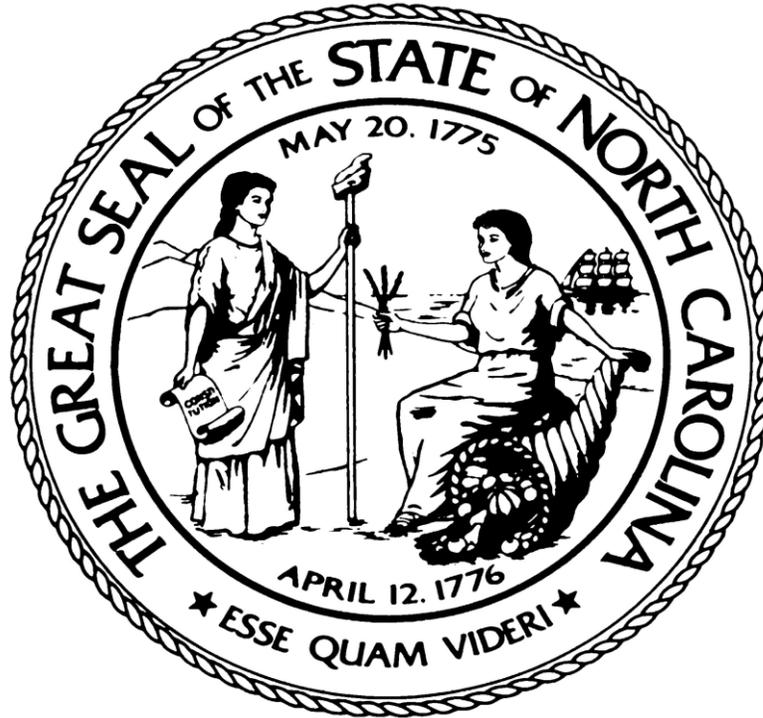


STATE OF NORTH CAROLINA
DEPARTMENT OF ADMINISTRATION
STATE CONSTRUCTION OFFICE



ELECTRICAL
GUIDELINES AND POLICIES
2020

The following guidelines and policies are established to aid the Designer during design development and specification writing. Contents herein are not to be included in Designer's specification by reproduction but shall be used as a guide only. Variances of these guidelines and policies shall be discussed with the State Construction Office prior to submitting design to alleviate possible extra work on the Designer's part.

Projects (SD, DD, and associated CD documents) submitted by January 31, 2021 will continue to be reviewed per the 2017 electrical guidelines unless the designers' request review per the 2020 electrical guidelines. The intent is that projects starting the review process January 31, 2021 and before will continue being reviewed per the 2017 guidelines.

These guidelines become effective for new SD, DD, and associated CD submittals February 1, 2021 and after.

The following replaces the Electrical Guidelines and Policies --2017 in its entirety.

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00 00 01 SCOPE

1. These Guidelines and Policies apply to all State Government funded projects on state owned property, Community College projects, except for “Code Only” projects and certain projects exempted by legislation or other approved policies. Other project delivery methods, i.e. Construction Manager at Risk (CMR), Design Build, Public Private Partnership (P3) may have other specific requirements. Refer to NC State Construction Manual.
2. The designer remains responsible to coordinate with owner for any specific or special requirements.

26 01 00 RECOGNIZED STANDARDS

- a) AEIC (American Association of Edison Illuminating Companies)
- b) ANSI C82.11 (American National Standards Institute for Fluorescent Ballasts)
- c) ASHRAE/IES (90.1 energy conservation code)
- d) ASTM (American Society for Testing and Materials)
- e) BOCA (Building Officials Code Administrators)
- f) DOE United States Department of Energy
- g) EPA Environmental Protection Agency
- h) EPAct (Energy Policy Act of the US Department of Energy)
- i) ICBO (International Conference of Building Officials)
- j) ICC (International Code Council)
- k) ICEA (Insulated Cable Engineers Association)
- l) IEEE (Institute of Electrical and Electronic Engineers)
- m) IES (Illuminating Engineering Society)
- n) NCAC (North Carolina Administrative Code)
- o) NCCM N.C. State Construction Manual
- p) NCBC (N.C. Building Code), also NCSBC (N.C. State Building Code)
- q) NCBCC (N.C. Building Code Council)
- r) NEC (National Electrical Code) as amended by NC Building Code Council
- s) NECA (National Electrical Contractor Association)
- t) NEIS (National Electrical Installation Standards)

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- u) NEMA (National Electrical Manufacturers Association)
- v) NESC (National Electrical Safety Code)
- w) NETA (International Electrical Testing Association)
- x) NFPA (National Fire Protection Association)
- y) OSHA (Occupational Safety and Health Administration)
- z) TCLP (Toxicity Characteristic Leaching Procedure)
- aa) UL (Underwriters' Laboratories Inc.)

26 01 00 BASIC ELECTRICAL REQUIREMENTS

1. Specifications for electrical work shall clearly indicate the responsibility of the Electrical Contractor to notify the State Electrical Inspector with Department of Administration; for state-owned projects, and to notify the local inspectors; for community college & county owned buildings, to schedule required inspections.
2. Non-Appropriated Funds Projects, such as: Privately Funded Projects on State Land, or Privately Funded Projects on Private Land that will be maintained by the state, or Privately Funded Projects on Community College Land shall be designed to meet or exceed requirements issued by this office including: Electrical Guidelines and Policies, the Fire Alarm Guidelines and Policies, the State Construction Office Manual. Adherence to these publications is expected. Please see State Construction Manual, Table 500 for the non-appropriated funds projects.
3. For review submittals to the SCO office, all documents inclusive of electrical drawings and specifications shall be sealed by the Design Engineer of Record registered in the State of North Carolina. Bid documents must be sealed, signed, and dated. Professional seal is also required on plans for the design of the special systems, such as theatrical stage lighting, audio/video, access control, lightning protection, and the like. Provide engineering firm license number on drawings Per 21 NCAC 56.1103.
4. An electrical symbol schedule and legend shall appear on the first sheet of the electrical drawings. The electrical symbols shown on the bid documents shall consist of standard design symbols. To clarify, "standard symbols" can be found in current editions of the Architectural Graphic Standards, the American Electricians' Handbook, and in the IEEE Standards. Fire Alarm and life Safety symbols should be based on symbols defined in the American National Standard NECA 100.
5. On the electrical drawings, the Designer shall include a Load Tabulation Breakdown in KVA rating for the existing peak demand load, if any, the new connected load, and demand load, and the diversity factor. Perform the calculation as required by NEC Article 220. Where two or more non-coincident loads will not be used simultaneously, the largest load only shall be calculated. (See Appendix, Sheet E-8).
6. Special attention is directed to N.C. General Statute 133-3 (Specifications to Carry Competitive Items, Substitution of Materials) for strict adherence thereto (for all equipment where available). See the procedure provided on the SCO web site regarding this issue.

7. The Design Engineer shall provide short-circuit coordinated protection where required by NEC. It is the Engineer's responsibility to make sure the system is fully coordinated and properly protected against short circuit, overload, and ground fault. During design of new installations where preliminary calculated fault current exceeds 80% of equipment withstand rating, the Design Engineer shall select the next higher standard rating. For existing installations, Design Engineer shall evaluate the existing equipment withstanding rating and coordinate with State Construction Office (SCO) for fault reduction measures if needed. In addition to required performance for projects involving Emergency Systems (Article 700), Health Care Facilities (Article 517) and Critical Operations Power Systems (Article 708), any SCO projects which involve the use of protective relays, adjustable trip circuit breakers, and main fuses shall also require completion of a coordination study. This includes SCO projects involving modifications to existing equipment. These studies shall be performed in accordance with recommendation of the IEEE standards and NEC. At the time of construction document submittal, where NEC Article 240 arc energy reduction provisions apply (or upon request by the SCO), the Engineer's basis-of-design shall clearly document the Engineer's selected arc energy reduction method. After the Design Engineer's approval of the vendor "shop drawings" a final coordination study inclusive of arc flash hazard analysis based on the protective devices provided for the project should be reviewed, approved, and dated by the Engineer of Record. If requested, the study shall be submitted to SCO.
8. In accordance with N.C. General Statutes 66-23 thru 25, the project documents shall require all electrical materials, devices, appliances, and equipment to be evaluated for safety and suitability for intended use. The project documents shall specifically refer to the current List for third-party Agencies Accredited by the NCBCC to Label Electrical and Mechanical Equipment, as the basis for evaluation with the applicable nationally recognized standards. The current list of NCBCC accredited NRTL agencies shall be obtained from Department of Insurance and can be found on DOI web site. The following or equivalent wording shall be included within the project documents where referring to third-party/NRTL certification: "*Third party agencies shall be amongst those acceptable to the NCBCC (North Carolina Building Code Council) to Label Electrical & Mechanical Equipment.*"
9. To demonstrate the basis of conformance with the North Carolina Energy Code, the Designer shall include North Carolina Building Code Appendix B Energy Summary. (An Energy Table may be included within the electrical drawings if Appendix B is not included elsewhere within the project documents.) Identify the method of compliance (prescriptive or performance) selected for the project and the total watts specified VS. allowed for the interior and the exterior lighting. Provide supporting calculations. The Designer may use North Carolina COMcheck or equivalent software to meet documentation requirements on the construction documents submittal, signed and dated by the Engineer of Record.
10. For all projects with medium voltage applications (>1000 volts), the project documents shall require the installing Contractor to be responsible for conducting a thermal detection test. The test shall be performed on MV equipment connections, preferably July or August, prior to the expiration of the one-year contracted warranty. The results of the test shall be documented in a report to be provided to the Designer of Record with a copy also provided to the Owner.
11. The Electrical Designer shall coordinate with the Mechanical Engineer of Record for all projects involving equipment with non-linear characteristics such as but not limited to variable frequency controllers. The Electrical Designer shall:

- a) Review and provide input to the specification for the variable frequency controller including verifying equipment short circuit rating (SCCR) is equal to or higher than the upstream overcurrent device.
 - b) Coordinate with the electrical utility to identify the point of common coupling and reflect within the project documents including the project riser or one-line diagram. Secondary points of common coupling shall also be determined and identified within the documents.
 - c) Modify the project documents with transformer kVA, impedance, utility available short-circuit current, and configuration of the electrical system inclusive of service and feeder conductor sizes and lengths to permit evaluation of harmonics as required by IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
12. Equipment Installation: The complete electrical installation shall fully comply with all requirements of applicable regulations, laws, ordinances, the National Electrical Code, referenced standards, including those of the Owner/Agency, the State Construction Office Electrical Guidelines and Policies, and other Codes applicable to this project. For Community College projects, comply with the requirements of the local jurisdiction having authority and Private Plan Review section of the Department of Insurance. Equipment shall be installed in accordance with the manufacturer's instructions as required by NEC 110. While SCO reviews are intended to be thorough and accurate, they do not include all aspects of the applicable Codes, nor do they relieve the need for the Designers to thoroughly check their plans for compliance with applicable Codes, SCO Guidelines and Policies, and requirements of other state agencies. Therefore, any change order due to not complying with these Codes' requirements is the responsibility of the Engineer of Record.
13. Existing Electrical System. For projects involving existing electrical system infrastructure, the Design Engineer shall employ engineering judgment and due diligence in their evaluation and recommendations to the Facility Owner and to the State Construction Office. Typical aspects of an electrical system analysis may include age and condition, safety and security, code compliance, fault interruption adequacy, capacity for growth, reliability and redundancy, energy efficiency, physical distribution, ease of operation, and maintainability. The Design Engineer shall follow recognized industry practices in the analysis such as IEEE Standard 493 *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems*. Emphasis should be on existing systems having an installation age exceeding 20-30 years. Evaluate factors that could shorten life expectancy (for example: environmental factors such as ambient temperature, humidity, corrosion exposure; and other factors). Consider replacement and/or retrofit of obsolete components especially for those involving physical switching or fault interrupting characteristics, i.e. such as transfer and fused switches as well as breakers. The Design Engineer is also urged to consult with major electrical equipment manufacturer application engineers to identify potential field evaluations to be implemented during design (or potentially during construction) that could verify the present condition of electrical equipment inclusive of the bus, enclosure, terminations, etc.
14. Prevention thru Design (PtD) is an initiative launched in 2006 by the National Institutes for Safety & Health and encompasses all disciplines to anticipate and eliminate through design potential hazards to workers. The State Construction Office expects Designers for state projects to implement PtD in their design to ensure as much as possible the safety of all State of North Carolina employees who work with products of their designs. The Designer shall follow the Hierarchy of Hazard Control Measures from ANSI Z10 *American National Standard for Occupational Health Safety and Management Systems* which in decreasing order of safety

control effectiveness are: Elimination, Substitution, Engineering Controls, Warnings, Administrative Controls, and Personal Protective Equipment (PPE).

- a) In consideration of PtD, required submittals from the contractor should include all factory construction drawings, factory assembly drawings, and installation drawings for equipment (i.e. luminaires, air handlers, chillers, equipment skids, etc.). Project construction schedule shall allow sufficient time for design team review and approval before ordering equipment. The contractor should maintain the factory drawing packages on the construction site for electrical inspector use and for verification of installation.

26 02 05 DIVISION OF WORK

1. This section delineates the division of work between the Electrical Contractor, Mechanical Contractor, and Plumbing Contractors. For single prime contracts, "Construction Manager at Risk" (CMR), Public Private Partnership (P3), and "Design Build" the project manager determines division of work or as directed in contract documents.
2. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Divisions 22 and 23 equipment shall be performed under those Divisions.
3. Electrical and Mechanical designers shall coordinate the specifications and review the submittal package to consider electrical safety for the owner's maintenance staff that service the units. HVAC equipment shall be specified to require construction to, and certification for UL 1995, complete with third party testing and approval. Submittal drawings shall provide third party approved factory electrical drawing package. This electrical package must be available at all electrical inspections.
4. All individual motor starters and drives for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
5. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter, VFD or disconnect switch. Under Division 26, line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Divisions 22 and 23.
6. Duct smoke detectors, if required by NCBC, shall be furnished, and wired by Division 28, installed by Division 23. Fire alarm AHU shut down defeat switch shall be inside or immediately beside the fire alarm panel. The shutdown defeat circuit shall be wired from the fire alarm control panel to a termination point, adjacent to the AHU control, under Division 28. AHU control wiring from the termination point to the equipment shall be under Division 23
7. Equipment less than 120 Volt, all relays, actuators, timers, seven-day clocks, alternators, pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches, aqua-stats, freeze-stats, line and low voltage thermostats, thermals, remote selector switches, remote pushbutton stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances inclusive of control system power supplies

associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.

8. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Divisions 22 and 23.
9. Equipment with built-in disconnects or outlets provided under Divisions 22 or 23 shall be wired under Division 26 to the line side of the disconnect switch, or the outlet. A disconnect switch shall be provided under Division 26 if the equipment is not provided with a built-in disconnect switch. In this case wiring from the switch to the equipment shall be under Divisions 22 or 23. See sheet E-18 regarding the location and wiring of disconnects for other equipment. The built-in switch for outdoor equipment shall be in minimum NEMA 3R enclosure.
10. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specified in Section 23, HVAC Control System.
11. Horsepower for all motors shall be consistently identified on the Division 23 and Division 26 Drawings.
12. Under Division 23, the cable from the load side of the VFD to the driven equipment shall comply with the equipment manufacturer's recommendations.
13. All sprinkler flow and tamper switches shall be furnished and installed under Division 21 and wired under Division 28.
14. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. Exception to that is the low-voltage control wiring; the use of the J-Hooks to support the low-voltage control wiring system is acceptable as outlined in Section 4 of the Telecom STS - 1000 Guidelines.
15. For kitchen equipment and elevator equipment, Division 26 Contractor shall provide disconnecting means if needed and install wiring from a power source to a termination point adjacent to the kitchen or elevator equipment. Contractor providing kitchen or elevator equipment shall wire to the equipment from the termination point.
16. Electrical contractor shall provide disconnect means, if needed, wiring, and equipment connections for Owner furnished equipment
17. The use of combination starters is recommended over the use of individual starters and disconnect switches. Unless confirmed otherwise with the Mechanical Designer, typical pump and fan applications have variable load profiles where the use of VFD for pump and fan motors five HP and larger is recommended. For non-VFD driven motor applications rated 100 HP or higher, solid-state reduced voltage starting shall be required to reduce voltage drop during motor starting.
18. A diagram clarifying division of work responsibility to provide and install the termination point, such as (trough, VFD, individual starter, disconnect switch, JB, --- etc.) shall be placed on the electrical and the mechanical plans. (See Appendix, Sheet E-18)

19. Reports showing the sizes of the maximum overcurrent protection (MOCP), minimum circuit ampacity (MCA), and overload setting of the devices for all motors; shall be provided by the Contractor providing the equipment to the Electrical Engineer before project final approval.
20. All electrical work shall be performed by individuals and/or companies who are properly licensed by the NC State Board of Examiners of Electrical Contractors.
21. Exit doors & other doors provided with built-in outlets shall be wired by the Electrical Contractor all the way to the door outlet. Electrical Engineer shall coordinate with the Architect when specifying door shutters and magnetically held doors to ensure all required fire alarm devices are shown and specified.

26 05 00 EXISTING ELECTRICAL CONDITIONS ENCOUNTERED DURING REMODELING, ADDITIONS, OR ALTERATIONS

1. Existing Circuits: All existing circuits which are re-used for connection to new or replacement equipment shall be thoroughly inspected for size, condition, and suitability for re-use.
2. Remediation of Hazardous Materials. Existing facility/building shall be investigated through appropriate testing and/or inspection methods to confirm the presence of any hazardous material that may exist in the electrical system components. If it is determined that remediation is required, then a plan must be implemented rendering the facility free of hazards. This includes but is not limited to Asbestos, Lead, and PCB's.
3. Abandonment of existing electric system components. Abandoned conduit/boxes shall have all electrical wiring removed completely and not just made "safe." Conduit/boxes shall be removed where practical without creating additional demolition/restitution work for other trades. All existing power supply wiring or cabling associated with equipment demolished or removed as part of the project scope shall be completely removed back to supply distribution panel and circuits breakers relabeled as "SPARE" or with the new circuit title.
4. Abandoned existing conduits concealed within floors and walls shall be cut flush with the surface and grouted over. Openings in fire rated assemblies shall be properly fire stopped in accordance with the barrier rating following removal of wiring and conduit.

26 05 13 MEDIUM-VOLTAGE CABLE

A. CABLE CONSTRUCTION

1. Conductors shall be soft drawn, Type MV-105, Class "B", concentric compact or compressed, stranded copper, single conductor shielded cable. The shielding process shall be one of the following: either a, b, or c:
 - a) A true triple extrusion (done simultaneously, in a common extrusion head which does not expose the EPR insulation to the atmosphere). The cable shielding shall consist of, semiconducting strand shield, EPR insulation and semi-conducting insulation shield.
 - b) A true triple tandem extrusion process, where the semi-conducting strand shield, the insulation and the semi-conducting insulation shield are EPR.

- c) Double extrusion process for the non-conducting cable shield and the insulation; the nonconducting cable shield shall be continuously tested for 2kv DC test while the shield is over the conductor and prior to the EPR insulation & the insulation shield being applied.
2. Cable shall operate at a normal continuous conductor temperature of 105°C, an emergency overload conductor temperature of 140°C, and a short circuit conductor temperature of 250°C.
3. Cable shall be shielded with minimum 5 mil metallic uncoated copper tape helically applied with 25% nominal overlap.
4. The overall jacket or sheath shall be oil, acid, alkali, and sunlight-resistant PVC compound which shall be rated for use in conduit or aerial construction. Cable identification shall be printed on this jacket using indelible ink. The cable identification shall indicate “the manufacturer, the plant number, cable size, year of manufacture, insulation thickness, insulation type, voltage rating, KV% insulation level& sequential footage number.”
5. Cable thickness shall meet or exceed AEIC and ICEA requirements and shall have 133% insulation. The primary cable ratings shall be:
 - a) 5,000 Volts; nominal 115 mils thickness,
 - b) 15,000 volts; nominal 220 mils thickness, or
 - c) 25,000 volts; nominal 345 mils thickness.
6. Each medium voltage circuit shall be provided with insulated 600-volts equipment grounding conductor.
7. Cable shall pass the flame test in accordance with the IEEE 1202, CSA FT4 & ICEA T-29-520.
8. The cable shall meet or exceed the following standards: ICEA S-93-639, NEMA WC 74, AEIC CS-8, ASTM B-496, UL-1072 (type MV-105) for all cables, IEEE 383 for cables 1/0 AWG and larger.
9. The Quality Assurance Program and the ISO certification shall be provided to State Construction Office upon request.
10. Qualification Test Report for the cable insulation system (conductor-shield, insulation, and insulation-shield) shall be provided to State Construction Office upon request.
11. The cable supplied must have been manufactured within 12 months prior to date of order placement.

B. INSTALLATION

1. The approved cable shall be installed in continuous lengths where possible, and shall be fireproofed in each manhole
 - a) The fireproofing tape shall consist of a flexible conformable fabric having one side coated with a flame-retardant, flexible polymeric coating and/or a chlorinated elastomer.

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- b) The tape shall be minimum 1/16-inch thick by 3 inches wide, wrapped around each conductor spirally with the coated side toward the conductor.
 - c) The tape shall extend for the total length of the conductor in the manhole and 1 inch into the ducts.
 - d) The tape shall be non-corrosive to the cable jacket, self-extinguishing, and shall not support combustion.
2. Splices are to be permitted only at points designated on the plans. All splices and terminations, unless otherwise specified, are to be fabricated in accordance with the cable and termination manufacturer's recommendations, or in accordance with the details of such instructions included on the drawings.
 3. MV Cable pulling tension and side wall pressure calculations shall be performed to ensure that all circuits are installed in strict accordance with the physical limits of the cables as stated by the manufacturer.
 4. Cable shall be manufactured by General Cable (Prysmian), Kerite, Okonite, LS Cables (Tarboro, NC) or an approved substitute. Before approval by the Engineer, any proposed substitution shall be discussed with the State Construction Office prior to opening bids.
 5. Do not route medium voltage cables or associated duct banks under buildings.

C. MEDIUM VOLTAGE CABLE TEST REPORT

1. The cable shall be tested at the factory. The Contractor shall be required to furnish a Certified Manufacturer's Test Report for the "Master Reel" of each cable length shipped, for approval by the Engineer. The test report shall include:
 - a) A high voltage test (AC)
 - b) Corona test.
2. The manufacturer's certified test report shall include all the data. Copy of the test report shall be included in the final documents provided to the Owner.
3. After installation, but prior to energizing the system, the Contractor shall also conduct a "Very Low Frequency with dissipation factor, Tangent Delta" (VLF tan delta) withstand test of the system in accordance with IEEE 400 and the Design Engineer's specified testing procedure, as witnessed and "signed-off" by the Design Engineer. See ANSI/NETA Maintenance Testing Specifications. Copies of this test report shall be sent to the Owner, to the Engineer, and available at Beneficial or Final inspection by State Construction Office. Include the test report in the Operations and Maintenance Manual for owner's future reference.

D. MEDIUM VOLTAGE CABLE WARRANTY

1. The cable manufacturer shall warrant to the Owner that each reel of cable is free from defects in material, design and workmanship and will provide reliable performance for a twenty-five (25) year life from the date of project final acceptance.

2. The warranty assumes the cable is installed, spliced, terminated, and maintained in accordance with manufacturer's recommendations.
3. Prior to cable termination or splicing, Contractor shall submit the qualifications of personnel directly responsible for completing this work to the Engineer. Upon approval by the Engineer in writing, Contractor may proceed with this portion of the work.
4. Defective cable shall be replaced, to include material and labor, at no cost to the Owner.
 - a) When the manufacturer and the Owner mutually determine a portion of or all the cable is defective, the cable manufacturer shall furnish replacement of said cable without charge.
 - b) The replacement cable shall comply with these requirements and be delivered to the original delivery point free of any charge to the Owner or the State of North Carolina.
5. Cable shop drawings shall include said described warranty from the cable manufacturer properly signed and having the manufacturer's corporate seal affixed thereto.

E. REEL HANDLING AND STORAGE:

1. The manufacturer shall ship all reels in an upright position on the flanges. The cable ends shall be sealed to prevent the entrance of moisture, gases, or vapors into the cable. After the cutting of any length, the exposed ends of any remaining cable on the reel shall have heat-shrinkable end caps applied to prevent the entrance of water or vapor. The manufacturer shall be responsible to indicate to any commercial carrier the requirements for shipping the reels of completed cable. The Contractor and the Engineer shall be responsible for the acceptance inspection of the shipped cable reels and shall note any visible damage on arrival in any unacceptable orientation or condition and inform the carrier, distributor and manufacturer of such damage or unacceptable condition. Any movement or lifting of completed reels of cable shall use a bar inserted through the arbor hole in the cable reel and, as appropriate or necessary, use of a spreader bar to avoid damage to the reel flanges. No completed reel of cable shall be lifted by any force on or connection directly to the reel drum. Completed reels of cable shall be covered with a suitable material to reduce the impact of weather, rain, or sunlight on the cable. Reels under the covering should have adequate ventilation to prevent the formation of condensation.

F. CABLE IDENTIFICATION:

1. Each reel shall have an identification tag by the manufacturer securely attached to each flange and shall contain the following information, manufacturer's name & location, cable trade name, conductors size and voltage rating, identification of insulation and jacket material, date of manufacture, footage, and NCBC approved third-party label.

26 05 19 BUILDING WIRE AND CABLE

A. GENERAL

1. All wire and cable shall be listed by an NCBC approved third-party testing agency accredited by the NCBC.

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2. Prior to energizing, feeders, sub-feeders, and service conductor cables shall be tested for electrical continuity and short circuits. A copy of these tests shall be sent to the Engineer of Record, the Owner, and made available at Beneficial and Final Inspections by State Construction Office.
3. All wire and cable shall run in raceway.
4. In special cases, type "AC" and type "NM" cables are permitted provided the State Construction Office has approved the application in advance.
5. Upon consultation with the State Construction Office, Review Section, the use of type MC Cable may be approved for certain applications. The MC Cable: 1) conductors shall be provided with minimum #12 AWG solid copper rated at 600 Volts, 2) Ungrounded conductors shall match the color code of associated phase conductors, and 3) shall contain minimum #12 AWG insulated green equipment grounding conductor. In small buildings (less than 6000 square feet) with wood frame construction, designer may specify MC Cable to minimize damage to structure.
6. Minimum full size individual neutral wire shall be provided for each single phase, branch circuit requiring a neutral; in other words, no sharing of the neutral between branch circuits is allowed.

B. CONDUCTORS

1. Power and lighting circuits #10 AWG and smaller shall have solid copper conductors. Conductor sizes #8 AWG and larger shall have Class B stranded copper conductors. Aluminum conductor may be used as a service conductor for the main distribution panel, and/or as a feeder conductor for the electrical sub-panel, in situations where the Designer and State Construction Office find it to be beneficial.
2. Power and lighting circuits' minimum conductor size shall be #12 AWG, and maximum conductor size allowed shall be 500 Kcmil. For large electrical services, more than 3000-amps, Designer may specify up to 750-Kcmil with prior approval from SCO Design Review Section.
3. Fire alarm and control wiring shall have stranded copper conductors. See the Fire Alarm Guidelines available on the State Construction Office Web Site.
4. Full size neutral conductor shall be provided for each service panel and sub-panel.

C. INSULATION

1. The insulation type for wiring shall be dual-rated THHN/THWN or XHHW. Provide minimum 90 degree C insulation where required by conditions or NEC.

D. VOLTAGE DROP

1. Conductors for branch circuits shall be sized to prevent a voltage drop exceeding three percent (3%) at the farthest outlet of power, heating and lighting loads, or any combination of such loads. The maximum total voltage drops on both feeders and branch circuits to the farthest outlet shall not exceed five percent (5%).

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2. If the actual load to be plugged to the receptacles is not known; assume 16-amp load for the 20-amp circuit breaker, and 12-amp load for the 15-amp circuit breakers, unless the breakers are rated to carry 100% load.
3. Where the conductor length from the panel to the first outlet on a 277-volt circuit exceeds 125 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Conductor size of remaining branch circuit shall increase as needed to meet above voltage drop limitations.
4. Where the conductor length from the panel to the first outlet on a 120-volt circuit exceeds 50 feet, the branch circuit conductors from the panel to the first outlet shall not be smaller than #10 AWG. Conductor size of remaining branch circuit shall increase as needed to comply with above voltage drop limitations.

E. COLOR CODING

1. The building entrance conductors, feeders and branch circuits shall be color coded as follows:

<u>PHASE</u>	<u>208/120v</u>	<u>480/277v</u>
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	White	Natural Gray
Ground	Green	Green

F. SPLICING

1. Joints in solid conductors shall be spliced using Ideal "wire nuts", 3M Company "Scotchlock" or T&B connectors in junction boxes, outlet boxes and lighting fixtures.
2. "Sta-Kon", "Piggy", or other permanent type crimp connectors shall not be used for #10 AWG and smaller conductors.
3. Joints in stranded conductors shall be spliced by approved mechanical connectors that are insulated with gum rubber tape and insulating tape. Permanent compression connectors for splices and taps, provided with UL-approved insulating covers, may be used instead of mechanical connectors plus tape. Power Distribution Blocks may be used where listed for the enclosure size and available fault current.
4. Conductors, in all cases, shall be continuous from outlet to outlet and no splicing shall be made except within outlet or junction boxes, troughs and gutters.

26 05 26 GROUNDING AND BONDING

1. Grounding conductors, where insulated, shall be colored solid green. Conductors intended as neutral shall be colored solid white on 120/208-volt circuits and gray on 277/480-volt circuits.

