.8 GUARANTEE
- A. The Contractor shall guarantee that the work done has been done in accordance with the Contract Documents, free of imperfect materials and defective workmanship. For a period of one year after acceptance by the Owner, the Contractor shall repair or replace, at no additional expense to the Owner, any imperfect materials or defective workmanship. 1.9 OPERATING AND MAINTENANCE INSTRUCTIONS
- A. At the completion of the project, submit 3 sets of complete operating and maintenance instructions.

B. Organize material in the following format:

- 1. Section I: a. Name of Project
- b. Address
- c. Owner's Name d. Electrical Contractor's Name and Address
- e. Warranty Dates 2. Section II:
- a. Description of System 3. Section III:
- a. Major Equipment List (name, manufacturer)
- b. Routine Maintenance Instructions in Step-by-Step form 4. Section IV:
- a. Operating and Maintenance Instructions by Manufacturer
- b. Shop Drawings c. Wiring Diagrams

d. Warranty Information

PART 2 - PRODUCTS

2.1GENERAL

- A.Except where reuse of existing items is specifically indicated or permitted, all materials and equipment shall be new and shall conform to the standards of the National Electrical Manufacturer's Association and Underwriter's Laboratories, Inc. in every instance where such a standard has been established for the item involved.
- B. Catalog numbers and trade names in these specifications and drawings are intended to describe the material, devices, or apparatus wanted. Similar materials, devices, or apparatus of other manufacturers; of equal quality, size, capacity, character, and appearance may be substituted on the written approval of the Architect/Engineer. Requests for approval of substitutions shall be made after the award of the contract in accordance with the bidding requirements of these specifications.
- C.It is the intent of the drawings and specifications that the installation be complete, of finished appearance, and ready for operation. Manufacturers' catalog numbers as used herein and on the drawings are indicative of the type of product to be installed, and do not necessarily identify all parts and accessories required for the proper assembly, installation, and utilization of the product. All required parts and accessories shall be provided.
- D.Materials shall be inspected by the Contractor upon their arrival at the site to be sure they are correct. Material and equipment stored on the site shall be protected against physical damage, dirt and damage caused by precipitation, wind, condensation, excessive humidity, and extremes of temperature. Materials shall be stored in their original cartons within substantial, clean and dry storage facilities provided under this Contract. Conduit, large galvanized boxes, and lighting poles may be stored outdoors on suitable blocks or racks clear of the earth and undergrowth and pitched to drain. Large electrical equipment intended for ultimate installation outdoors may be stored in the weather on suitable blocks or platforms clear of the earth and undergrowth, and with interior lamps or space heaters continuously energized to prevent condensation. Alternate storage provisions may be submitted to the Architect/Engineer for approval prior to the arrival of the material. Under no circumstances shall equipment be stored in the weather under a cover of polyethylene or tarpaulin. The Architect/Engineer will be the sole judge as to the acceptability of storage facilities, and when directed by the Architect/Engineer, improperly stored or damaged material shall be removed from the site and replaced with new material.

2.2SUBMITTALS

- A. Within 30 days after the date of award of contract, submit a complete list, in quadruplicate, of materials proposed for installation including requests for approval of substitutions and names of specialty sub-contractors to the Architect/Engineer for approval. Upon approval of the list, the Architect/Engineer will indicate those items for which submittal of shop drawings, cuts, descriptive literature and/or samples are required; and these items will not be approved until such supplementary data is approved. Any items which fail to comply with specification requirements will be rejected. Intent to use exact material specified does not relieve the Contractor of responsibility for submitting a list and mention of several manufacturers for any item will not be acceptable
- showing construction, size, arrangement, operating clearances, performance, characteristics and capacity. Each item of equipment proposed shall be standard catalog product of an established manufacturer and of equal quality, finish, performance, and durability to that specified. C. Submittal of shop drawings, cuts, and descriptive literature shall be made in sufficient quantity to permit the retention by the Architect/Engineer of two copies. Submittal data will not be checked prior to the

B. Prior to delivery of any material to the job site, and sufficiently in advance of requirements to allow the Architect ample time for checking, submit for approval detailed, dimensioned drawings or cuts,

- Approval of the Contractor's material list. In addition to the submittal data requested by the Architect/Engineer, the Contractor may, at his option, submit additional shop drawings and/or descriptive data or approval, provided the manutacturer of the additional items has previously been listed on the Contractor's approved Material List. D. Submittal data shall be thoroughly reviewed and approved by the Contractor prior to being forwarded to the Architect/Engineer. Submittal data received from the Contractor will be considered to have
- been reviewed and approved by the Contractor as suitable for the application and for installation in the space allotted. E. The submittal of shop drawings shall be with the Contractor stamp affixed. This stamp indicates that the Contractor, by approving and submitting shop drawings, represents that he has determined and
- verified all field measurements and quantities, field construction criteria, material, catalog material, and similar data that he has reviewed and coordinated information in the shop drawings with the requirements of the work and the Contract Documents. It, also, indicates that any deviation from the Contract Documents has been shown on the submittal and clearly defines the deviations from the F. Approval rendered on shop drawings shall not be considered as a guarantee of quantities, measurements, or building conditions. Where drawings are approved, said approval does not mean that

drawings have been checked in detail. Said approval does not in any way relieve the Contractor from his responsibilities or necessity of furnishing material or performing work as required by the contract

- drawings and specifications. G.Failure of the Contractor to submit shop drawings in ample time for checking shall not entitle him to an extension of Contract time, and no claim for extension by reason of default will be allowed. H. All shop drawings and submittals are to be in the office of the Architect within 30 days after the Contracts have been awarded. Contractor shall be financially responsible for any price increase of shop drawing items from the time these drawings are issued until they are returned to the Contractor for purchase of items.
- I. Contractor shall keep on the job at all times copies of all approved shop drawings. 2.3EQUIPMENT DEVIATIONS
- A. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical, or architectural layout, all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Contractor at his own expense and
- B. Where such approved deviation requires a different quantity and arrangement of wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such structural supports, electrical wiring and conduit, and any other additional equipment required by the system, at no additional cost to the Owner.

3.1 GENERAL

- A. The Contractor shall coordinate the work and equipment of this Division with the work and equipment specified elsewhere in order to assure a complete and satisfactory installation. Work such as excavation, backfill, concrete, flashing, wiring, etc., which is required by the work of this section shall be performed in accordance with the requirements of the applicable section of the specifications.
- B. It is the intention of these specifications and drawings to call for finished work, tested and ready for operation. Whenever the work "provide" is used, it shall mean "furnish and install complete and ready 3.2DUTIES OF CONTRACTOR
- A. Contractor shall furnish and install all materials called for in these Specifications and accompanying drawings and must furnish the apparatus complete in every respect. Anything called for in the specifications and not shown on the drawings or shown on the drawings and not called for in the specifications must be furnished by the Contractor.
- B. Contractor is responsible for familiarizing himself with the details of the construction of the building. Work under these specifications installed improperly or which requires changing due to improper reading or interpretation of building plans shall be corrected and changed as directed by the Architect/Engineer without additional cost to the Owner.
- C. The Contractor shall follow drawings in laying out work and check drawings or other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points.
- D. While every effort has been made to accommodate the equipment necessary for the work of this contract, it is the responsibility of the Contractor to ensure that equipment supplied as a part of this contract will fit in the spaces provided for by the drawings. Any concern by the contractor regarding the adequacy of a space for the equipment supplied, shall be brought to the attention of the Architect/Engineer in a written form prior to the approval of the related equipment submittals and prior to any rough-in associated with this equipment.

Where headroom or space conditions appear inadequate, Architect/Engineer shall be notified before proceeding with installation.

- E. The plans are diagrammatic and are not intended to show each and every fitting or a complete detail of all the work to be done; but are for the purpose of illustrating the type of system, etc., and special conditions considered necessary for the experienced mechanic to take off his materials and lay out his work. This Contractor shall be responsible for taking such measurements as may be necessary at the job and adapting his work to local conditions.
- F. Conditions sometimes occur which require certain changes in drawings and specifications. In the event that such changes in drawing and specifications are necessary, the same are to be made by the Contractor without expense to the Owner, providing such changes do not require furnishing more materials, or performing more labor than the true intent of the drawings and specifications demands. It is understood that while the drawings are to be followed as closely as circumstances will permit, the Contractor is held responsible for the installation of the system according to the true intent and meaning of the drawings. Anything not entirely clear in the drawings and specifications will be fully explained if application is made to the Architect/Engineer. Should, however, conditions arise where in the
- G. The right to make any responsible change in location of apparatus, equipment, routing of conduit up to the time of roughing in, is reserved by the Architect without involving any additional expense to the

judgement of the Contractor certain changes will be advisable, the Contractor will communicate with the Architect/Engineer and secure his approval of these changes before going ahead with the work.

- H.It shall be the duty of prospective Contractors to visit the job site and familiarize themselves with job conditions. No extras will be allowed because of additional work necessitated by, or changes in plans required because of evident job conditions, that are not indicated on the drawings.
- I. Contractor shall leave the premises in a clean and orderly manner upon completion of the work and shall remove from the premises all debris that has accumulated during the progress of the work. 3.3 COORDINATION
- A. This Contractor shall coordinate the work of all subs and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or
- B. Where the work will be installed near, or may interfere with the work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If so, directed by the Engineer, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 3/8" = 1'-0", clearly showing how his work is to be installed in relation to the work of other

trades. If the Contractor installs his work before coordination, or to cause any interference with work of any subs, he shall make the necessary changes in his work to correct the condition without extra

- C. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent
- 3.4EXCAVATION

A. Required excavation for installation of all electrical work shall be provided by the Electrical Contractor. Particular care shall be taken not to disturb or damage work of other trades.

B. Permitted cutting or patching necessary shall be done by Contractor. Structural members shall not be cut except by written permission of Architect/Engineer

- B. In backfilling pipe trenches, approved fill shall first be compacted firmly and evenly on both sides of pipe in 6" layers to a depth of 12" over the top of the pipe. Remainder of trench shall be backfilled to established grade in 6" layers. The Contractor shall compact between each layer with a high-frequency vibrator tamper such as Dart Soil Compactor (as manufactured by Dart Manufacturing Company, Denver, Colorado). Fill shall be compacted to density specified in Earthwork Section for the area through which trench is cut. Where compaction requirements are not established for an area, the Contractor shall compact fill to 95% maximum density at optimum moisture content.
- C. Excess earth shall be deposited on the site as directed by the Architect/Engineer.
- D. Where ditches occur outside of building, the surface shall be finished to match existing surfaces. Any existing work, or work of other trades, which is damaged or disturbed shall be repaired or replaced and left in good order. 3.5 SLEEVES, CUTTING, AND PATCHING
- A. Contractor shall place his own sleeves and advise other trades of required chases and openings so they can be properly built in. Sleeves provided under this division shall be formed out of no less than schedule 40 galvanized rigid steel conduit. Where any raceway supports installed under this Contract pierce the roof, suitable pitch pockets shall be provided and coordinated with the roofing contractor as necessary to be acceptable to the Architect/Engineer. Provide suitable fittings where any raceways or equipment cross expansion joints.
- 3.6PROTECTION AND CLEAN-UP A.Protect all material and work from damage during construction. Equipment installed in the building prior to its being closed in and dried out shall be protected from the elements in the same manner as previously specified for stored materials. Protect finished surfaces from splattering of mortar, paint, dirt, plaster, etc. Do not install device plates, face plates, canopies, flush cabinet trims, or fixtures on
- walls or ceilings until after painting or cleaning of the surface has been completed and arrange for such items that are required to be field painted to be painted before being mounted. Repair, clean and touch-up or replace all damaged material. At the completion of the project, remove all dust from finished surfaces, including lighting fixtures, lenses and lamps.

B. The Contractor shall keep premises free of debris resulting from his work. 3.7PAINTING AND FINISHING

- A. Suitable finishes shall be provided on all items of electrical equipment and materials which are exposed. This shall consist of either an acceptable finish as manufactured and supplied to the job or application of suitable finishes after installation.
- B. Where installed in finished areas, exposed equipment and materials shall be supplied with prime coat and shall be professionally painted or enameled as directed to match or blend with adjacent surfaces.
- C.In unfinished areas such as equipment rooms, exposed equipment shall be furnished with suitable factory applied finishes (e.g. standard gray enamel finish for panelboards, etc.).
- D. Equipment furnished in finishes such as stainless steel and brushed aluminum shall not be painted.
- E. All finishing shall be as directed by, and shall be satisfactory to, the Architect/Engineer.
- F. Paint material shall be selected from the products listed below and, insofar as practical, products of only one manufacturer shall be used. Contractor shall submit to the Architect/Engineer the listed manufacturer he proposes to use in the work. Should the Contractor desire to use products of a manufacturer not listed below, or products made by a listed manufacturer but not scheduled herein, Contractor shall submit complete technical information on the proposed products to the Architect/Engineer for approval. Only products approved by the Architect/Engineer shall be used.
- 1. Rust Inhibitive Primer: a. Devoe: Bar-Ox Quick Dry Metal Primer, Red.

b. Duron: Deluxe Red Primer.

- c. Glidden: Rustmaster Tank and Structure Primer.
- d. Pittsburgh: Inhibitive Red Primer. 2. Galvanized Metal Primer:
- a. Devoe: Mirrolac Galvanized Metal Primer b. Duron: Duron Deluxe Galvanized Metal Primer.
- c. Glidden: Rustmaster Galvanized Iron Metal Primer. d. Pittsburgh: Speedhigh Galvanized Steel Primer.

3.8 OBSERVATION

A. The project will be observed periodically as construction progresses. The Contractor will be responsible for notifying the Architect/Engineer at least 72 hours in advance when any work to be covered up is ready for inspection. No work shall be covered up until after observation has been completed.

END OF SECTION 260100

SECTION 260180 - SEISMIC RESTRAINT REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

- A. All seismic restraint materials specified herein shall be provided by a single manufacturer to assure single responsibility for their proper performance. Installation of all seismic restraint materials specified herein shall be accomplished following the manufacturer's written instructions.

B. The Contractor shall furnish to the seismic restraint materials contractor a complete set of shop drawings and other necessary information, for all electrical equipment and components that receive seismic

devices. The information to be furnished shall include operating weight of the equipment to be restrained, distribution of weight to support points and dynamic characteristics along with any internal

isolation systems to be analyzed. The Contractor shall also furnish a complete layout of conduit, components and equipment to be restrained, including vertical risers, showing size or weight and support

- points, to the seismic restraint materials contractor for selection and layout of mountings. C. The seismic restraint materials contractor shall use the above listed information to design a complete system of seismic mounts in accordance with the contract documents along with the ASCE 7 Standard and the International Building Code. The seismic restraint materials Contractor shall analyze all "multiple degree of freedom" systems and provide properly designed restraint systems avoiding
- all resonance frequencies. To accomplish this, the seismic restraint materials contractor shall employ an Engineer registered in the State of South Carolina to design all restraint systems and prepare a complete set of calculations and shop drawing submittals with his professional Engineer's seal certifying that the design meets all requirements of these contract documents. A seismic design "errors and omissions" insurance certificate must accompany submittals from the Seismic Engineer. Manufacturer's product liability insurance certificates are not acceptable.
- D. The Seismic Engineer or his designated representative shall inspect the project upon completion of the applicable work and provide written certification that the installation is in compliance with the approved shop drawing submittals. This certification shall also bear the professional Engineer's seal and shall become part of the contract closeout documents. All seals shall be signed and dated appropriately.

PART 2 - PRODUCTS AND EXECUTION

2.1 SEISMIC RESTRAINT

- A. All required equipment shall be bolted to the structure to allow for seismic acceleration with no failure or displacement. All connections shall be positive bolted type; no friction clamps of any kind are
- B. Provide cable and connection sets for suspended equipment at each of four comers secured to the building structure. C. Floor mounted equipment shall be provided with seismically housed springs or springs with seismic snubbers as determined by the equipment to be restrained.
- D. Seismic restraint systems shall be provided by The VMC Group, Mason Industries, Consolidated Kinetics, or prior approved equal. 2.2 WIND RESTRAINT
- A. All electrical equipment exposed to wind must be evaluated and restrained for wind loading per the requirements of the International Building Code.