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2. The raceway system shall not be relied on for equipment ground continuity. A green equipment grounding conductor, properly sized per NEC Table 250-122, shall be run in ALL raceways except for telecommunications, data, audio systems, and low voltage raceways for fire alarm systems.
3. Grounding electrode conductors #4 AWG and larger shall be installed in a raceway system.
4. Transformer grounding requirements: See Appendix relating to these requirements.
5. Generator and ATS grounding requirements: See Appendix relating to these requirements.
6. The electrical service shall be grounded by three (3) means, when available:
 - a) To the metallic cold-water pipe, as per NEC Article 250-52.
 - b) To the steel frame of the building, provided the building frame is effectively grounded. In new construction, effectively ground and bond steel building frame.
 - c) To ground rod(s). Ground rods shall be 10 feet long and 3/4-inch in diameter and shall be of copper-clad steel construction. All ground connections shall be accessible. Provide a minimum of one test well at one driven ground rod.
7. Boxes with concentric, eccentric, or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per NEC Table 250-122 and lugged to the box.
8. Where one building is feeding another building, the installation shall comply with applicable requirements of NEC Articles 225 and 250.
9. The gas piping system shall be bonded to the equipment ground as required per the NEC and NC Fuel Gas Code.
10. Identify each grounding electrode that is connected to a common ground bus. The common ground bus shall not be less than 2" high by 1/4" thick, with length determined by the Engineer.
11. SCO has observed shock hazards at various RV pedestals at several state-owned recreational parks. Therefore, at recreational vehicle (RV) parks, provide an auxiliary copper clad steel ground rod (3/4-inch x 10-feet) at each electrical power pedestal used for a RV electrical connection, as permitted by National Electrical Code Article 551. Provide minimum #6 AWG solid copper grounding electrode conductor from the pedestal to the ground rod.

26 05 29 SUPPORTING DEVICES

1. Raceway and boxes shall be supported in a method and at a spacing as approved by the NEC, except as described herein.
2. Conduit shall be supported by approved pipe straps or clamps.
 - a) Conduits installed on the interior of exterior building walls shall be spaced off the wall surface a minimum of 1/4 inch using "clamp-backs" or strut.
3. Pipe straps or clamps shall be secured by means of:

- a) Toggle bolts on hollow masonry.
 - b) Metal expansion shields and machine screws, or standard pre-set inserts, on concrete or solid masonry.
 - c) Machine screws or bolts on metal surfaces.
 - d) Wood screws on wood construction.
4. Powder actuated fasteners are not allowed.

26 05 33 CONDUIT

A. UNDERGROUND RACEWAYS

1. Raceways run external to building foundation walls, except branch circuit raceways, shall be encased with a minimum of three (3) inches of concrete on all sides.
 - a) Encased raceways must have a minimum cover of eighteen (18) inches, except for raceways containing circuits with voltages above 1000 volts, which must have a minimum cover of thirty (30) inches.
 - b) Encased raceways shall be of a type approved by the NEC as "suitable for concrete encasement."
 - c) Steel reinforcing shall be required under roadways and within 10 feet of all manholes and building entrances. The steel reinforcing of the duct bank shall be tied to the wall reinforcing at manholes and building entrances.
2. Branch circuits run underground external to building foundation walls shall be run in conduit installed in accordance with the NEC and shall be of a type approved by the NEC as "suitable for direct burial." Minimum raceway size shall be 3/4 inch.
3. All underground raceways, except branch circuits, shall be identified by underground line marking tape located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright colored, continuous printed, plastic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below.
4. Raceways run underground internal to building foundation walls shall be of a type and installed by a method approved by the NEC.
5. Where underground raceways are required to turn up to cabinets, equipment, etc., and on to poles, the elbow required and the stub-up out of the slab or earth shall be of rigid steel for the last two feet minimum. Contractor may use Schedule 40 PVC conduit into open bottom, floor mounted cabinets or equipment where permitted by NEC. With prior coordination with State Construction Office, the stub up above grade may be Schedule 80 PVC in certain corrosive environments.
6. The raceway system shall not be relied on for grounding continuity. See Section 26 05 26 Grounding and Bonding for clarification.

7. Where passing through a "below grade" wall, raceways shall be sealed utilizing fittings similar or equal to OZ/GEDNEY type "FSK" thru wall fitting with "FSKA" membrane clamp adapter if required.

B. ABOVE GROUND RACEWAYS

1. Conduit shall be sized in accordance with the latest edition of the NEC unless shown otherwise, with minimum conduit size being 1/2 inch. In dry locations, flexible metallic conduit in size 1/2 inch and larger is acceptable for final connection to field replaceable equipment (dry type transformer, motor, appliance, and fixture) provided green insulated ground wire is installed and NEC is followed. Provide liquid tight flexible metallic conduit in wet locations.
2. Conduit exposed and concealed (except "in-slab") shall be neatly installed parallel to, or at right angles to beams, walls and floors of buildings.
3. EMT may be utilized as permitted by the NEC, with the following restrictions. EMT conduit, couplings, elbows, and fittings shall not be installed in locations as follows:
 - a) Any location outdoors, in direct contact with earth, or underground (in/below slab- on grade or in earth)
 - b) Indoors in wet or damp locations, or in concrete, cinderblocks, or bricks.
 - c) Where exposed to severe corrosive influence and/or severe physical damage.
 - d) Encased in concrete.
 - e) For transition between EMT and rigid conduits, use JB.
4. The raceway system shall not be relied upon for grounding continuity. Section 26 05 26 Grounding and Bonding for clarification.
5. EMT conduit provided below roof deck shall be installed minimum 1-1/2 inches away from the deck to avoid screws penetrating the EMT conduit during reroofing.
6. Junction boxes, wireways, and troughs shall be metallic and with enclosure rating appropriate for the location. Non-metallic enclosures including fiberglass shall not be used without prior SCO approval. Conduits, JBs, Troughs, and enclosure mounted outside on the walls, shall be off the walls by minimum one inch.
7. The use of "LB's" shall be limited where possible. Where necessary to use "LB's" sized larger than 2 inches, mogul units shall be installed.
8. PVC schedule 40 shall not be used exposed or concealed in gypsum walls but may be used in CMU walls. PVC schedule 40 may only be used in elevated floor slabs and in foundation slabs with prior written approval from the Structural Engineer. Minimum concrete cover shall be 3/4 inch at finished or formed surface and shall be 3 inches at concrete surface cast against earth or for slabs placed on-grade. Greater amounts of concrete cover shall be used in areas subject to damage or corrosion. Installed systems shall comply with the minimum requirements of ACI318 Chapter 6. The placement of conduit in floor slabs must be thoroughly coordinated with, and approved by, the Structural Engineer of Record. Such

placement must be clearly addressed by the construction documents. Potential conflicts with steel reinforcing bars, composite slab shear anchors, and reductions in net concrete sections are among the issues that must be considered by the Structural Engineer. The effect of closely spaced conduit groups on fire-rated horizontal assemblies shall be addressed by the design team. Post-bid proposals to move under-floor conduit into the slab require approval from the Structural Engineer. Related slab reinforcement or slab reconfiguration could require a credit from the Contractor.

9. All building interior portions of grounding electrode conductors less than 6 feet above finished floor shall be protected against physical damage by routing in raceway except for final terminations to equipment where concealed (example, final stubbing beneath floor mounted equipment). Acceptable raceways include non-metallic PVC Schedule 40 and ferrous metallic conduit other than EMT; however, where metallic conduit is used, the conduit must be bonded to the grounding electrode conductor on both ends.
10. In corrosive locations or coastal environments, Designer may use Schedule 80 PVC with appropriate supports where permitted by NEC, allowed by Owner, and with prior approval from SCO Design Review Section.

C. TERMINATIONS

1. IMC and GRC shall terminate with either a double locknut / bushing set, or in a threaded hub.
2. Where concentric, eccentric, or over-sized knockouts are encountered, a grounding-type insulated bushing shall be provided.
3. All conduit terminations shall be provided with Insulated throat.
4. EMT terminations shall be made utilizing plated steel hexagonal compression connectors. No pot metal, set screw, or indented type fittings shall be utilized.

D. CONDUIT FITTINGS

1. Where conduits of any type pass over a building expansion joint, a standard "expansion joint coupling," compatible with the type raceway being used, shall be provided.
2. Conduit couplings for IMC, GRC and PVC shall be in accordance with the NEC.
3. EMT couplings shall be of the plated steel hexagonal compression type. No pot metal, set screw, or indented type couplings shall be utilized.
4. In outdoor locations or interior damp or wet locations, gasketed fittings inclusive of couplings shall be used in all metallic raceways.

26 05 43 DUCT BANKS

(See Section 26 05 33 Underground Raceways, for additional information on underground raceways.)

1. Excavation and backfill shall conform to the appropriate civil construction divisions of the specifications except heavy-duty, hydraulic-operated compaction equipment shall not be used.

2. Trenches should be cut neatly and uniformly, sloping uniformly to required pitch.
3. Ducts should be pitched to drain toward manholes and hand-holes and away from buildings and equipment. Minimum slope shall be 4 inches in 100 feet. Where necessary to achieve this between manholes, ducts should be sloped from a high point in the run to drain in both directions.
4. Concrete encased nonmetallic ducts shall be supported on plastic separators coordinated with duct size and spacing. Separators shall be spaced close enough to prevent sagging and deforming of ducts. Separators and ducts should be secured to the earth to prevent floating during placement of concrete. Steel should not be used in such a way as to form conductive or magnetic loops around ducts or duct groups.
5. Waterproof marking cord (130-pound tensile test marked at least every foot equivalent to Greenlee No. 435), should be installed in all ducts, including spares, after thoroughly rodding, clearing and swabbing all ducts free of all obstructions.
6. All ducts should be sealed at terminations, using sealing compound and/or plugs,
7. The installation of MHs should be in accordance with OSHA requirements. For non-roadway installations, manhole top elevation shall be 4-6 inches above finished grade to assure positive drainage away from cover.
8. If duct bank enters a building above associated equipment, provide pull box with means to drain any accumulated water to prevent water from entering equipment.

26 05 53 ELECTRICAL IDENTIFICATION

1. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, transformers, switchboards, motor control centers and other electrical equipment supplied for the project. For switchboards and switchgear provide nameplates for each feeder and/or branch circuit. The Designer may specify attaching with two-part epoxy, self-tapping stainless-steel screws with the screw sharp end protected, non-corrosive machine screws or rivets. In outdoor locations, labels shall be applied using two-part epoxy that is weatherproof and sunlight resistant. Letters shall be approximately 1/2-inch high except where resultant nameplate size exceeds equipment size. Nameplate lettering may be adjusted accordingly with approval of the Engineer. Nameplates shall remain legible. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:
 - Blue surface with white core for 120/208-volts equipment.
 - Black surface with white core for 277/480-volts equipment.
 - Bright red surface with white core for all equipment related to *fire alarm* system.
 - Dark red (burgundy) surface with white core for all equipment related to *security*.
 - Green surface with white core for all equipment related to *emergency* systems^{1,2}.
 - Orange surface with white core for all equipment related to *telephone* systems.

- Brown surface with white core for all equipment related to *data* systems.
- White surface with black core for all equipment related to *paging* systems.
- Purple surface with white core for all equipment related to *TV* systems.

Designer shall confirm with the Owner identification of other systems, such as Legally Required and Optional Standby systems.

Notes

- a) Emergency systems are those defined by NEC Art 700; *legally required* and *optional standby systems* (defined under NEC Art 701 and 702 respectively) shall not be uniquely identified and shall retain the nameplate color consistent with their system voltage, i.e. blue for 120/208-volt and black for 277/480-volt.
 - b) Identification of the *essential* electrical system within Health Care Facilities (defined by NEC Art 517) shall be coordinated with the Facility Owner and compliant with NFPA 99.
2. 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 cord or wire attached to conduit or fitting.
 3. All outlet boxes, junction boxes and pull boxes shall have their covers and exterior visible surfaces painted with colors to match the surface color scheme outlined above. This includes covers on boxes above lift-out and other type accessible ceilings, where identification shall also include branch circuit designation.
 4. The State Construction Office acknowledges certain existing state facilities may have been constructed under previous guidelines and policies having different equipment identification. Therefore, the Designer shall be responsible for confirming any identification system that differs from current guidance and obtaining direction from SCO as to the identification system to be implemented for any existing electrical systems that are retrofitted or modified.

26 08 00 ELECTRICAL TESTING AND COMMISSIONING

NOTE: *The electrical testing and commissioning described in this section shall be performed in accordance with NFPA 70E Electrical Safety in the Workplace.*

A. FEEDER INSULATION RESISTANCE TESTING

1. All current carrying phase conductors and neutrals of low voltage systems rated 1000 volts or below shall be tested for insulation resistance and accidental grounds. For new installations, testing shall be initiated upon completion of cable installation and prior to final terminations. For retrofit installations when the electrical load-center (panel, switchboard, etc.) is to be replaced and where associated feeders and service conductors remain without replacement, test associated conductor insulation. Insulation resistance testing shall be performed with a 500-volt insulation tester. The procedures listed below shall be followed:
 - a) Minimum readings shall be one million (1,000,000) 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 conductor.

- b) After all fixtures, devices and equipment are installed and all connections completed to each panel, the Contractor shall disconnect the neutral feeder conductor from the neutral bar and take a 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. The Contractor shall then individually test each branch circuit interconnection with the panel and until the source of low readings are found. The Contractor shall then correct the cause of the low resistance 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.
- c) At final SCO inspection, the Contractor shall, upon request, furnish an insulation tester and show the Engineers and State Construction Office representatives that the conductor insulation complies with the above requirements. The Contractor shall also furnish a clamp-on type ammeter and voltmeter to take current and voltage readings as directed by the representatives.

B. GROUND SYSTEM TESTING

1. 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 shall be taken to reduce the resistance to 25 ohms, or less, by driving additional ground rods. (The compliance should be demonstrated by retesting.)

C. CIRCUIT BREAKER TESTS

1. For services and feeders rated 1000 amperes and larger, and any installation utilizing selective coordination, the following tests shall be performed on the service circuit breakers and the distribution circuit breakers. Testing shall be performed by a qualified manufacturer's factory technician at the job site. All readings shall be tabulated:
 - a) Phase tripping tolerance (within 20% of UL requirements).
 - b) Trip time (per phase) in seconds.
 - c) Instantaneous trip (amps) per phase.
 - d) Insulation resistance (in megohms) at 1000-volts DC (phase to phase, and line to load).

D. GROUND FAULT PROTECTION SYSTEM

1. Provide ground-fault protection of equipment for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amperes or more.
2. The ground fault protection of the service disconnect shall be performance tested in the field using primary current injection and properly calibrated and set in accordance with the coordination study.

E. COMMISSIONING

1. The commissioning and placing into service of all newly installed and retrofitted electrical power equipment and systems shall follow the procedures and documentation criteria of ANSI/NETA ECS-2015 Standard for Electrical Commissioning Specifications. The project documents shall require individual component testing as well as the correct functioning of all integral components as a complete electrical system. Commissioning shall verify the proper operation of all sensing devices, indicating components such as meters, equipment alarms, and interlock safety devices for fail-safe functions.
2. Electrical commissioning shall be a pre-requisite for final acceptance of the project and must be completed prior to scheduling SCO final inspection.
3. Upon completion of all commissioning activities, documentation required by ANSI/NETA ECS-2015 shall be included in final project operation and maintenance manuals which shall be reviewed, stamped approved and dated by the Design Engineer of Record; if requested, the commissioning documents shall be submitted to the SCO for verification.
4. Electrical commissioning shall be performed on those projects with any of the following characteristics:
 - a) Low voltage systems 1000A or greater.
 - b) Generator or inverter equipment supplying emergency or legally required systems.
 - c) Medium voltage systems.
 - d) SCADA systems.

F. TESTING DOCUMENTATION

1. All tests specified shall be completely documented indicating time of day, date, temperature, and all pertinent test information including the entity conducting the tests.
2. 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.