SECTION 261000 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL (NOT USED)

PART 2 - PRODUCTS

- A. Unless otherwise indicated or specified, the Wiring Method for this project shall consist of copper conductors with 600-volt insulation installed in metal raceways.
- B. The word "Raceway" and the word "Conduit" (or abbreviation "C") used herein or on the drawings indicate Rigid Metal Conduit and, where permitted, Intermediate Metal Conduit, Electrical Metallic
- C.Reference to "Rigid Conduit" or "RMC" indicates heavy-wall Rigid Metal Conduit only.

Tubing, Rigid Nonmetallic Conduit, Flexible Metal Conduit, or Liquid-tight Flexible Metal Conduit.

- D. Reference to "IMC" indicates Intermediate Metal Conduit.
- E. Reference to "PVC" indicates Rigid Nonmetallic Conduit.
- F. Reference to "EMT" or "Tubing" indicates Electrical Metallic Tubing.
- G.Reference to "Flex" or "Flexible Conduit" indicates Flexible Metal Conduit, or, where required, Liquid-tight Flexible Metal Conduit.
- H. Other wiring methods, such as Surface Metal and Nonmetallic Raceways, shall be provided to the extent indicated on the drawings and/or hereinafter specified.
- I. Aluminum conductors may be used only where specifically indicated on the drawings; however, aluminum shall not be used for grounding. 2.2FASTENING METHODS
- A. Acceptable fastening methods include wood screws and nails on wood construction, toggle bolts on hollow masonry, expansion bolts and lead anchors on brick and concrete, and machine screws on
- B. Explosive set (powder actuated) fasteners are not allowed for support of conduit.
- C. Wire, perforated metal strap, and wooden plugs are not acceptable as fastening material.
- D. Materials used shall be good quality, made of zinc or cadmium coated steel or other non-corroding material.
- E. Materials, whether exposed or concealed, shall be firmly and adequately held in place. Fastening and support shall afford safety factor of three or higher and shall be in full compliance with the seismic protection requirements of the International Building Code.
- F. Fixtures, raceways, and equipment shall be supported from the structure. Nothing may be supported on suspended ceiling unless noted so on the Drawings or specifically permitted by the
- G.Equipment and raceways attached to outside walls, or interior walls subject to permanent moisture, shall be shimmed out with non-corrodible material to provide 1/4" air space between wall and
- 2.3EQUIPMENT IDENTIFICATION
- A. Suitable nameplates shall be provided for the identification of electrical equipment including Switchboards, Panelboards, Motor Starters, Safety Switches, and Circuit Breakers.
- B. Nameplates shall be of engraved white core plastic laminate, not less than 1/16" thick. Nameplates shall have white letters on black backgrounds.
- C.Engraving shall be of professional quality, with block style letters, minimum 1/4" high.
- D. Nameplates shall be attached with sheet metal screws. They shall be sized to allow for installation of screws without obscuring text.
- E. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or 2.4 SLEEVES AND PENETRATIONS
- A. The Electrical Contractor shall provide sleeves and openings for his penetrations through exterior walls, interior walls and partitions, floors, and roofs. Provisions for all such penetrations shall be as
- B. For any raceway passing through an exterior wall, above or below grade, provide appropriate sleeve and water proofing. Center the conduit in the sleeve and fill the space between conduit and sleeve with appropriate compound such as lead and oakum, and then apply caulking compound flush with the wall surfaces. C.For raceways penetrating floor slabs, smoke partitions, and fire-rated walls, provide steel pipe sleeves and seal with high-temperature non-shrink grout or other material as approved by the
- Architect/Engineer. Materials and installation methods shall be UL listed as a Through-Penetration Firestop System suitable for use with the UL Fire Resistance Design encountered. Refer to the UL fire protection details shown on the drawings.
- D. Conduits penetrating roof surfaces for purpose of connecting to roof-top mechanical equipment shall utilize openings and curbs provided for the equipment where possible. E. For other raceway penetrations through the roof the Contractor shall provide appropriate prefabricated roof curb assemblies.
- PART 3 EXECUTION (NOT USED)

END OF SECTION 261000

SECTION 261100 - RACEWAYS AND FITTINGS

PART 1 - GENERAL

- 1.1 SCOPE A. Provide complete raceway systems as indicated on the drawings, as herein specified, and as required by applicable codes. Comply with Section 261000 Basic Materials and Methods.
- B. All wiring shall be installed in raceways unless specifically noted otherwise. 1.2 SUBMITTALS
- A. Submit for approval manufacturer's data sheets for all raceway system components

location shall be PVC jacketed liquid-tight complete with liquid-tight connectors.

PART 2 - PRODUCTS

2.1MANUFACTURERS

- A.Metal raceway and components shall be as manufactured by Allied, Triangle, Wheatland, Thomas & Betts, or other approved manufacturers. B. Non-metallic raceway system components shall be as manufactured by Carlon, Queen City Plastics, Ipex, or other approved manufacturers.
- 2.2MATERIALS AND APPLICATIONS
- A.Rigid Metal Conduit shall be zinc coated Schedule 40 steel or alloy 6063-T42 aluminum with threaded couplings and fittings. Termination at sheet metal enclosures shall consist of double locknuts and insulating bushings. Rigid Steel conduit shall be used for all exposed and concealed work except where other raceways are indicated or permitted. Aluminum conduit complete with aluminum fittings may be used in lieu of steel conduit except in wet locations, underground, or in poured concrete. Steel and aluminum shall not be mixed in the same run of conduit.
- B. Intermediate Metal Conduit (IMC) with threaded couplings and fittings may be used for exposed and concealed work in lieu of rigid metal conduit except underground outside the building foundation, or where supporting lighting fixtures, or in hazardous locations, or where exposed to severe impact or injury. Termination at sheet metal enclosures shall consist of double locknuts and insulating bushings.
- C.Electrical Metallic Tubing (EMT) of 3" maximum size may be used for concealed work in lieu of Rigid Metal Conduit except underground or in poured concrete. EMT of 3" maximum size may be used for exposed work in lieu of Rigid Metal Conduit except outdoors, or above a roof, or where supporting lighting fixtures, or where exposed to severe impact or injury, or in hazardous locations, or less than 10 feet above a floor or platform in other than in electrical, mechanical, or communications closets or equipment rooms. D.Rigid PVC Conduit shall be Schedule 40, UL listed for use with 90°C. Conduit run underground or run in or under a poured concrete slab shall be rigid PVC, suitable for direct burial. Concrete encased
- rigid PVC conduit shall be suitable for concrete encasement. Vertical elbows and vertical extensions from underground or concrete embedded PVC conduits smaller than 3" trade size may also be of PVC if they remain concealed in CMU but shall be of Rigid Steel Conduit (or IMC where permitted) otherwise. An insulating bushing or end bell shall be provided at each termination. Conduit run underground and not under a poured concrete slab shall have installed continuously above it a warning tape. Tape shall be 12 inches wide, centered on conduit and located 12 inches below finished grade. E. Flexible Metal Conduit shall be of zinc coated steel of minimum length and shall be used in lieu of Rigid Metal Conduit for connections to moving or vibrating apparatus, recessed lighting fixtures, dry-type
- F. Fittings for steel conduit and tubing shall be of zinc coated steel or malleable iron. Insulating bushings of plastic provided for Rigid and Intermediate Metal Conduits shall be rated for 150°C. Bonding bushings shall be steel or malleable iron with non-removable plastic throats rated 150°C. EMT fittings shall be of the compression type and concrete tight or rain tight as applicable. Setscrew, indenter, pressure cast, and die cast fittings are not acceptable. Connectors for EMT, Flexible Metal Conduit and Liquid-tight Flexible Metal Conduit shall be the insulated throat type. Connectors for Flexible Metal

H.Minimum raceway size shall be 1/2". Other raceway sizes, unless indicated on the drawings, shall be determined by the Contractor in accordance with NEC requirements for type THW insulated

transformers, and motors. Flexible Metal Conduit may be used where rigid connections are impractical due to obstructions or space limitations. Flexible Metal Conduit used in wet, damp, or corrosive

- Conduits shall be of the "Tite-Bite" design. G.Conduit expansion fittings shall be of zinc coated cast or malleable iron and steel conduit, complete with flexible bonding straps. Expansion fittings shall allow longitudinal conduit movement of 4 inches.
- conductors, or the actual insulation used if it is thicker than type THW.

END OF SECTION 261100

- A.Rigid and Intermediate Metal Conduits shall be made up with full threads, to which a conductive pipe compound has been applied, and butted in coupling. Terminations at sheet metal enclosures in indoor dry locations shall be made with double locknuts and an insulating bushing. Terminations at sheet metal enclosures in outdoor, damp, and wet locations shall be made with threaded conduit hubs of zinc
- coated malleable iron. B. Except where run under a concrete slab on grade, underground conduits shall be installed a minimum of 30" below grade. Underground encased conduits shall be installed a minimum of 18 inches below grade. Trenching and backfilling shall comply with Section 260100 Electrical General Requirements.
- C. All underground conduits shall have metalized warning tape installed above the conduit that identifies the specific system buried below. The warning tape shall consist of a minimum 3.5 mil solid foil core encased in a protective plastic jacket (total thickness 5.5 mils). Tape shall be 6 inches wide with black lettering imprinted on a color-coded background that conforms to APWA color code specifications. Tape shall be installed 18 inches above the conduit and in no case less than 6 inches below grade.
- D.Installation of PVC conduit shall be in accordance with the manufacturer's recommendations using solvent welded couplings and fittings. Field bends shall be made with approved heating equipment. Open flames are not permitted. An insulating bushing or end-bell shall be provided at each termination. E. Conduits shall be rigidly supported not more than 8 feet on center and shall be concealed within walls, ceilings, and floors, except as indicated or specifically approved by the Architect/Engineer; kept at

least 6" from flues and steam or hot water pipes; and protected against the entry of dirt, plaster, or trash. Raceways shall be supported independently of suspended ceiling members and suspension

- F. Suspended EMT shall be provided with additional hangers at elbows and bends, and where necessary to avoid strain at couplings and connectors.
- G.Exposed conduits, where permitted, shall be run parallel or perpendicular to walls, structural members and ceilings; with right-angle turns consisting of symmetrical bends or cast metal fittings with threaded hubs. Offsets may be used where necessary if they are of minimum length.

H. Conduits crossing expansion and contraction joints shall cross perpendicular to the joint and shall be provided with expansion fittings. Conduits shall not be embedded in the concrete slabs at the

expansion and contraction joints

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PART 3 - EXECUTION

1.1 SCOPE

A. Furnish and install a complete system of wire and cable in compliance with SECTION 261000 BASIC MATERIALS AND METHODS.

1.2 SUBMITTALS

A. Submit for approval manufacturer's data sheets for all conductor types. All wire shall be listed by an "approved" third party testing agency.

PART 2 - PRODUCTS

2.1MATERIALS

A. Insulated conductors shall be as manufactured by Rome, Triangle, Southwire, or approved equal.

B. Unless otherwise indicated, all wire and cable conductors shall be copper.

C. Conductors shall be not smaller than No. 12 AWG except that No. 10 AWG minimum is required for the entire length of 120-volt branch circuits whose distance to the center of the load exceeds 75 feet. Where conductor sizes are increased due to length, the associated equipment ground conductor must also be increased proportionately per NEC 250.122(B).

D.No.14 AWG may be used for signal and remote-control circuits. Conductors that are smaller than No.14 AWG may be used only where specifically indicated on the drawings or specified herein.

E. Conductors no. 10 AWG and smaller shall be solid, dual rated type THWN/THHN.

F. Conductors no. 8 AWG and larger shall be Class B stranded, dual rated type THWN/THHN.

G.Each conductor shall bear easily readable markings along entire length, indicating size and insulation type.

H. Insulation on conductors no. 10 AWG and smaller shall be suitably colored in manufacture.

I. Conductors in any location subject to abnormal temperature shall be furnished with an insulation type suitable for temperature encountered.

J. Where no indication is made of wire size, the conductor shall be of N.E.C. size to match its overcurrent protective device, but in no case smaller than no. 12 AWG.

PART 3 - EXECUTION

3.1 SPLICES, TAPS, AND CONNECTIONS

A. Splices in conductors no. 10 AWG and smaller shall be made with twist-on spring steel devices UL listed as Pressure Cable Connectors, with integral insulating covers rated 75oC at 600 volts, except that those used for connections to lighting fixtures and other heat-producing equipment shall comply with temperature ratings marked on the equipment but not less than 90oC.

B. Splices in copper conductors no. 8 AWG and larger shall be made with mechanical devices UL listed as Pressure Cable Connectors and insulated with thermoplastic tape UL listed for use as sole insulation. Tape may be omitted from connectors supplied with securely fastened insulating covers which completely enclose the connector and the conductors. Insulating covers shall be rated 75°C at

C. Connect solid wires to equipment, switches, and devices equipped with binding screw terminals by looping the wire under the screw head in such a manner that the loop is tightened as the screw is tightened. Straight-in wiring under screw terminals is not acceptable.

D. Stranded wires shall not be inserted into back-wiring holes on devices, nor shall they be directly connected to screw head terminals. They shall be fitted with insulated crimp-on type spade terminals for 3.2 COLOR CODING

A. All wiring shall be color coded.

B. On 120/208V, 3 phase, 4 wire power systems, conductor insulation shall be color coded Black (Phase A), Red (Phase B), Blue (Phase C), and White (Neutral). On 277/480v, 3 phase, 4 wire power systems, conductor insulation shall be color coded Brown (Phase A), Orange (Phase B), Yellow (Phase C), and Gray (Neutral).

C.Insulation for grounding conductors on all systems shall be Green.

D. Conductors no. 8 AWG and larger may be identified with two or more bands of proper color plastic tape applied near each splice and termination. Painting of wire will not be acceptable.

E. Phase sequence shall be "A", "B" and "C" from left to right, top to bottom or front to back when facing equipment.

F. Control and signal wiring shall not use the above-named colors except green for grounding. Any other colors or striping may be used but the coding shall provide same color or striping between any two

G.Switch legs, including "Travelers", shall be the same color as phase circuit conductors.

3.3 SERVICE & FEEDER CONDUCTORS:

A. Unless specifically shown otherwise, each feeder and each set of service conductors shall be installed in a separate raceway.

B. Where paralleling of conductors is shown for feeders or service entrance, it is absolutely required they be the same length between terminations.

C. Where service or feeder conductors are so installed that the conductor markings cannot be read without moving or twisting conductors, they shall be provided with suitable tags indicating the conductor

END OF SECTION 261200

SECTION 261220 METAL-CLAD CABLE SYSTEMS

1.1 <u>SCOPE:</u>

a. Furnish and install a complete system of Metal-Clad Cable for branch circuit, signal, and remote control wiring as specified herein.

b. Other branch circuit cable systems such as Types AC, NM, and NMC are not permitted.

1.2 APPLICATIONS:

a. Metal-clad cables may be used in lieu of wire in metal raceway only for concealed work in dry locations above suspended ceilings and within stud partitions.

b. Cables may not be run in, or through, concrete or masonry, fire-rated partitions, smoke partitions, or floors.

1.3 SUBMITTALS:

a. Submit for approval manufacturer's data sheets for metal-clad cable systems

2.1 MATERIALS:

a. Metal-clad cables shall be UL listed as type MC with copper conductors, THHN insulated; with full size green insulated grounding conductors. Minimum sizes shall be #12 AWG for branch circuits, #14 AWG for signal and remote control. Maximum size shall be #10 AWG.

b. Cable connectors shall be UL listed for grounding the metal sheath. Connectors shall be of steel or malleable iron with insulated throats.

c. Cables shall be color-coded in manufacture.

3.1 INSTALLATION:

a. Cables shall not be run exposed. Conduit skirts may be provided on surface mounted panelboards to conceal cables between panel tops and ceilings.

b. Except where installed in continuous rows, lighting fixtures shall be individually connected to a concealed outlet box. Cables may not be looped from fixture to fixture.

c. Cables above ceilings shall be supported from overhead structure clear of ductwork, suspended ceilings, and ceiling hanger wires.

End of Section 261220

SECTION 261300 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SCOPE

A. The electric system neutral, the neutral of each separately derived system, and all non-current-carrying metal parts, raceways, and enclosures shall be permanently and effectively grounded.