26 11 00 UNIT SUBSTATIONS

1. The pad mounted transformer shall be of the five-legged core design, filled with "Listed less flammable type" oil for cooling. See Section 261219, Pad Mounted Distribution Transformers for further details.
2. The substation shall be "Metal-clad" type with "draw-out" vacuum breakers or SF6 for 5 KV, 15 KV or 25 KV, as applicable.
3. Equipment shall meet requirements of the Arc Resistant Standards.

26 12 19 PAD MOUNTED SERVICE TRANSFORMERS

THREE-PHASE PAD MOUNTED TRANSFORMERS (DEAD FRONT)

(NOTE: For use of "LIVE FRONT" construction, contact State Construction Office.)

Note 1: Locate pad mounted transformers at a suitable point outside the building, accessible to maintenance personnel and to truck-mounted crane. Provide minimum of ten feet (10'-0") clearance in front of the transformer to permit hot-stick operation in the primary section. No other equipment or structures shall be installed above or adjacent to the transformer, which may impede its installation or removal.

A. CONSTRUCTION

1. Transformer construction and installation shall comply with latest applicable standards of NEMA and ANSI/IEEE including:
 - a) *C57.12.00 Standard General Requirements for Liquid Immersed Distribution, Power, and Regulating Transformers.*
 - b) *C57.12.10 Standard Requirement for Liquid Immersed Transformers,*
 - c) *C57.12.28 Switchgear and Transformers, Pad-Mounted Equipment—Enclosure Integrity:*
 - d) *C57.12.70 Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers; and*
2. Transformer tests shall be performed in accordance with *C57.12.90 Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers*
3. Transformers shall be NCBCB approved third-party listed. Comply with NCGS 133-3 when using brand name specifications.
4. The "compartment type" pad mounted transformer shall be three-phase, less flammable liquid insulated, tamper resistant, 65 degree C temperature rise rated, 60 hertz frequency, with wye connected primary and secondary, and voltage as applicable for the project. Transformer insulating fluid shall be "R-Temp" or any LISTED "less flammable liquid" similar to BIOTEMP, or FR3, with a fire point of not less than 300-degree C when tested according to ASTM D92. The less-flammable insulated transformer installation shall comply with the installation criteria of the NCBCB approved third-party testing agency per NEC 450-23. SCO is aware of only two (2) NCBCB approved third-party testing agencies *Underwriters Laboratories (UL)* and *Factory Mutual (FM)*, with listing for less-flammable liquid insulating fluids, however, each have differing criterion within their published listing instructions. Note that under the alternative UL listing criterion, minimum clearances can be reduced, and spill containment avoided that would otherwise be necessitated under FM listing, based upon satisfaction of certain transformer tank pressure manufacturing characteristics as well as overcurrent protection. The Designer shall consult together with the Owner to identify which listing is preferable.

5. The transformer tank shall be of a sealed-tank construction as specified in ANSI Standard C57.12.26. The tank shall be a minimum of 12-gauge sheet steel, and strong enough to withstand a pressure of 7 psi without permanent distortion and 15 psi without rupturing or displacing of transformer components. A removable main cover may be provided over a bolted-on, tamperproof handhold. Handholds shall be provided for access to high voltage isolation links, three-phase switches, neutral connections, etc. The high and low voltage compartments shall be located side by side, separated by a steel barrier. When facing the transformer, the low voltage compartments shall be on the right. Terminal compartments shall be full height, air-filled, with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened.
6. Transformer tank grounding provisions shall be in accordance with ANSI standards. The grounding provisions shall be capped before painting the unit.
7. The core and coil assembly shall be of a five-legged wound core type design to provide adequate short-circuit strength and heat dissipation. Transformers connected wye-wye shall be built with five-legged core-type design to avoid the tank heating problems sometimes associated with wye-wye connections. When required, corrugated cooling panels shall be provided on the back and sides of the oil-filled tank to maintain a safe operating temperature. Internal leads shall be insulated, trained, and anchored to prevent phase-to-phase flashover.
8. Transformers are to be equipped with four (4) taps rated approximately 2-1/2 percent, with two (2) above and two (2) below normal. The tap changer shall be externally hook stick operated and located in the high voltage compartment. The tap changer shall be designed and marked for de-energized operation. As part of the transformer installation, perform a turns ratio test between windings at all tap positions with the final tap setting to be set at the secondary system rated voltage at full load or as directed by the Engineer.
9. The high voltage terminations and equipment shall be of the dead front construction.
10. Two high voltage bushings per phase shall be provided to permit operating a loop feed dead front transformer from a looped primary cable system. The high voltage bushings shall be one-piece type for use with load-break elbow terminators. As an optional method, provide a radial feed transformer, where applicable, with one bushing well and one load-break feed-thru insert per phase. Construction shall conform to ANSI/IEEE Standard 386. Bushings shall be externally clamped and externally removable. High and low voltage winding lead lengths shall be long enough to permit field replacement of bushings or bushing wells. All gasketed joints are to afford a sealed tank in accordance with industry standards. Gasket material must be durable and reusable. Parking stands shall be provided for mounting accessory equipment.
11. Lightning arrester mounting provisions in live front units only: For live front units only, provide three (MOV rating based upon kV class) distribution class lightning arresters for surge protection. Arresters are to be mounted in the high voltage compartment per ANSI/IEEE Standard 386.
12. Transformer overcurrent protection shall be a combination of oil-immersed current-limiting fuses in series with bayonet oil-immersed, overload sensing, expulsion fuses coordinated to provide full range protection with the expulsion fuse clearing low-current faults and the current limiting fuses clearing high-current faults up to 50,000 amperes. The fuse assembly shall have an interrupting rating of (3500A at 8.3 KV) or (1800 A at 15.5 KV) single phase, and a load break rating of 125A at 80% power-factor for (8.3 KV or 15.5 KV) single phase. The bayonet fuses must be accessible through the primary compartment. They must be externally

removable and field replaceable using a hot stick. This operation must be accomplished without having to remove the transformer compartment top. A welded-on oil drip shield must be located under the bayonet fuse to protect the primary connections.

13. The low voltage bushing shall be molded epoxy and capable of withstanding a load in a vertical direction of 800 inch-lbs. without causing a deflection sufficient to produce a leak. The bushings shall be externally clamped, blade type spade terminals with four (4)-hole NEMA standard spacing for transformers up to 500 KVA. Transformers above 500 KVA shall be equipped with six (6)-hole NEMA spacing. The bushings shall be arranged for vertical take-off.
14. For wye-wye connected transformers, the high voltage neutral shall be connected internally to the low voltage neutral with provisions for opening this connection for testing. The neutral bushing shall be fully insulated but connected to an adjacent ground pad (on the tank) with a detachable strap sized to carry the maximum fault current available from the transformer.
15. Equipment to be furnished as standard shall include:
 - a) A 1-inch drain valve with sampling device on units rated 750 kVA and above and 1-inch filler plug provided on 75–500 kVA.
 - b) Magnetic liquid level indicator
 - c) Dial type thermometer.
 - d) Pressure vacuum gauge.
 - e) Lifting, pulling, and jacking provisions.
 - f) Pressure-relief device suitable for the transformer as recommended by transformer manufacturer that will automatically relieve pressure and effectively keep the transformer sealed with no leakage of air or oil or any permanent distortion. Any pressure-relief device must exclude moisture from the transformer and have a life equal to the transformer.

B. GROUNDING: See Appendix, Sheet E-7.

26 18 00 LOADBREAK INTERRUPTER AND PADMOUNT SECTIONALIZING SWITCHES

1. All switches shall be dead front application type.
2. Padmount sectionalizing switches shall be puffer vacuum air interrupter switch, and/or gas (SF6) switch.
3. Loadbreak interrupter switches shall be fused or air (load-break) type.

26 18 01 OIL INTERRUPTER SWITCHES

1. Oil interrupter switches are not acceptable for new construction.

2. Existing oil switches "RA" style, which do not have a close-into-fault rating, shall be removed, and replaced with manual air switches, puffer vacuum air interrupter switches, or gas (SF6) switches.
3. The "non-spring loaded" type switch is not acceptable for new construction.

26 22 00 DRY TYPE TRANSFORMERS

1. The US Department of Energy (DOE) 10 CFR 431 energy efficiency standards for low-voltage dry-type, and medium-voltage dry-type distribution transformers shall be enforced.
2. The use of energy efficient transformer is required. Transformers with load factor up to 35% of their capacity shall have efficiency of 98% and shall meet or exceed DOE and NEMA requirements. Class 220, 115 ° C transformer shall be used when the load factor is up to 50% of their capacity, otherwise, Class 220, 80° C rise shall be specified. The transformer overload capability shall be in accordance with IEEE C57.96; for standard transformers, and IEEE C57.110, for K-rated transformers. When used, K-rated transformer shall be energy efficient, shall bear the energy star label, and shall also meet DOE and NEMA requirements.
3. All dry type transformers shall be installed in accordance with the manufacturer instructions which typically require anchorage for floor mounted installations with anchor size and depth determined by the Designer.
4. Consult with SCO for transformers greater than 112.5 kVA capacity due to possible undesirable computed arc flash hazards at downstream panels and equipment.

26 24 13 DISTRIBUTION SWITCHBOARDS (600 Volt)

1. Switchboards shall have proper working clearances per NEC. Attention is directed to NEC Article 110-26.
2. All bussing shall be tin-plated or silver-plated copper.
3. Switchboards identified for use as service equipment shall be so labeled.
4. Switchboards shall be provided with "Mimic Bus" on front of enclosure to depict actual bus arrangement inside cubicles.
5. Switchboards shall be mounted on a nominal four (4) inch concrete housekeeping pad properly anchored in accordance with manufacturer's recommendations.
6. Each switchboard component shall be provided with adequate nameplate on front of cubicle (see Section 26 05 53 Electrical Identification).
7. Design documents shall include plan, side, and top views of switchboards along with adequate schedule locating and describing components therein.
8. Switchboards with bussing 1000 ampere or larger shall contain a metering section to include meters such as ammeters, voltmeters, watt-hour, power factor, or electronic power metering.

9. Upon completion of installation, and prior to final inspection, the Contractor shall reduce in size the "as-built" single line diagram (riser), frame same under glass, and mount in a conspicuous place adjacent to the switchboard.
10. SCO recommends all breakers 600 ampere and larger to be solid state trip type.
11. The arc-flash protection boundary and the incident energy for the electrical equipment shall be in accordance with Section 260100 of these guidelines.
12. The minimum switchboard feeder ampacity must be adequate for the computed load; however, additional number and size of installed raceways shall also be provided to enable future installation of additional parallel sets of cables required to supply the switchboard main bus rating.
13. For circuit breakers larger than 1200-amps, provide draw out type switchgear and circuit breakers.

26 24 16 PANELBOARDS

1. Panelboards identified for use as service equipment shall be so labeled.
2. Panels 600-amps and less shall have either bolt-on breakers or plug-in type breakers secured in place with 1 or 2 fastening screws. Fusible panelboards are acceptable where necessary such as applications involving selective coordination of overcurrent protection devices within emergency and legally required standby power systems.
3. Bus bars shall be copper.
4. Full size copper neutral bus shall be included in all panels. Copper ground bus shall be provided with the panel.
5. Panels 600-amps and less shall be reversible from top to bottom feed and bottom to top feed.
6. Feed-through or sub-fed lugs within panels are not permitted, except upon consultation with SCO, for interconnecting multi-section panels. When sub-feed or feed-through lugs are incorporated, the multi-section panelboard must be protected by a single main overcurrent device either in the panelboard or immediately upstream.
7. A typed directory card shall be supplied, mounted on the inside of each door.
8. An engraved nameplate shall be provided for each panel. See Section 26 05 53, Electrical Identification.
9. "Load Centers" are not acceptable except in certain instances approved by the State Construction Office.
10. The use of series rated breakers is not acceptable.
11. Panelboards feeding electronic equipment shall be provided with a "full size" ground bus, a "full size" neutral bus, or 200% neutral bus, and shall be fed with feeders having a "full size" or larger neutral. Single phase branch circuits requiring a neutral shall have individual neutrals, in other words, no sharing of the neutral between circuits is allowed.

12. Panelboard schedules placed on contract documents typically follow the preferred format as indicated in Appendix E-6.
13. Equipment labeling for the flash protection boundary and the incident energy shall be determined in accordance with IEEE 1584, NFPA 70E & NEC 110-16 requirements.
14. Each panelboard section shall not exceed 42 single pole spaces.
15. On large buildings (20,000 sf and larger), the electrical panels that feed luminaires shall not feed receptacles and electrical panels that feed receptacles shall not feed general lighting luminaires.
16. Provide a permanent tag attached to the branch circuit wire identifying the associated circuit breaker position.
17. Panelboard construction shall utilize hinged trim along one vertical side of the enclosure, sometimes termed "door-in-door", thereby enabling full access to the branch wiring terminations along both sides of the enclosure.
18. The minimum panelboard feeder ampacity must be adequate for the computed load; however, additional number and size of installed raceways shall also be provided to enable future installation of additional or larger conductors required to supply the panelboard main bus rating.

26 24 19 MOTOR CONTROL CENTERS

1. Motor control center structure shall be a totally enclosed, free-standing assembly, ninety (90) inches high and not more than twenty (20) inches deep.
2. Motor control center shall be mounted on a nominal four (4) inch high housekeeping pad.
3. A horizontal copper ground bus shall be provided for the entire length of the enclosure.
4. All bus assemblies shall be braced for minimum of 42,000 ampere short-circuit current.
5. The main horizontal and vertical busses shall be tin-plated or silver-plated copper.
6. The main horizontal busses shall run the full length of the enclosures. Provisions shall be made to extend the horizontal bus at either end in the future with standard splice plates. Bus shall be pre-drilled to accept standard splice plates.
7. The motor control center bus compartments shall have horizontal and vertical bus barriers to reduce the hazard of accidental contact with the bus.
8. A minimum six (6) inch high horizontal wireway, with steel covers removable from the front, shall be provided at the top and bottom of each unit. Adequate vertical wiring space, accessible from the front, shall be provided for each section.
9. Factory internal wiring shall be NEMA Class 1, Type B. Each combination starter shall be provided with removable-type terminal strips. A wiring diagram for each starter shall be mounted inside the door of each unit.

10. Unit compartments shall have padlocking provisions for one to three padlocks to lock the disconnect in the "OFF" position.
11. Unit compartments shall have mechanical interlocks to prevent opening of the door unless the disconnect device is in the "OFF" position. This interlock shall be defeatable.
12. Control components shall be provided as required by the mechanical control sequence and shall be powered by individual fused control transformers in each starter assembly.
13. Units shall be properly identified. See Section 26 05 53, Electrical Identification.