B. Grounding and bonding shall be provided in strict accordance with the National Electrical Code, and as specified herein and on the drawings.

C. The Contractor shall note that required grounding conductors and connections are not all shown on the drawings. NEC requirements apply.

A. Submit for approval manufacturer's data sheets for grounding and bonding materials.

PART 2 - PRODUCTS

2.1MATERIALS AND APPLICATIONS

A. Grounding conductors shall be of THWN insulated copper, unless otherwise indicated.

B. Grounding bus bars in distribution equipment shall be bare copper.

C. Aluminum and aluminum alloys are not acceptable as grounding materials.

D. Clamps for attaching conductors to water pipes and ground rods shall be of bronze. Ground rod clamps shall be U.L. listed for direct burial.

E. Clamps for attaching conductors to building steel shall be of steel, bronze, or malleable iron.

F. Threaded hubs for bonding metal raceways to the contained grounding electrode conductors and to the water pipe clamps shall be of bronze or malleable iron. Similar hubs shall be used to bond the

same raceways to the conductors and to sheet metal equipment enclosures.

G.Driven grounding electrodes shall consist of copper clad steel rods. Rods shall be 10 feet long and 3/4" diameter unless otherwise indicated.

H.Bonding bushings shall be of steel or malleable iron with non-removable plastic throats rated 150°C.

I. Bonding locknuts and wedges for service conduits shall be of zinc coated steel.

J. Grounding type insulated bonding bushings and jumpers shall be provided where conduits terminate in service entrance equipment, generator feeders, transfer switches, transformers, and where concentric, eccentric or over-sized knockouts are encountered. The jumpers shall be sized per NEC Table 250-66 for services, generator feeders, and transformers, and per Table 250-122 for branch

PART 3 - EXECUTION

3.1EQUIPMENT GROUNDING

A. All non-current-carrying metal parts, raceways, and enclosures of the electrical system and of equipment supplied through the electrical system shall be permanently and effectively grounded.

B. Equipment grounding conductors shall be provided for each feeder and for each branch circuit and shall be contained within the same raceways as the feeder and branch circuit conductors. The equipment grounding conductor shall be THWN insulated copper, not smaller than #12 AWG.

C. Copper bonding strips normally included in small sizes of liquid-tight flexible metal conduit and dependent upon the terminal connectors for bonding continuity will not be accepted in lieu of the equipment grounding conductors specified herein.

D. Grounding terminals on wiring devices, including switches, shall be connected to the equipment grounding conductor included in the branch circuit raceway, and to the device box with suitable jumpers and lugs bolted to the box, not the plaster ring. "G" clips are not acceptable, and "self-grounding" type device mounting screws will not be accepted as the device grounding method.

E. Where metal raceways enter sheet metal enclosures through knockouts provide bonding bushings and jumpers to the enclosure under any of the following conditions:

1. Voltage exceeds 250 volts to ground.

2. Branch circuit conduit exceeds 1" in size.

Feeder conduit regardless of size. 3.2 GROUNDING OF OTHER SYSTEMS

A. All metal piping systems including water piping, gas piping and sprinkler piping shall be permanently and effectively bonded to the electrical equipment ground system as required by N.E.C. 250.

3.3 GROUNDING ELECTRODE SYSTEM

A. The grounding electrode system for the service neutral and service equipment shall include connections to the following:

B. Structural metal systems shall be permanently and effectively bonded to the electrical grounding electrode system as required by N.E.C. 250.

1. The water main at the nearest accessible point to where it enters the building and on the street side of the main valve. This connection shall remain accessible after construction is complete. 2. A ground rod using #4 AWG copper conductor. Ground rods shall be driven to a depth equal to their length plus six inches. Provide additional ground rods not less than 10 feet apart where needed to comply with NEC ground resistance limitations, and resistance limitations specified herein. 3. Structural metal building frame, where applicable.

B. Grounding electrode conductors shall be without splice and shall be contained within steel raceways and bonded to the raceway at both ends. Raceway may be omitted only where specifically indicated on

C. A mechanical clamp type ground conductor connection is acceptable only if the connection is readily accessible for inspection and tightening. Any connection point not readily accessible shall be made by the thermal welding process.

D. The Contractor shall test the ground resistance of the completed grounding electrode system. If test indicates a resistance to ground in excess of 25 ohms it shall be reduced to 25 ohms or less by E. Prior to making the final main bond jumper connection from the grounding electrode conductor to the system neutral, the contractor shall demonstrate by megger test adequate isolation from ground of the system neutral. This test will require that the system neutral be suitably isolated from service neutral if it has been grounded in any way.

END OF SECTION 261300 SECTION 261400 - BOXES

PART 1 - GENERAL

1.1 SCOPE

A.Furnish and install outlet boxes, switch boxes, pull boxes, terminal boxes, junction boxes and floor boxes complete as shown and specified.

1.2 SUBMITTALS

A. Submit for approval manufacturer's data sheets for all box types.

PART 2 - PRODUCTS

2.1MATERIALS AND APPLICATIONS A. Unless specifically noted or approved otherwise, boxes shall be of zinc coated steel or cast ferrous alloy as manufactured by Steel City, Raco, Crouse-Hinds, Appleton, or approved equal.

B. For exposed work on the exterior of the building, and in damp or wet interior locations, boxes shall be of cast metal with threaded conduit hubs and gasketed covers; or of zinc coated sheet steel of NEC gauge and size with screw fastened gasketed covers and threaded conduits hubs of zinc coated malleable iron and no knockouts or extraneous openings. Cover screws shall be stainless steel.

C. For exposed work in interior dry locations less than 8 feet above a floor or platform in other than Electrical, Mechanical or Communications Closets or Equipment Rooms, boxes shall be of cast metal with threaded conduit hubs and matching covers; or of zinc coated sheet steel of NEC gauge and size with screw fastened covers and no knockouts or extraneous openings. Cover screws shall be steel.

D. For exposed work in interior dry locations in Electrical, Mechanical, or Communications Closets or Equipment Rooms; or, in other dry areas, 8 feet or more above a floor or platform, boxes 5" square and larger shall be NEC gauge and size of zinc coated sheet steel. 4" octagonal, 4" square and 4-11/16" square "knockout" boxes shall be of zinc coated steel, NEC gauge and size. Box extensions are not permitted on exposed "knockout" boxes, and covers shall be of the raised surface type. "Handy" boxes are not permitted.

E. For concealed work, fixture outlet boxes shall be 4" octagonal minimum, provided with plaster rings in plastered surfaces. Concrete ring boxes shall be used in poured concrete. Switch and outlet boxes in plastered and dry walls shall be 4" square minimum or one-piece multi-gang with appropriate plaster rings. Switch and outlet boxes in exposed brick, block or tile walls shall be single or multi-gang one-piece boxes not less than 3-1/2" deep with square corners and with internal device mounting holes. Boxes in walls finished with ceramic tile or wood paneling shall be 4" square minimum or one-piece multi-gang boxes, fitted with appropriate tile rings having square corners and internal device mounting holes. Gangable boxes are not permitted.

PART 3 - EXECUTION 3.1INSTALLATION

A. Set recessed boxes with edges flush with finished surfaces.

B. Immediately after installation cover boxes to prevent entrance of foreign matter.

C.Scaling of plans for outlet locations is not necessarily accurate enough for the intent of these specifications. It is the Contractor's responsibility to comply with the evident intent for centering or symmetric arrangement in ceiling and wall spaces. Special attention is also directed to the location of any outlets which are built into, or located in relation to, other features such as shelving, work counters, and equipment. The Contractor shall consult plans and shop drawings on such features and locate outlets as thereby indicated.

D. Mounting heights indicated herein and on the drawings are approximate dimensions of the center of the box to the floor and may vary slightly in order to clear obstructions and match joints in masonry. References to "Horizontal" and "Vertical" apply to the orientation of the long dimension of a single-gang plate and of the device mounting strap. Alignment tolerance shall be 1/16 inch.