26 27 26 WIRING DEVICES

A. SWITCHES

1. Toggle switches shall be single pole, three-way, or four-way as indicated on the drawings. Switches shall be of the grounding type, with hex-head grounding screw, rated 20A, 120/277-volt, AC only. Lighted handle switches shall have neon lights of the correct voltage rating where indicated on the drawings. All switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be listed by an NCBCC approved third-party agency, approved for the voltage and amperage indicated.
2. Consult with SCO before designing automatic lighting controls for the interior emergency egress and exit lighting. If automatic lighting controls are used for interior emergency lighting, the Designer shall incorporate UL 924 or UL 1008 branch circuit transfer equipment to bypass all controls and bring emergency lighting to full brightness in the event of loss of normal illumination. Emergency egress lighting shall be supplied by a minimum of two branch circuits which may include a normal branch circuit and an emergency branch circuit OR two emergency branch circuits. Refer to NEC 700.17. In lieu of two branch circuits, egress lighting may receive power from a normal power branch circuit with unitary battery-operated emergency egress lighting equipment connected ahead of any lighting controls. See Section 265100.E, Interior Luminaires.

B. RECEPTACLES

1. Duplex receptacles shall be of the grounding type, arranged for back and side wiring, with separate single or double grounding terminals. Receptacles shall be straight blade, rated 20A, 125-volt and the face configuration shall conform to the NEMA Standard No. WD-1, NEMA WD6, DSCC W-C-596G & UL-498 and shall be NCBCC approved third-party listed. Self-grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a direct, green insulated conductor connection to the equipment grounding system.
2. Receptacles shall be federal specification grade, mounted vertically. Receptacles mounted over counters, back-splashes, etc., shall be mounted horizontally.
3. Special wiring devices shall be shown on the drawings with complete description thereof.
4. GFCI receptacles shall be rated minimum 20-amp (NEMA 5-20R configuration).

5. GFCI receptacles shall be provided where used at indoor wet locations, including near eye-wash stations, emergency showers, and other locations required by applicable codes.
6. Provide arc fault protection for outlets in dwelling units, residence halls, and dormitories, etc. as required per code with NC amendments.
7. Receptacles shall not be mounted back to back.

C. DEVICE PLATES

1. Cover plates for flush mounted wiring devices and for telephone outlets shall be Type “302” stainless steel or nylon type, standard size, single or ganged as shown on the drawings. Cover plate mounting screws shall be slotted head oval screws and shall match the finish and material of the plate and shall be furnished with the plate by the plate manufacturer. Quantity of 2% spare cover plates of each type shall be provided to the Owner.
2. Switch and receptacle cover plates on exposed work shall be galvanized cast ferrous metal, standard size, and shall be single or ganged as indicated on the drawings.
3. Exterior mounted receptacle plates, and those noted to be weatherproof, shall be extra duty rated, standard size, single or ganged as indicated on the drawings, and shall be NCBCC approved third-party listed as “weatherproof while in use.”

26 28 13 FUSES (600 VOLTS OR LESS)

1. Fuses shall be so selected as to provide a fully selective system.
2. The following criteria shall be followed for fuse selection:

<u>CIRCUIT TYPE</u>	<u>FUSE TYPE</u>
Service Entrance & Feeder Circuits over 600A	Class L, current limiting with 200K Amp interrupting rating.
Service Entrance & Feeder Circuits 600A and less	Class RK1 or J, current limiting with 200K Amp interrupting rating.
Motor, Motor Controller & Transformer Circuits	Class RK1 or RK5, current limiting time delay, with 200K Amp interrupting rating.
Individual Equipment where fault Current does not exceed 50 KA	Class K5, with 50 KA interrupting rating.

3. Specify spare set of fuses for the equipment.

26 28 16 ENCLOSED SWITCHES

1. Safety switches shall be the "heavy duty" type. General duty switches are unacceptable, except on single family dwellings.

2. Switches shall have defeatable door interlocks that prevent the door from opening when the operating handle is in the "on" position.
3. Switches shall have handles whose positions are easily recognizable in the "on" or "off" position. For safety reasons, padlock shall be provided for switches located in public areas.
4. Switches shall have non-teasible, positive, quick make-quick break mechanisms.
5. Fusible safety switches with short-circuit withstand ratings of 100K Amp or 200K Amp require Class R or Class J rejection fuse block feature.
6. Switches shall be properly labeled. See Section 26 05 53, Electrical Identification.

26 32 13 PACKAGED ENGINE GENERATOR SYSTEMS

A. GENERAL

1. These guidelines cover emergency, legally required, and optional standby power systems engine generator sets and associated auxiliary and control equipment. The engine generator shall provide back-up power for the emergency power distribution system during utility or normal power outage. Power outage sensing, generator starting, transfer of load, re-transfer to normal power, and engine cool down running time shall be a completely automated system and shall not require attended operation. Generator specifications shall reference the generator UL-2200 listing for units rated 1000-volts and less.

B. ENGINE REQUIREMENTS

1. The engine shall be a compression ignition model for diesel fueled that has been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability. In some locations, Natural Gas fuel with spark ignition is also acceptable, check with the AHJ regarding the location. The engine shall be 4 stroke cycle multi-cylinder design. The engine speed shall not exceed 1800 RPM at normal full load operation when equipped with all necessary operating accessories such as air cleaners, oil pump, water pump, generator, etc. In conformance with the requirements of NFPA 110 Standard for Emergency and Standby Power Systems, the engine shall produce enough power to pick up 100% of nameplate KW rating in one step, less applicable site condition derating factors. Engine ratings shall not exceed the standby power service rating published by the manufacturer.
2. The diesel engine shall be designed to operate on no. 2 fuel oil.
 - a) The fuel system shall be that which is normally used by the diesel engine manufacturer and shall include secondary fuel filter, water separator, manual fuel priming pump, fuel shut-off solenoid, and all piping and appurtenances required for a complete system.
 - b) It shall include a fuel transfer pump (if needed to lift the fuel from the fuel tank) and a replaceable fuel filter element conveniently located for servicing.
 - c) Tank pressure test shall meet UL 142 requirements and applicable EPA requirements.

- d) Where the tank may need additional protection, specify an EPA and UL 2085 tank rated for minimum two hours. Consider the following tank location criteria to determine need for a UL 2085 rated tank:
 - (1) Installed within 15-feet of an occupied structure.
 - (2) Installed within 15-feet of a vehicle way and is not protected by bollards, a 1-hour rated screen wall, or equivalent means of substantial protection.
 - (3) Installed in areas subject to hunting or target shooting.
 - (4) Installed where additional protection may be required near a water way or water shed area.
 - e) The sub-base fuel tank assembly shall be welded steel construction and have the structural integrity to support the generator set and associated components. It shall include, but not be limited to heavy gauge steel, double wall tank, with all welded construction, prime coated and finished painted outside. Minimum capacity shall be 100 gallons with secondary containment of fuel tank and all other accessories, lockable fuel filler cap, low fuel level alarm switch, fuel level gauge, inter-tank leak detection alarm switch, fractional HP thermally protected motor, fuel line check valve, tank drain, threaded pipe connections.
- 3. Tank vent and fuel fill port shall include spill containment. Extend fill port if needed to allow convenient and safe refueling.
 - 4. If generator designed to operate on liquid propane gas (LPG): The fuel system shall be that which is normally used by the engine generator set manufacturers and shall include a secondary regulator and gas carburetor specifically adjusted for the fuel used. Provide primary line regulator, fuel shut-off solenoid, and flexible section of fuel line for connection between stationary gas piping and the engine components.

C. BATTERY CHARGING

- 1. Specify an automatic, solid-state, current limiting, float/equalizing battery charger. It shall maintain the battery at normal capacity and recharge battery after cranking. The charger shall be 120-volts input with appropriate output. It shall be capable of automatically switching from one rate to another rate to meet the needs of the discharged batteries. It shall recharge a completely discharged battery in a maximum of 8 hours. It shall also have overload protection, voltage surge suppressers, D.C ammeter, D.C voltmeter, low D.C voltage alarm relay; with a minimum continuous output of 10 amperes D.C, battery charger malfunction alarm contact, and NCBC approved third-party listed and labeled.

D. GOVERNOR

- 1. The engine governor shall maintain acceptable frequency regulation from no load to full rated load. The steady state operating band shall be within 2%. The generator controls shall accommodate harmonic distortion within the criteria of IEEE 519.

E. LUBRICATING SYSTEM

1. The engine shall have a lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, pistons pins, timing gears, camshaft bearings and valve rocker mechanism. Full flow oil filters, conveniently located for servicing, shall be provided. Lube oil drain extension and valve terminated on the outside of the generator base shall be provided.

F. AIR CLEANERS

1. One or more dry type air cleaners shall be provided, as recommended by the manufacturer.

G. EXHAUST

1. Critical grade silencer shall be provided to reduce engine exhaust noise to a maximum DBA level of 85 at 10 feet. If the equipment is located outside, the silencer with piping shall be mounted on top of the weatherproof enclosure. The exhaust silencer outlet shall be terminated with a tailpipe (45 degree cut) or an exhaust elbow and rain cap and directed away from buildings and pedestrian pathways. If the equipment is located inside the building, the exhaust piping shall extend through the building side wall using a ventilated thimble discharge (horizontal discharge with tailpipe 45 degree cut, or vertical discharge with a rain cap. Piping shall be schedule 40, black steel; piping inside the building shall be insulated. A seamless stainless-steel flexible connector shall be installed on the engine exhaust outlet.
2. Coordinate the generator exhaust diameter and length with the Mechanical Engineer to ensure that the generator's backpressure specification is not exceeded.

H. ENGINE BLOCK HEATER

1. A thermostatically controlled, immersion type engine coolant heater shall be provided. Minimum coolant temperature shall not be less than 120 degrees F. Each heater shall be provided with contactor in a rated NEMA enclosure. Heater(s) shall not operate while the engine is running.

I. COOLING SYSTEM

1. A closed recovery cooling system with enough capacity shall be provided to cool the engine when the generator set is delivering full rated load at minimum ambient temperature of 105 degrees F. Radiator, fan, engine-driven centrifugal water pump and thermostatic valve shall be provided. System shall be protected against freezing and corrosion. Radiator duct flange shall be provided for equipment installed inside the building.

J. BASE AND VIBRATION ISOLATORS

1. The engine-generator assembly shall be fastened to a welded steel base which shall allow mounting to a raised concrete pad or the sub-base fuel tank. Anchor bolts and vibration isolators shall be used to mount the heavy steel base to the concrete pad. Vibration isolators, either integral or external, shall be provided and installed as recommended by the manufacturer. Vibration isolators shall be one-piece units, resistant to corrosion and environmental degradation. When sub-base tanks are specified, vibration isolators shall be located between the generator set and the fuel tank

K. OUTDOOR ENCLOSURE

1. Enclosure shall be tamper-resistant, heavy gauge steel or aluminum construction, gasketed with fixed open or motorized air louvers, lockable latches, and side and rear doorways to access components. Where air louvers are motorized, they shall be powered from the generator starting battery and shall fail open upon loss of power. Enclosure shall be primed and finished painted. Enclosure shall be designed to withstand the wind and snow loading for the installed location as determined by the North Carolina Building Code. For locations subject to hurricane force winds, consider turn-down plenum air intakes. Where subject to corrosive environments (i.e. coastal areas), provide a corrosion resistant enclosure. Provide stainless-steel 316L if needed. All installations where generator controls exceed 6 feet 7 inches above grade, or where interior floor height within the generator enclosure exceeds four (4) feet above grade (such as with base mounted fuel tank), provide an exterior access platform meeting minimum NEC working clearance requirements, with handrails, enabling access to all enclosure doors.

L. EMERGENCY LIGHTING UNIT

1. Emergency lighting unit, with battery back-up, shall be provided in the generator room or within outdoor generator enclosure.

M. GENERATOR

1. The generator shall be 208/120 or 480/277 volt, three-phase, 4-wire (or match voltage and configuration of electrical system) for rated KW and power factor. The rating shall be applicable for continuous service in stand-by application.
 - a) Generator shall be revolving field type, close-coupled or directly coupled to the engine flywheel. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% over-speed.
 - b) The generator shall have Class H insulation as recognized by NEMA. The field shall be equipped with full amortisseur windings.
 - c) The voltage regulator shall be of the solid-state design with true RMS sensing and provide volts-per-hertz operation. It shall be mounted on top or side of the generator and enclosed in a "NEMA RATED" enclosure. A built-in voltage adjusting rheostat shall provide 10% voltage adjustment. An isolation transformer in the voltage regulator circuit shall be provided.
 - d) Provide two-thirds pitch alternator.
2. If adding a second generator to the same building, Contact State Construction Office for specific requirements.

N. GENERATOR SET MAIN CIRCUIT BREAKERS

1. Molded case with solid state trip unit circuit breakers in suitable enclosures for generator shall be provided. Resettable three phase line current sensing circuit breakers with inverse time verses current response, set to open after a 10 second fault condition, shall be provided for generators 1000-KW and larger. The generator circuit breakers shall be NCBCC approved

third-party listed. Emergency system overcurrent devices shall be selectively coordinated with all supply side overcurrent protective devices. (See Appendix Sheet E-1)

2. For generator applications where loads include an electric driven fire pump:
 - a) Provide molded case breaker at the generator. Breaker shall be short circuit protection only and shall be sized above 125% of the motor IFL and less than 250% of the motor IFL.
 - b) Identify and label the available short circuit fault current at the fire pump controller.
 - c) The breaker at the generator shall be time-current coordinated (TCC) with the magnetic only motor circuit protection (MCP) breaker at the fire pump.
 - d) After approval of the fire pump shop drawings by the Mechanical Engineer, the Electrical Engineer shall obtain the required electrical information from the Mechanical Engineer to perform TCC coordination.
 - e) The TCC coordination shall be sealed and signed by the Engineer of Record.
 - f) The instantaneous trip setting for the breaker at the generator shall not exceed the calculated short circuit fault available from the generator.
 - g) Copy of the breakers TCC shall be submitted to SCO upon request.
3. If only one feeder is provided from the generator to the building to feed emergency and non-emergency loads, the feeder shall terminate within compartmental type panel/switchboard/switchgear or gutter with properly sized fused disconnect switches or circuit breakers. The emergency breaker shall be in a compartment segregated from the non-emergency breakers. (See Appendix Sheet E-1)
4. A facility with an electric driven fire pump and a generator, which permits occupancy during a normal power interruption, the generator shall provide back-up power to the fire pump.

O. GENERATOR LOAD BANK

1. The Designer shall evaluate all generator designs in coordination with the SCO office and the Facility Owner for incorporation of a permanently installed load bank. Past SCO experience has shown that generator installations without load banks are not regularly exercised under load after original commissioning. As a result, in response to a subsequent power interruption, the generator either fails to start or fails shortly after load is applied. This does not apply where the agency has a documented and implemented generator maintenance schedule meeting manufacturer recommendations.
2. Load banks shall be connected to the generator output terminals and enable generator operation without an outage of normal power to the supplied facility. Load banks shall have adequate rating to enable exercising the generator between 40 and 100 percent rated capacity. Utilize automatic load control to maintain preset minimum load on generator as the building load increases.
3. Load banks shall be provided by the generator manufacturer and included in the initial generator performance test and warranty.

P. GENERATOR PERFORMANCE

1. The voltage regulation from no load to rated load shall be within a 2% band of rated voltage.
 - a) Steady state voltage modulation shall not exceed one Hertz.
 - b) For any additional load up to and including 90% of the rated load capacity, the voltage shall recover to, and remain within the steady band, in not more than 1.5 seconds. The voltage dip shall not exceed 20% of the rated voltage at any time.
 - c) The frequency regulation from no load to rated load shall conform to the engine governor performance. For any additional load, up to 90% of rated load, the frequency shall recover to the steady state frequency within 5 seconds.
2. Generator's control panel specifications shall be per NFPA 110 requirements. A generator with emergency loads shall comply with level 1 requirements.