1. Wall receptacle, data, and telephone outlets shall, unless otherwise indicated, be installed vertical, 18" up.

2. Outlets indicated as "counter height," as well as boxes for wall switches, fire alarm manual stations, and wall telephones shall be installed vertical, 46" up, clear of wall cabinets, back-splashes, and

3. Fire alarm signal devices shall be installed with the top of the device approximately 6" below the ceiling or with the bottom of the device 80" above the floor, whichever is lower.

E. Switch boxes beside doors shall be on the strike side, with edge approximately 2" from door jamb or trim.

F. Junction and pull boxes may be used as necessary to facilitate wiring provided, they are hidden from sight (but accessible), or installed in locations where exposed wiring is permitted, or flush mounted at locations approved by the Architect/Engineer.

END OF SECTION 261400 SECTION 261500 - WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. The Contractor shall furnish and completely install lighting switches, convenience outlets, and special purpose receptacles along with appropriate outlet boxes and device plates as indicated on the

B. Where connection to an item of equipment is required under this contract, and where such equipment requires a receptacle for connection, the Contractor shall furnish and install the appropriate device, whether the device is specifically shown or specified. 1.2 SUBMITTALS

A. Submit for approval catalog data sheets for all wiring devices.

PART 2 - PRODUCTS

2.2DEVICES AND PLATES - GENERAL

2.1MANUFACTURERS

A. Wiring devices and device plates shall be manufactured by Hubbell, Pass & Seymour or Leviton.

B. Catalog numbers of one or more of the manufacturers are used herein and, on the drawings, to set a standard of quality and capacity. Equivalent products of the other named manufacturers are also acceptable, provided they are submitted and approved in accordance with Section 260100, Electrical General Requirements.

C. All wiring devices of any one general type (e.g. all duplex receptacles or all light switches) shall be of the same manufacturer and shall match throughout.

A. Wiring devices shall be industrial specification grade, minimum.

B. Receptacles shall be listed to meet the requirements of Fed Spec WC596.

C. Switches shall be listed to meet the requirements of Fed Spec W-5-896E.

D.Unless otherwise indicated or directed, devices shall be gray in color.

E. Unless otherwise indicated, plates for flush outlets shall be stainless steel (type 302). Those for surface cast boxes shall be of steel, of shape and finish to match the box. Screws shall be steel slotted head oval type to match the plate. Quantity of 2% spare cover plates of each type shall be provided to the owner.

F. Each device (including each switch) shall be equipped with a Hex-Head green grounding screw for grounding the device and plate to the outlet box and to the equipment grounding conductor run with the circuit conductors. "Self-Grounding" type mounting screws will not be accepted as the device grounding method. 2.3SWITCHES

A. Switches used for lighting control shall be rated 20 amps, 120-277 VAC, side wired

B. Switches used for disconnecting small single-phase motors and appliances shall be rated 20 or 30 amps to match the branch circuit rating and comply with their horsepower ratings, 120-277 VAC, side

C. Weatherproof switches shall be equipped with stainless steel covers UL listed for wet locations with cover closed.

D. Switches with collars around the operating toggle will not be accepted. 2.4RECEPTACLES

A. Unless otherwise indicated or required, duplex receptacles shall be the grounding type, arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall have a green hex head grounding screw and a direct, green insulated conductor connection to the equipment grounding system. Duplex receptacles shall be rated 20 amps, 125 volts, NEMA 5-20. Receptacles shall conform to NEMA WD-1, WD-6, and UL 498.

B. GFCI receptacles shall be Class A, listed to UL standard 943.

C. Where indicated on the drawings, weather-resistant receptacles shall consist of Ground Fault Circuit Interrupter receptacles as specified above with a weather-resistant "WR" rating. Provide receptacle with aluminum "in-use" cover, UL listed for wet location while in use.

PART 3 - EXECUTION

END OF SECTION 261500

3.1INSTALLATION

A.Devices shall be mounted tightly to boxes and be adjusted plumb and level. Devices shall be mounted flush with its associated cover plate. Ears on flush devices shall be in uniform contact with wall surfaces, or the devices shall be fitted with Caddy RLC device levelers. Device plates shall not be used for support of flush devices.

B. Where two or more devices are indicated for gang installation, they shall be trimmed with gang type plates. C. Grounding type receptacles shall be grounded with insulated copper grounding conductors routed with the circuit conductors.

D. The Contractor shall provide suitable testers, and demonstrate, when directed, that receptacles are operational and correctly wired; and that ground fault circuit interrupter type receptacles will trip when current to ground has a value in the range of 4 through 6 milliamperes.



1.1 SCOPE

A. Provide equipment for overcurrent protection, switching, disconnecting, transformation, and control of services, separately derived systems, feeders, and branch circuits as indicated on the drawings and as herein specified.

B. Equipment specified by this section shall be third party listed.

PART 2 - PRODUCTS

2.1MANUFACTURERS

A. Distribution equipment, other than fuses, shall be manufactured by Square D, General Electric, Siemens, or Eaton. Equipment design features and components indicated on the drawings are those of Cutler-Hammer, and the standard construction features of that manufacturer shall be considered as minimum requirements, with additional requirements as specified herein and on the drawings.

B. Fuses shall be manufactured by Bussmann, Gould Shawmut, or Littelfuse.

2.20VERCURRENT PROTECTION DEVICES

- A. Unless otherwise indicated, circuit breakers shall be provided as the overcurrent protection devices for services, separately derived systems, feeders, and branch circuits. Fuses may be used only where indicated on the drawings, or required by the nameplate for equipment connected, or specified herein.
- B. Molded-case and insulated-case circuit breakers shall be the static or thermal-magnetic type, quick-make and quick-break for manual and automatic operation. Multipole breakers shall be common trip. Circuit breakers shall be bolted in place where possible. Thermal-magnetic breakers shall be calibrated at 40oC or ambient compensated. Ampere ratings, frame sizes, and short circuit ratings shall be as indicated on the drawings. Series ratings may be applied only where specifically indicated on the drawings. Individual enclosures shall be NEMA 1 indoors, 3R outdoors, unless otherwise indicated. Other circuit breakers shall be suitable for installation in Panelboards as hereinafter specified.
- C. Single-pole 15- and 20-amp circuit breakers shall be SWD rated.

D. Fuses shall be the non-renewable, time delay, cartridge type, UL Class RK5 unless otherwise indicated; for installation in Safety Switches, as hereinafter specified.

2.3 SWITCHING EQUIPMENT

- A. Fusible switches shall be incorporated into Safety Switches, as hereinafter specified. Manual operation shall be quick-make and quick-break. Fuse holders shall be the Class R rejection type unless
- B. Safety Switches shall be the NEMA heavy duty type, horsepower rated, with interlocked covers, non-fusible except where fused switches are indicated, or fuses are required. Switch mechanisms shall be quick-make and quick-break. Enclosures shall be NEMA 1 indoors, NEMA 3R outdoors unless otherwise indicated. Fuse holders, where required, shall be as specified above for fusible switches.

C. Switches for disconnecting small single-phase motors and appliances shall comply with SECTION 261500 WIRING DEVICES.

2.4 APPLICATION

- A. Distribution Equipment shall be sized for installation with required clearances at the locations shown on the drawings. Alternative arrangements may be submitted to the Architect/Engineer by the Contractor for approval, in the form of shop drawings, drawn to scale and showing actual dimensions of proposed equipment and required clearances.
- B. Unless otherwise indicated, Distribution Equipment shall be connected with wire and cable as specified in SECTION 261200 CONDUCTORS. In general, these specified conductors are rated for a maximum operating temperature of 75°C and are sized for that temperature rating in an ambient of 30°C. Distribution equipment, including terminal lugs, temperature sensitive devices, and enclosures shall be designed, sized, and labeled for field connection with conductors as specified.
- C. Power conductors shall be properly tightened and/or torqued as recommended by the equipment manufacturer supplying the lugs/terminals used for terminating the conductors.
- D. Lugs/terminals shall comply with UL standards UL486A and UL486B.
- E. Wiring run within distribution equipment shall be neatly laced and grouped.