Q. CONTRACTOR TESTING

1. Prior to acceptance of the installation, the generator shall be tested in accordance with NFPA 110. This test shall be performed at the job site in the presence of the Owner and Engineer's Representative. After testing is complete:
 - a) A full tank of fuel shall be provided, replacing any fuel used for testing (N/A for natural gas). Diesel fuel shall be treated with an alcohol-free additive to disperse water and clean the injectors.
 - b) A copy of the generator's test report shall be sent to the Engineer of Record, the Owner, and made available at Beneficial and Final Inspection to the State Construction Office.

R. FINAL ACCEPTANCE

1. The installation shall be supervised, checked, and tested by an authorized representative of the engine generator manufacturer. Written certification shall be sent to the Designer and/or Owner prior to final acceptance.

S. DOCUMENTATION AND TRAINING

1. Documentation: Prior to final acceptance, the manufacturer shall supply three (3) copies of complete instruction manuals to the Owner. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, and unit wiring diagrams and schematics, and interconnection wiring drawings.
2. Training: Prior to final acceptance, the manufacturer shall provide comprehensive training to the Owner's designated personnel. Training shall cover, but not be limited to, operation, maintenance and troubleshooting of the equipment.

T. WARRANTY

1. The generator, transfer switch and associated equipment shall be warranted by the manufacturer for a period of five (5) years, from the date of final acceptance. The warranty

shall be included in the record documents. The warranty shall include all parts, labor (including travel), expenses and equipment necessary to perform replacement and/or repairs.

26 33 00 STATIC EMERGENCY POWER SUPPLIES (Central Inverter Systems)

1. Emergency power supplies with central battery and remote devices shall have minimum ten (10) years prorated warranty.
2. Specify power supply unit with maximum 5% total harmonic current distortion at full load. If providing power to emergency solid state lighting (LED), use sign wave output, not square wave output, and provide unit with NCBCC approved third-party listing for use with emergency lighting.
3. Limit load to 80% of the power supply rating

26 36 00 AUTOMATIC TRANSFER SWITCHES

A. GENERAL

1. The automatic transfer switch shall be either four-pole type with switched neutral or three-pole with solid neutral. Full-size neutral contactor shall be provided. The ATS shall conform to the requirements of UL1008-Standard. Provide four-pole transfer switch on electrical systems using ground-fault main or feeder circuit breakers.

B. SEQUENCE of OPERATION

1. Transfer to alternate power if normal source drops below a range of 70-95% of rated voltage (factory set at 85%) after an adjustable time delay period of .05 to 6 seconds (factory set at 3 seconds) to allow for momentary dips. The transfer switch shall transfer to emergency as soon as the generator voltage has reached a range of 75-100% of rated voltage (factory set at 90%) and generator rated frequency of 85-100% (factory set at 90%).
 - a) After restoration of normal power on all phases to 90% of rated voltage, an adjustable time delay period of 0-30 minutes (factory set at 5 minutes) shall delay re-transfer to normal power until it has stabilized. If the emergency power source should fail during the time delay period, the time delay shall be by-passed and the switch shall return, immediately, to the normal source.
 - b) Provide open transition transfer switches.
 - a) If Owner or Designer prefers closed transition, Designer shall be responsible to comply with all the requirements of the Electric Utility.
 - c) After the switch has transferred to normal, the engine generator shall be allowed to operate at no load for 5 minutes minimum, or manufacturer's recommendation, to allow it to cool before shutdown. The engine cool-down timer may be installed in the generator control panel.
 - d) Where multiple transfer switches supplying differing systems (emergency, legally required, and optional standby) are present, transfer times shall satisfy 2018 NC Building

Code Chapter 27. In addition, restoration to normal power shall be staged amongst the transfer switches to provide minimum 15 second separation times.

C. Components

1. The automatic transfer switch shall include, but not be limited to, the following features and characteristics:
 - a) The transfer switch shall be continuous duty rated.
 - b) Three phase transfer switches shall be 3-pole with solid neutral, or 4-pole with neutral contacts of same capacity as phase contacts.
 - c) Transfer Switch Control System:
 - (1) The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be microprocessor-based. The control settings shall be stored in nonvolatile memory.
 - (2) The control module shall have a three-position, key-operated, programming control switch. The key shall be removable in any position. The positions shall be:
 - i. *Off* - Allows all enabled accessories to be monitored only. Settings cannot be changed while in this position.
 - ii. *Local* - Allows all enabled accessory settings to be changed locally at the transfer switch control panel
 - iii. *Remote* - Allows all enabled accessories to be altered via the remote communications port.
2. Test switch or push button to simulate normal power failure.
3. Generator exercising time switch with load/no load selector switch.
4. Transfer time not to exceed one-sixth (1/6) second.
5. The normal and emergency contacts shall be positively, mechanically, and electrically, interlocked, to prevent simultaneous closing. The main contacts shall be mechanically locked into position for both the normal and emergency positions without the use of hooks, latches, magnets, or springs.
6. In-phase monitoring shall continuously monitor the contactor transfer times, source voltage, frequency, and phase angle to provide a self-adjusting, zero crossing contactor transfer signal.
7. Anti-single phasing protection shall detect regenerative voltage as a failed source condition.

D. Status Indicators

1. Light-emitting diodes shall indicate the following:
 - a) Contactor Position: Normal (Utility) and Emergency (Generator).

- b) Plant Exerciser Active.
 - c) In Phase Monitor Active.
 - d) A test push button shall light all light-emitting diodes.
2. NO/NC auxiliary contacts shall be furnished for the following:
- a) Contactor in normal positions, 2 sets minimum
 - b) Contactor in emergency position, 2 sets minimum.

E. Construction

1. The transfer switch shall be rigidly constructed to close into and withstand the bolted fault current available at the switch.
- a) All transfer switch coils, springs, and control elements shall be easily accessed for inspection and conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors.
 - b) All feeder lugs, relays, timers, control wiring and accessories shall be front accessible.
 - c) The control module and transfer switch shall be physically separated.
 - d) Main contacts shall be of silver alloy composition.

26 41 00 LIGHTNING PROTECTION SYSTEMS

1. Determination for the need of a lightning risk assessment shall be evaluated in consultation together with the SCO office during the advanced planning and schematic design phase of the project. The lightning risk assessment may be performed in accordance with the Simple or Detailed Risk Methods of NFPA 780 *Standard for the Installation of Lightning Protection Systems* or an alternative evaluation elected by the Designer and approved by the SCO office. A lightning protection system shall be required where the evaluated annual lightning threat occurrence (N_a) exceeds the tolerable lightning frequency (N_c). When performed, the lightning risk assessment shall be stamped by a registered professional engineer licensed in North Carolina and submitted to the SCO office upon request.
- a If a new lightning protection system is required, provide the new lightning protection system as required by this section.
2. Building surge protection system shall be Underwriter's Laboratories certified in accordance with UL-96A requirements. (See latest edition of NFPA 780 Lightning Protection Code). Lightning protection system UL Master Certification shall specifically state that building surge protection devices are included and not omitted from amongst the evaluated devices and components.
- a The surge protection at the service entrance shall be rated for "Lightning Surges" based on the risk assessment.

3. Upon completion and review by an NCBCC approved third-party lightning protection agency, Contractor shall obtain, and deliver to Owner the certifications.
4. The system shall be bonded to the building grounding electrode system.

26 43 13 SURGE PROTECTIVE DEVICES (SPD)

1. The System shall meet the following standards: IEEE C62.34, C62.41& C62.45, NEMA LS 1, UL 1449 (latest edition), NEC Article 280 or 285 as applicable. Each SPD shall be installed on the load side of an overcurrent protective device. Provide either a Type 1 or Type 2 SPD at each service unless exception is given by SCO.
 - a. Type 1 (if provided): The device may be installed upstream of the service disconnecting means. Provide a means to disconnect the SPD for maintenance or repair.
 - b. Type 2 (if provided): Should be mounted at the service equipment on the load side of the service overcurrent device.
 - c. Type 3 (if provided): Shall be mounted at the branch panel.
 - d. Type 4 (if provided): Shall be furnished and installed where required by the equipment listing.

26 51 00 INTERIOR LUMINAIRES

A. GENERAL

1. Specify luminaires listed and labelled to UL 1598 (latest edition) standards. Coordinate with architect and lighting designer such that installation complies with all applicable NEC Articles. Where installing the luminaires in hard ceilings, verify required access to all luminaire components and associated junction boxes.
2. When LCCA is provided; as required per the State Construction Manual, the LCCA shall be submitted to State Construction Office for review in the Schematic Design submittal and amended or updated as needed at the Design Development. The LCCA submittal shall be prepared per the SCO LCCA Manual.
3. Lighting control conductors used in plenum applications shall be listed as having adequate fire resistance and low smoke producing characteristics. Conductors insulated with materials that produce toxic smoke are not acceptable. The manufacturer of the cable shall certify that its product complies with the above.
4. Evaluation of the life cycle cost shall be performed as required per legislative actions as adopted by the NC State Legislature. See Appendix Sheet E-00
5. The thickness of the lenses shall not be less than 0.125.
6. Where a recessed LED, fluorescent, high intensity or downlight fixture replaces a section or part of a ceiling tile, support fixture at two (2) opposite ends from the steel frame of the building. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track and shall be distinguished by color and tag. Attach one end of the wire to one corner of the luminaire and the other end to the building's structural system. The lay-in

luminaire shall then be secured to the main runners of the lay-in ceiling track at minimum two (2) diagonally opposite corners. For fire rated suspended ceiling, luminaire shall be supported to the Building Structure as per the Ceiling Design Criteria, luminaire shall then be secured to the main runners of the suspended ceiling track at all four (4) corners. It is the Designer's responsibility to make sure this work is coordinated with the work of the Ceiling Contractor through the ceiling specifications. Also, see the ASTM Section "E-580-02" items 3.3, 4.3, 5.5& 5.6 and the NEC 300.11 & 410-36(B)

7. To save energy, the lighting illumination levels shall be designed in accordance with the North Carolina Energy Conservation Code and the IES standards. Lighting system shall be controlled utilizing any of the following methods: lighting control panels, occupancy sensors, optical sensors, automatic day-lighting controls, bi-level HID controls, dimming control, and plug load controls, timers, photo cells, or manual control. Lighting and controls shall comply with North Carolina Energy Conservation Code. For safety reasons, automatic lighting shut-off controls shall not be used in Electrical and Mechanical Rooms unless a separate manual override switch is also provided at the entry to the room.
8. Calculations regarding point by point symmetrical and asymmetrical lighting distribution shall be provided to State Construction Office upon request.
9. Where disconnecting means is required for the double-ended lamps, per NEC 410-130, the disconnect shall be labeled and located next to the room's local switch, and shall be within sight of the lighting fixture, unless included as part of the listed fixture package. Where reinstalling existing fixtures, ensure integral disconnecting means is provided at the ballast.
10. Provide a table or a drawing showing the designed illumination levels in Foot-candles for each functional area of the facility. The provided lighting levels for each functional area of the facility shall comply with tables listed in the North Carolina Energy Conservation Code, and/or with tables provided in the IESNA standards, whichever is more stringent. The lighting levels shall be part of the building integrated Life Cycle Cost analysis where required per G.S 143-64.15(a).
11. Install battery operated unit equipment in the following locations, in addition to egress illumination noted in paragraph E below:
 - a) Electrical spaces to illuminate automatic transfer switches.
 - b) Fire pump room to illuminate the fire pump controller.
 - c) Sprinkler riser room to illuminate the main shut-off valves.

B. Fluorescent Lighting

- A. Specifying of energy efficient luminaires is required. Where electronic ballasts are specified, meet the following criteria:
 - a) Ballast to be "UL Listed, Class P", "Sound Rated A", and meet or exceed ANSI C82.11 requirements.
 - b) Ballast shall have high power factor (minimum of 90%).
 - c) Lamp current crest factor shall be equal to, or less than, 1.7.

Electrical Guidelines and Policies - 2020

- d) Input current third harmonics shall not exceed ANSI recommendations (32% total harmonic distortion, 27.5% of the third triplets).
- e) Flicker shall be 15% or less with any lamp suitable for the ballast.
- f) Ballast design shall withstand line transients per IEEE 587, Category A and shall meet FCC Rules and Regulations, part 18.
- g) Ballast case temperature shall not exceed 25 degrees C rise over 40 degrees C ambient.
- h) Parallel wiring between the ballast and the fixture is recommended.
- i) Minimum of five (5) years warranty is required with each electronic ballast.
- j) The listed manufacturers shall have at least five (5) years of experience in manufacturing electronic ballasts.
- k) The electronic ballast shall be provided with end-of-life shutdown circuit.
- l) Program start or rapid start ballasts shall be specified when occupancy sensors are used. It is not recommended to use instant start ballasts with occupancy sensors as they shorten the life of the lamps.
- m) Fluorescent lamps shall comply with the EPA Guidelines regarding the Toxicity Characteristic Leaching Procedure TCLP.

C. SOLID STATE (LED) LIGHTING

- 1. Require power factor greater than 90%.
- 2. Require less than 20% total harmonic distortion (10% or less preferred if available).
- 3. For indoor and building mounted fixtures, provide minimum 2-KV rated surge suppression integral with the driver (5-KV preferred if available).
- 4. Where LED lighting is connected to a circuit greater than 50-volts, provide integral disconnect plug for disconnecting the driver from the circuit.
- 5. Require a minimum 5-year warranty.
- 6. Do not share neutrals on LED lighting circuits.
- 7. For more information on LED lighting, see Solid State Lighting Guidelines (SSL) available on SCO website. <https://ncadmin.nc.gov/document/ssl-guidance>

D. EMERGENCY EXIT LUMINARE

- 1. GENERAL
 - a) It shall be completely self-contained, provided with maintenance-free battery, automatic charger, and other features. No battery is required if the fixture is fed from a generator, or

any other emergency power source. Luminaires must be NCBCC approved third-party listed as emergency lighting equipment and meet or exceed the following standards: NEC, North Carolina Building Code, North Carolina Energy Conservation Code, NFPA-101, and NEMA Standards.

2. BATTERY

- a) It shall be sealed, maintenance-free type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0-degree C to 60-degrees C. Battery operated luminaires installed in cold environments, including exterior, shall have a low temperature option.

3. CHARGER

- a) It shall be fully automatic solid-state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated when the line voltage drops below 80 percent. A low voltage disconnect switch shall be included if a lead-acid battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

4. ADDITIONAL FEATURES

- a) Provide:
 - (1) A pilot light to indicate the unit is connected to AC power. The battery shall have a high rate charge pilot light unless it is a self-diagnostic type.
 - (2) A tests switch to simulate the operation of the unit upon loss of A.C power by energizing the lamps from the battery. This simulation must also exercise the transfer relay.

5. WARRANTY

- a) The entire unit shall be warranted for three years. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

6. LED

- a) The use of LED is required due to their reliable performance, low power consumption, and limited maintenance requirements. Maximum LED failure rate shall be 25% within a seven (7) year period; otherwise, if exceeded, manufacturer shall replace the complete unit at no charge to the Owner.

7. UNIT TEST

- a) Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced and tested again. Copy of the test report shall be presented at final inspection and included in

Owner's Operation and Maintenance Manual. Include starting voltage, ending voltage, and percent voltage drop in the test report. Alternate method by measuring beginning and ending foot-candle output is acceptable.

E. EMERGENCY EGRESS LUMINARE

1. GENERAL

- a) Emergency egress lighting shall be powered via one of the sources permissible under NEC Article 700. Where the selected source is unit equipment, each unit shall be completely self-contained, provided with maintenance-free battery, automatic charger, two lamps, and other features. Luminaire shall be NCBCC approved third-party listed as emergency lighting equipment, and meet or exceed the following standards: NEC, North Carolina Building Code, North Carolina Energy Conservation Code, NFPA-101, and NEMA Standards. In addition:

- (1) Provide minimum 12-volt battery if using halogen or fluorescent lamps.
- (2) Provide battery voltage as recommended by luminaire manufacturer if using LED lamps.

2. ADDITIONAL FEATURES

- a) Pilot light to indicate the unit is connected to A.C power. The battery shall have high rate charge pilot light unless self-diagnostic type. A test switch to simulate the operation of the unit upon loss of A.C power by energizing the lamps from the battery. This simulation must also exercise the transfer rely. If fluorescent emergency unit is used, an LED charging indicator light must be easily visible after installation and a remote test switch shall be installed adjacent to the fixture.

3. BATTERY

- a) It shall be sealed, maintenance-free type, with minimum of 90 minutes operating endurance. Must have a normal life expectancy of 10 years. Batteries shall be a high temperature type with an operating range of 0-degree C to 60-degrees C. Battery operated luminaires installed in cold environments, including exterior, shall have a low temperature option.

4. CHARGER

- a) It shall be fully automatic solid-state type, full wave rectifying, with current limiting. Charger shall restore the battery to its full charge within 24 hours after a discharge of 90 minutes under full rated load. The unit shall be activated when the line voltage drops below 80 percent. A low voltage disconnect switch shall be included if a lead-acid battery is used, to disconnect the battery from the load and prevent damage from a deep discharge during an extended power outage.

5. WARRANTY

- a) The entire unit shall be warranted for three years. The battery must have an additional two more years pro-rated warranty. Warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

6. UNIT TEST

- a) Contractor shall perform a test on each unit after it is permanently installed and charged for a minimum of 24 hours. Battery shall be tested for 90 minutes, in accordance with NEC 700. The battery test shall be done 10 days prior to final inspection by the State Construction Office. Any unit which fails the test must be repaired or replaced and tested again. Copy of the test report shall be presented at final inspection and included in Owner's Operation and Maintenance Manual. Include starting voltage, ending voltage, and percent voltage drop in the test report. Alternate method by measuring beginning and ending foot-candle output is acceptable.

26 56 00 SITE and EXTERIOR LIGHTING

1. Pole bases for site lighting shall be detailed on the construction documents. The Designer shall verify that the base detail is adequate to sustain wind loads for the specific project location with the specified pole and luminaire. See Typical Exterior Pole Base Detail, Page E-17 of Appendix.
2. Lighting poles more than 12 feet in height shall have an NCBC approved third-party listing. Lighting poles less than or equal to 12 feet are listed with the luminaire.
3. For outdoor pole mounted or ground mounted LED luminaires, provide minimum 10.0-KV rated surge suppression integral with the driver.
4. Splices in branch circuit wiring shall be accessible at each pole by means of a gasketed hand-hole in the pole or a junction box beside the pole.
5. Lamps for luminaries specified shall be metal halide, high pressure sodium vapor, or LED.
6. Lighting fixtures mounted outside, such as in parking deck, shall be listed for the location and be installed according to the listing. Ballast and lamp shall be cold weather rated.
7. Control of site lighting fixtures shall be by means of a common photocell and/or contactor.
8. The use of solar powered lighting may be considered for area lighting.
9. Calculations regarding point by point symmetrical and asymmetrical lighting distribution shall be provided to State Construction Office upon request.
10. Provide a ground rod 10 feet long and 3/4-inch in diameter of copper-clad steel construction for poles greater than 12 feet in height.

27 05 00 TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY

1. Please refer to the following publication issued by ITS office: STS-1000.

TELECOMMUNICATION WIRING GUIDELINES. The publication can be downloaded from the SCO website or from <https://it.nc.gov/document/sts-1000-telecommunications-wiring-guidelines>.

2. Please contact the ITS Office for questions or clarifications regarding the above document.

28 31 13 FIRE ALARM SYSTEMS

1. Refer to State Construction Office Fire Alarm Guidelines and Policies.

33 71 00 OVERHEAD POWER DISTRIBUTION

1. Bare aluminum "ACSR" conductors shall be utilized for overhead primary distribution systems (5 KV, 15 KV, or 25 KV). Conductors shall be spliced using compression fittings by use of an approved die and tool compression arrangement.
2. If using wooden poles for overhead wiring, they shall be specified as pressure treated, Southern Yellow Pine, American Standard Class 5 poles. Poles shall be designed to support 125-150 ft. spans, adequate to sustain wind loads that meet or exceed NCSBC for the specific project location and a load in addition created by 1/2 inch of ice on the wire.
 - a) Cross arms shall be specified as untreated, straight-grain fir, or similar as approved by the State Construction Office. Dimensions shall be as recommended by the Edison Electric Institute Standards. The arms shall have spacing between center pins of 30 inches. Braces shall be made from galvanized flat iron.
3. Guywires shall not be less than 3/8-inch stranded galvanized cable, with appropriate galvanized steel hardware. They shall be heavy enough to sustain wind loads that meet or exceed NCSBC for the specific project location along with typical worst-case weather conditions appropriate for the area. Two (2) strain insulators shall be inserted in each guy-one six (6) feet from the pole itself, and the other six (6) feet from the lower end of the guy and at least eight (8) feet from the ground.
4. Insulators shall be made of porcelain with wire grooves on top and sides.

APPENDIX

Minimum Standards for Residential Projects (see note below)			
COMPONENTS	BASE	POSSIBLE UPGRADE	NOTES
Telecom & Low-voltage wiring	Plenum rated wiring		Where plenum ceiling exists only, supported in accordance w/ NEC
Electrical Wiring	MC Cable, up to #12 AWG Solid copper w/ ground	EMT	Must use EMT in all common use areas
Fire Alarm	Plenum rated wiring	Red MC Cable	Can use as specified in University Guidelines
Service Feeders	Aluminum Feeders > #1 AWG	Copper	
Main Distribution Panel	Load-center Panels	Copper Bus, Bolt-on Breakers	
Transformers	Aluminum Feeders	Copper	
Note: Apply only to privately funded projects such as Foundation projects and single-family dwellings such as Chancellors' residences and Park Rangers residences.			

Electrical Guidelines and Policies - 2020

COST ANALYSIS	Fixture Description	Fluorescent T8 (base option)	Fluorescent T8 (option #1)	Fluorescent T5 (option #2)	Fluorescent T5 HO (option #3)	LED (option #4)	LED (option #5)	Others (option #6)
	Lamp Watts	32	25	28	30	28	54	
	No. of Lamps/Fixture							
	Lamp life (hrs) 3hrs/start	24,000						
	Lamp Replacement cycle (year)	5						
	Ballast Type	Electronic Program Start						
	No. of Ballasts/Fixture	2	2	2	2	2	2	
	Ballast/Driver Power Input	81						
	Ballast Factor	0.88						
	Ballast Life (hrs.)	50,000						
	Ballast/Driver Replacement Cycle (year)	17						
	Total Number of Fixtures	100						
	Lumens/Fixture	5,920						
	Watts/sf							
	Area (sf)							
	Initial Fixture Cost (each)							
	Initial Installation Cost							
Capital Cost	Total Installed Fixture Cost							
Repair Replacement Cost	Lamp Replacement Cost							
Repair Replacement Cost	Ballast Replacement Cost							
	Utility Energy Charge/kwhr							
	Annual kwhr							
Energy Cost	Annual Energy Cost							
	Special Design Consideration		Lighting Sensor	Lighting Sensor	Lighting Sensor	Lighting Sensor	Lighting Sensor	Lighting Sensor
Maintenance Cost								

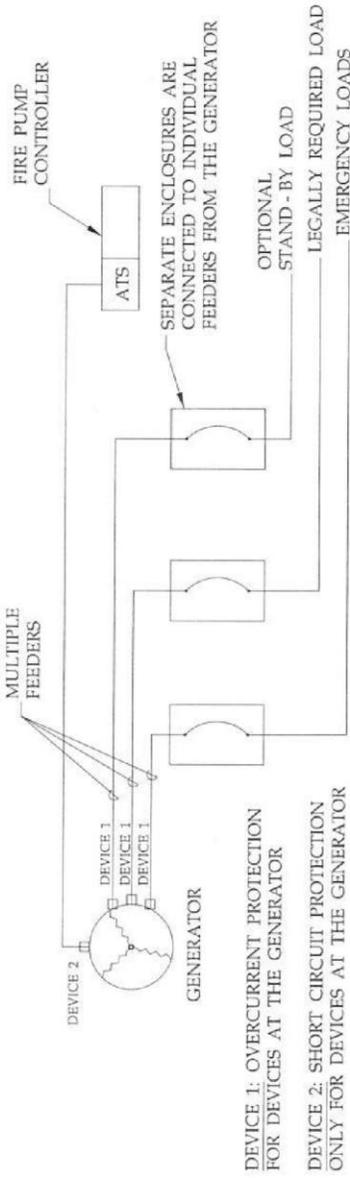
Notes:

1. Minimum of two options shall be selected to be evaluated against the base option.
2. Fluorescent fixtures shall be provided with the inboard/outboard feature for multi level switching.
3. No. of hrs per day 8 and no. of days per year 365= 2920 hrs/year. (Hrs can change per project scope of work.)
4. lamp replacement shall be @ 60% of lamp life
5. The fixture selected shall show ranking above unity in the SIR sheet.

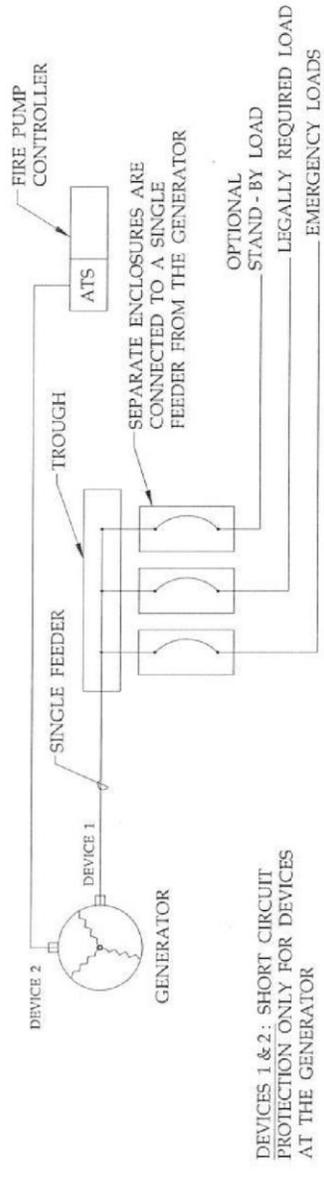
6. The above listed options (option #1 to option #6) are only recommendation. Designers shall select fixtures adequate for the project scope of work.

Lighting Life Cycle Cost Analysis (LCCA)					
REVISIONS:	DRAWN BY: FPW CHKD: BD	DATE: 10/6/2020	NC DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2827	PROJECT NO.:	SHEET NO.: E-00