2.5IDENTIFICATION

- A. Equipment nameplates; and nameplates for individually mounted switches, circuit breakers, and motor starters shall comply with SECTION 261000 BASIC MATERIALS AND METHODS
- B. Group mounted switches and circuit breakers in Panelboards shall be provided with nameplates as described above; or they shall be identified with numerals and cardboard directories in metal or heavy polycarbonate, directory frames. Directories in metal frames shall be protected with rigid plastic covers. Directories shall be sized to permit all circuit designations to be read without removing the card
- C. Manufacturer's nameplates or labels on custom fabricated or factory assembled custom equipment shall contain sufficient identification to expedite the future procurement of parts, additions, and shop
- D. Service Equipment shall be UL labeled as "Suitable for use as Service Equipment." Service disconnects shall be clearly identified.

PART 3 - EXECUTION

3.1INSTALLATION

- A. Distribution Equipment shall be installed in strict accordance with the manufacturer's instructions for handling, support, connections, assembly, protection, energization, adjustment, and similar
- B. Fastening methods shall comply with SECTION 261000 BASIC MATERIALS AND METHODS.
- C. Equipment interiors shall be thoroughly cleaned of dust, dirt, trash, and other foreign material prior to energization of the equipment.
- D. Exterior Safety Switches that are readily accessible to unauthorized persons shall have their covers padlocked closed by the Contractor. Keys shall be identified and delivered to the Owner.
- E. Upon completion or the project, furnish to the Owner one complete set of replacement fuses, consisting of three fuses of each type and rating used.
- F. Directory cards for Panelboards shall be neatly filled-in with a typewriter to indicate the type and location of the load on each circuit or feeder. Coordinate location designations with Owner.
- G. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers.

END OF SECTION 264000

SECTION 264010 - SURGE PROTECTION DEVICE SYSTEM

PART 1- GENERAL

1.1 SCOPE

- A. These specifications describe the electrical and mechanical requirements for a high energy Surge Protection Device System (SPD). The specified system shall provide effective high energy surge current diversion, sine wave tracking as required for electrical line noise filtering and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.11 C62.45 and MIL_STD_220A. The system shall be connected in parallel with the protected system; no series connected elements shall be used which limit load current or kVA capability.
- A. The SPD surge protection system shall be designed and manufactured, and where appropriate, listed to the following standards:
- Underwriters Laboratory (UL) 2. UL1449: Surge Protective Devices (SPD)
- 3. UL1283: Electromagnetic Interference Filters

B. Institute of Electrical & Electronic Engineers (IEEE)

- 1. C62.41.1: IEEE Guide on the Surge Environment in Low-Voltage (1000V and less) AC Power Circuits
- 2. C62.41.2: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits 3. C62.45: IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits
- 4. C62.62: IEEE Standard Test Specifications for Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits 5. C62.72: IEEE Guide for the Application of Surge Protective Devices for Low Voltage (1000V and Less) AC Power Circuits
- C. National Electrical Manufacturers Association (NEMA)
- D. National Fire Protection Association, NFPA 70, National Electric Code
- E. Federal Information Processing Standards Publication 94 (FIPS 94), Guideline on Electrical Power for ADP Installations
- F. MIL-STD 220A
- 1.3 SYSTEM DESCRIPTION
- A. Storage temperature range shall be _55 to +85 C (_67 to +187 F)
- B. Operating Temperature range shall be _40 to +50 C (_40 to +122 F)
- C. Operation shall be reliable in an environment with 0% to 95% non_condensing relative humidity.
- D. The SPD shall generate an audible noise level of not more than 45 dba at 5 feet.
- E. The system shall be capable of operating up to an altitude of 12,000 feet above sea level.
- F. The SPD maximum continuous operating voltage shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell)
- G. The operating frequency range of the system shall be at least 47 to 63 Hertz.
- H. Protection Modes
- 1. All Modes. L_N, L_L, L_G, (N_G where applicable)

Note: L = Line, N = Neutral, G = Ground

- I. The SPD shall be rated for "Lightning Surges" in accordance with UL master label requirements for lightning protection systems.
- J. All surge protection devices installed on this project shall be rated for "Lightning Surges" in accordance with UL master label requirements for lightning protection systems.
- K. UL 1449 4th Edition Listed, bearing the official UL 4th Edition gold hologram label.
- L. UL 1283 5th Edition Listed.
- M. The Surge Protective Device (SPD) shall be a standalone configuration. Systems that must be integral to the switchgear will not be considered.
- N. All SPD systems shall be permanently connected, parallel designs. Series suppression elements shall not be acceptable.
- O. The SPD shall be marked with a Short Circuit Current Rating (SCCR) and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code, Article 285, Section 6.
- P. All SPD units shall be from the same manufacturer.
- Q. SPD designs that limit the 100% rated surge protection shall not be acceptable.
- R. Hybrid design utilizing:
- Thermally Protected Metal Oxide Varistors 2. Filter capacitors to suppress EMI/RFI electrical noise.

1.4 DOCUMENTATION

- A. The manufacturer shall furnish an installation manual with installation, start up, trouble shooting guide and operating instructions for the specified system.
- B. Electrical and mechanical drawings shall be provided by the manufacturer which show unit dimensions, weights, component and connection locations, mounting provisions, connection details and wiring
- C. Documentation of specified system's UL 1449 Listing and voltage protection ratings of all protection modes shall be included as required product data submittal information.
- D. Independent fuse coordination tests from a nationally recognized independent testing laboratory.
- E. The manufacturer shall provide a full five-year warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes. Manufacturer shall make available local field engineering service support. Where direct factory employed service engineers are not locally available, travel time from the factory or nearest dispatch center shall be stated.

PART 2 - PRODUCTS

2.1MODULAR SURGE PROTECTION

- A. Configured for the voltage as shown on the riser diagram and/or panel schedules.
- B. The SPD surge current ratings shall be based on the electrical system ampacity listed in the table below.

Electrical System

Ampacity @ SPD Install Point		
Surge Protection (kA)	Per Mode	Per Phase
2500 - 6000A	300	600
1200 - 2000A	250	500
600 - 1000A	200	400
250 - 400A	150	300

- C. The SPD shall be rated for 480/277Vac 3 Phase, 4 Wire + Ground, wye or 208/120Vac 3 Phase, 4 Wire + Ground, wye as required.
- D. Modes of Protection: The SPD system shall provide surge protection in all possible modes (L-N, L-G, L-L, and N-G). Each replaceable module shall provide the uncompromising ability to deliver full
- E. SPD modules shall be configured to isolate individual suppression component failures without causing total loss of surge protection in that mode.
- F. Opening of supplementary protective devices, internal or external, shall not be permissible during UL 1449 3rd Edition Nominal Discharge testing.

G. Connection Method: Terminal Block, 60A #6AWG.

- H. Each individual module shall feature a green LED indicating the individual module has all surge protection devices active. If any module is taken off-line, the green LED will turn off and a red LED will illuminate, providing individual module as well as total system status indication.
- I. Monitoring: Solid State Status Indication Lights.
- J. The modular SPD shall be provided in a NEMA 12 enclosure.
- K. The SPD shall provide EMI/RFI electrical noise attenuation of 36 to 44dB in the range of 50kHz to 100MHz as defined by MIL-STD-220A test procedures.
- L. Voltage Protection Ratings: The UL 1449 Voltage Protection Ratings "VPR" (6kV, 3000 Amps, 8/20µs waveform) shall not exceed the UL assigned values listed below.

Voltage Protection Ratings (VPR) 6kV, 3000A, 8/20µs Waveform

Voltage Rating: 208/120V Line to Neutral 900V Line to Ground V008 Neutral to Ground 700V

Advanced Protection Technology

Line to Line 1200V 2000V M. Approved Manufacturers: The following SPD manufacturers and respective models shall be deemed acceptable, subject to conformance with indicated requirements: TSr Product Series

teXAS Series

THOR SYSTEMS **Current Technologies** SL2 Produce Series Intercepter II Series

PART 3 - EXECUTION

3.1INSTALLATION

- A. The installing contractor shall connect the SPD in parallel to the power source, keeping conductors as short and straight as practically possible. The contractor shall twist the SPD input conductors together to reduce input conductor impedance.
- B. A modular SPD shall be close-nippled to the distribution panel and shall be supplied by a 60 Amp circuit breaker. (Where possible, a bottom feed modular SPD is preferred, close-nippled to top of
- END OF SECTION 264010

<u>SWITCHBOARDS</u>

1.1 CONSTRUCTION FEATURES:

- a. Switchboard types, ratings, and contents shall be as shown on the drawings. b. Switchboard construction shall comply with NEMA Standard PB2 and UL 891.
- c. Switchboard enclosure shall be NEMA standard, type as indicated on drawings. Enclosure shall be finished with a medium light gray, standard with manufacturer both exterior and interior surfaces. All sheet metal parts shall be rustproofed after fabrication, prior to painting.
- d. Framework shall consist of code gauge steel rigidly welded and/or bolted together to support all cover plates, buswork, and component devices. Steel used for framework shall be zinc coated or
- e. Each section shall have an open bottom and an individual removable top plate for installation and termination of conduits.
- f. Switchboard current ratings shall be as indicated in switchboard schedule on drawings.
- g. Buswork shall be of copper or aluminum, sized to match the feeder ampacity and braced for 65,000 amperes short-circuit current unless otherwise indicated. Buswork shall be designed for connection to adjacent equipment and/or for future extension where so indicated on the drawings. A copper ground bus shall be fastened to the structure and shall extend for the full length of the switchboard.
- h. All busses, switching devices and connections shall be of sufficient size to limit the temperature rise to UL standards and all bus surfaces shall be corrosion resisting conductive plated surfaces. All bus
- connections shall be bolted. All busses shall be braced for short circuit stresses of not less than the fault values scheduled on drawings.
- other than on load side of overcurrent devices shall be by means of rigid bus and not cable. j. Provide digital multi-function metering complete with all associated current transformers, potential transformers, fusing, and connections, Square D "Power-Logic" or equivalent.

. Separate neutral and equipment ground busses sized at 50% and 12-1/2% of phase busses respectively, unless otherwise noted, shall be provided for the full length of the switchboard. Connections

1.2 FRONT ACCESS SWITCHBOARDS:

- a. NEMA from accessible switchboards shall be totally enclosed, dead-front, distribution type with one or more vertical sections designed to be floor mounted, self-standing, in which overcurrent protective devices for feeder circuits are group mounted in an integrated assembly accessible from the front only.
- b. The top and front covers, and side covers where indicated on the drawings, shall be removable with covers bolted to the frame. The front and side covers shall permit access from the front and/or side to the main bus. all bus tap connections and the line and load terminal connections of overcurrent protective devices in each vertical section, without being exposed to unreasonable electric shock hazard. This access shall also be provided so that future devices may be installed in spaces where provisions are noted on the drawings.
- c. Overcurrent protective devices shall be molded case circuit breakers, bolt-on.
- d. All overcurrent devices shall be removable from the front of the switchboard without removing the front panel assembly and without interfering with adjacent devices.
- e. Switchboards shown back-to-wall shall be designed for full front access, front and rear line-up, of 25" maximum depth. Front accessible switchboards shall have neutral bus located such that it will not

- be necessary to reach across or beyond a phase bus to make a connection.
- f. Feeder circuit breakers shall be group mounted in panelboard type construction with hinged covers providing access to vertical gutters.

1.3 <u>CIRCUIT BREAKERS:</u>

a. Circuit breakers shall be the electronic trip type utilizing solid-state circuiting to initiate the tripping action. Current sensing shall utilize digital sampling techniques and be true RMS with an error of less than 1% with load distortion of up to the 13th harmonic. Adjustments on electronic trip circuit breakers shall include a long time current setting, short-time pickup, and ground-fault delay. Other features shall include a rating plug, instantaneous trip and a ground fault trip indicator. Circuit breakers rated at 1000 amperes or larger shall also provide for adjustable long time delay, short time delay instantaneous pickup and ground-fault pickup.

1.4 SERVICE EQUIPMENT:

a. Switchboards used as service equipment shall be UL listed and labeled "Suitable for use as Service Equipment".

2.1 INSTALLATION:

- a. Installation of each Switchboard, including protection, assembly, testing, connections, and energization shall be in strict accordance with the manufacturer's instructions and Section 264000.
- b. In switchboard sections specified to include insulating barriers or insulated buswork, all phase terminals, lugs, and connections that remain un-insulated after installation shall be carefully taped with high temperature insulating tape, or equivalent protection as approved by the Architect/Engineer.

SECTION 265000 - LIGHTING FIXTURES AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall furnish and completely install Lighting Fixtures and Accessories as indicated on the drawings and as herein specified.
- B. A lighting fixture shall be provided for each lighting outlet indicated. Outlets lacking fixture designations shall be brought to the attention of the Architect/Engineer before submitting proposal; otherwise units selected by the Architect/Engineer shall be furnished and installed at no additional charge.

A. Submit for approval complete manufacturer's data sheets for all fixtures. Indicate all components, characteristics, and options.

B. Submit for approval Lighting Fixture samples as requested by the Architect/Engineer. Samples shall be equipped with lamps, cords, plugs, and ballasts for 120-volt operation.

PART 2 - PRODUCTS

2.1LIGHTING FIXTURES

- A. All fixtures shall be labeled by Underwriters' Laboratories, Inc.
- B. Fixture designations on the drawings generally consist of a letter indicating the fixture type. Fixture types are identified in the Lighting Fixture Schedule or Symbol Schedule; however, the Schedule does not necessarily list all accessories and hardware necessary for the complete installation, nor does it detail the construction to be encountered at the fixture locations. It is the Contractor's responsibility to properly determine and provide correct components, accessories, and hardware required for the installation.
- C. Recessed fixtures in plaster and gypsum board ceilings shall be equipped with plaster frames. In other ceilings they shall be equipped with plaster frames and/or other devices as approved by the Architect/Engineer, to facilitate removal of fixture and access to the concealed junction box.
- D. Plastic materials indicated to be "acrylic" shall be of 100% virgin methyl methacrylate produced by Rohm and Haas, Dupont, or Cyanamid.

2.2 LED DRIVERS:

- 1. Provide with ten-year operational life while operating at maximum case temperature and 90 percent non-condensing relative humidity. 2. Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC801-2.
- 3. Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the driver is under fully loaded conditions and under maximum case temperature 4. Maximum inrush current of 2 amperes for 120V and 277V drives.
- 5. Withstand up to a 4,000-volt surge without impairment of performance as defined by ANSI C62.41 Category A. 6. Manufactured in a facility that employ ESD reduction practices in compliance with ANSI/ESD S20.20.
- 7. Class A Sound Rating Inaudible in a 27-dBA ambient. 8. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- 9. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements. 10. Drives to track evenly across:
- a. Multiple fixtures.
- b. All light levels.
- 11. Constant current drives must provide models to: a. Support from 200mA to 2.1 Amps (in 10mA steps) to ensure a compatible driver exists.
- b. Support LED arrays up to 40W or 50W (710mA to 1.05A in 10mA steps). 12. Constant voltage drives must provide models to:
- a. Support from 10V to 40V (in 0.5V steps) to ensure a compatible driver exists. b. Support LED arrays up to 40W.
- 13. Configuration tool must be available to optimize the following for LED fixtures: a. Light level.

c. Thermal performance.

PART 3 - EXECUTION

b. Efficacy.

3.1 COORDINATION E. Contractor shall verify ceiling or wall type in or on which each fixture is to be mounted, and shall furnish unit with appropriate trim type, mounting hardware, and accessories to fit the construction; and

feed through junction boxes as required to maintain proper access to system wiring.

END OF SECTION 265000

- 3.2INSTALLATION A. Lighting fixtures shall be installed in accordance with the manufacturer's instructions.
- B. Lighting fixtures shall be supported from the building structure using corrosion resistant steel hardware in compliance with SECTION 261000, BASIC MATERIALS AND METHODS. C. A minimum of two No. 12 gauge wire supports attached to the structure shall be provided for each lighting fixture unless otherwise indicated or approved by the Architect/Engineer. The supports shall be
- D. In addition to the supports from the structure, fixtures shall also be secured to suspended ceilings on which they are mounted, or in which they are recessed. Where fixtures are secured to suspended

located at diagonal corners of rectangular fixtures and angled away from fixture. A minimum of three full twists shall be made at each end to secure wire.

- ceilings, the primary supports from the building structure shall be slack.
- E. Mount fixtures plumb and square. Keep rows in perfect line.

F. At time of project completion, fixtures shall be clean and fully operational.