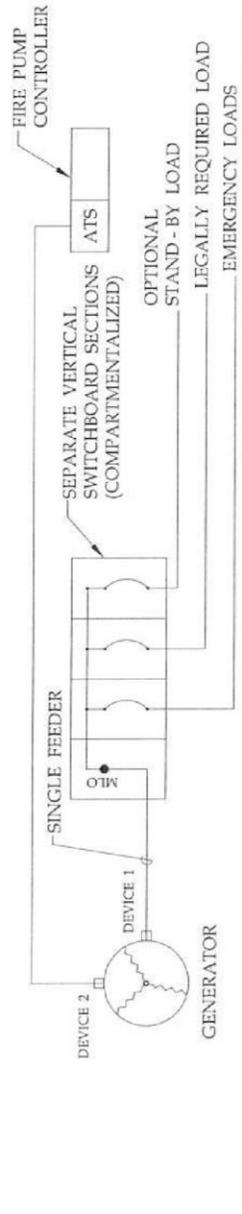
SEPARATE FEEDERS



SINGLE FEEDER TO A TROUGH

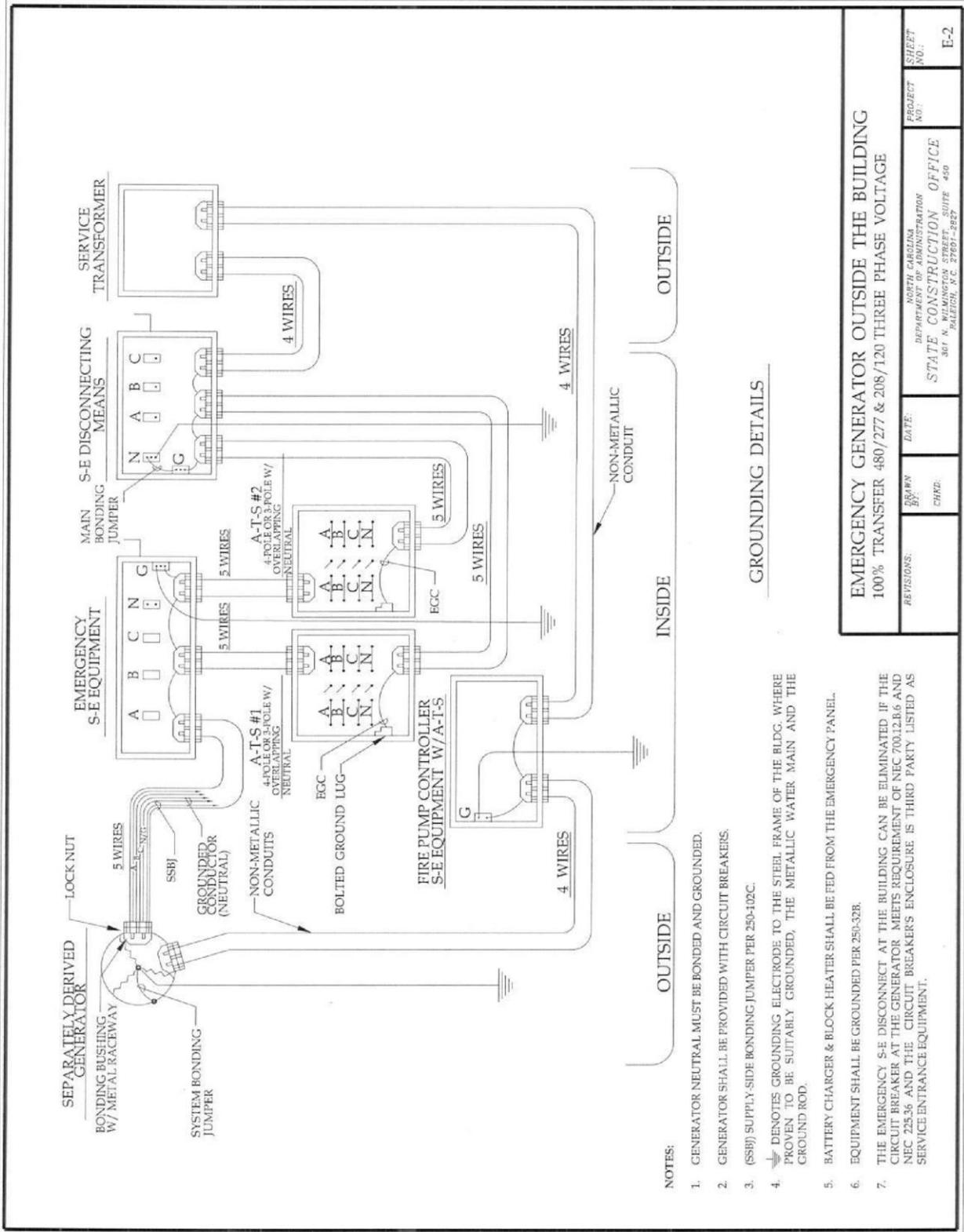


SINGLE FEEDER TO COMPARTMENTAL PANEL



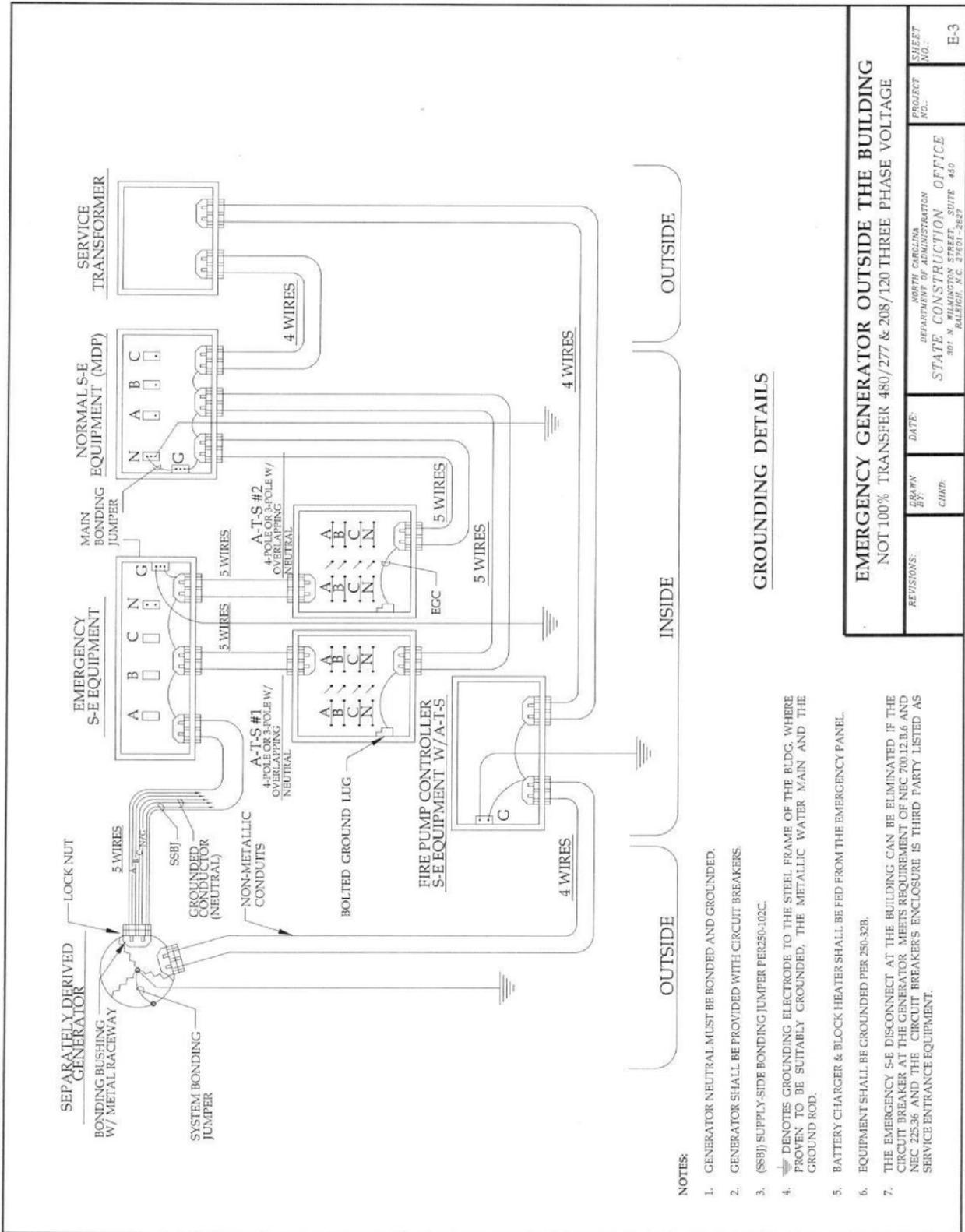
GENERATOR SYSTEM WIRING

REVISIONS:	DRAWN BY: CHAD	DATE:	NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. RALEIGH, N.C. 27601-3827	PROJECT NO.:	SHEET NO.:
					E-1



- NOTES:
1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
 2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
 3. (SSB) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
 4. ⚡ DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
 5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
 6. EQUIPMENT SHALL BE GROUNDED PER 250-32B.
 7. THE EMERGENCY S-E DISCONNECT AT THE BUILDING CAN BE ELIMINATED IF THE CIRCUIT BREAKER AT THE GENERATOR MEETS REQUIREMENT OF NEC 700.12.B.6 AND NEC 225.36 AND THE CIRCUIT BREAKER'S ENCLOSURE IS THIRD PARTY LISTED AS SERVICE ENTRANCE EQUIPMENT.

EMERGENCY GENERATOR OUTSIDE THE BUILDING		PROJECT NO.:	SHEET NO.:
100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE		DATE:	E-2
DRAWN BY:	CHD:	NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 361 N. WILMINGTON STREET, SUITE 450 RALEIGH, NC 27601-2887	
REVISIONS:			

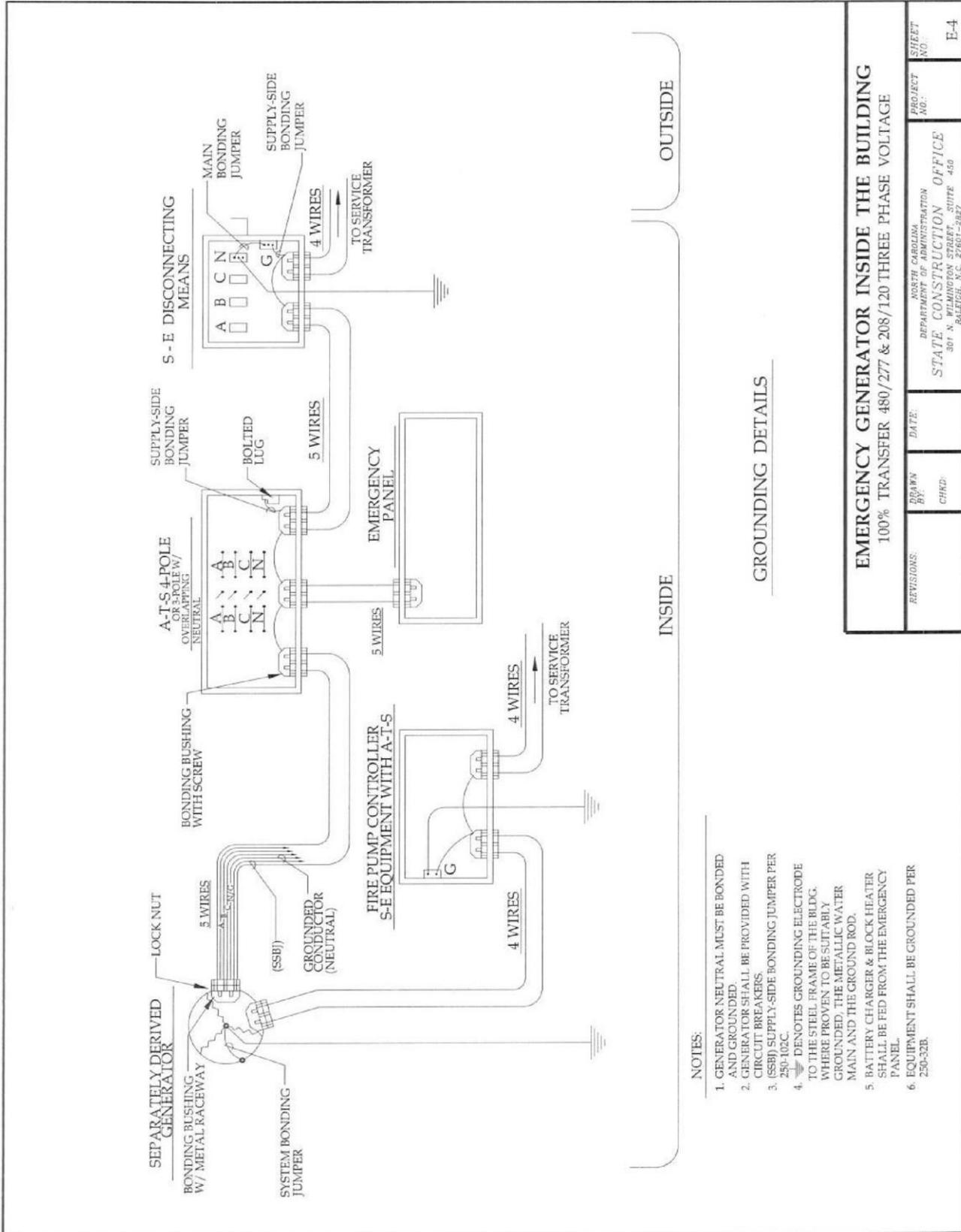


GROUNDING DETAILS

- NOTES:**
1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
 2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
 3. (SSBF) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
 4. DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
 5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
 6. EQUIPMENT SHALL BE GROUNDED PER 250-32B.
 7. THE EMERGENCY S-E DISCONNECT AT THE BUILDING CAN BE ELIMINATED IF THE CIRCUIT BREAKER AT THE GENERATOR MEETS REQUIREMENT OF NEC 700.12.B.6 AND NEC 225-36 AND THE CIRCUIT BREAKER'S ENCLOSURE IS THIRD PARTY LISTED AS SERVICE ENTRANCE EQUIPMENT.

EMERGENCY GENERATOR OUTSIDE THE BUILDING
 NOT 100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHAD:		STATE CONSTRUCTION OFFICE	E-3
			307 N. BALFOUR, A.C. 27601-2827	
			DEPARTMENT OF TRANSPORTATION	
			NORTH CAROLINA	

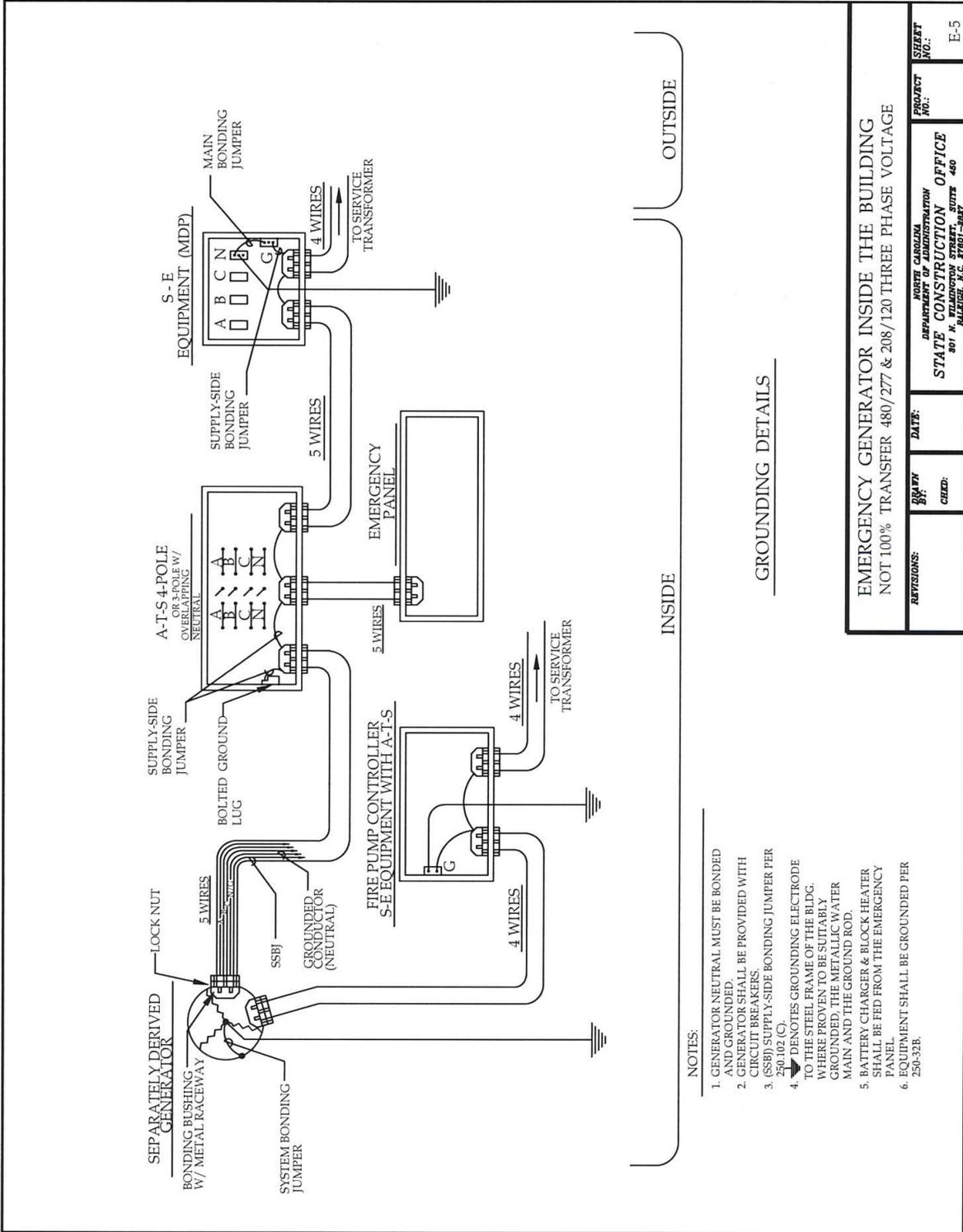


GROUNDING DETAILS

- NOTES:
1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
 2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
 3. (SSBJ) SUPPLY-SIDE BONDING JUMPER PER 250-102C.
 4. ⚡ DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
 5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
 6. EQUIPMENT SHALL BE GROUNDED PER 250-32B.

EMERGENCY GENERATOR INSIDE THE BUILDING
100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHD:		NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, NC 27601-2827	E-4



GROUNDING DETAILS

NOTES:

1. GENERATOR NEUTRAL MUST BE BONDED AND GROUNDED.
2. GENERATOR SHALL BE PROVIDED WITH CIRCUIT BREAKERS.
3. (SSBJ) SUPPLY-SIDE BONDING JUMPER PER 250.102 (C).
4. ⚡ DENOTES GROUNDING ELECTRODE TO THE STEEL FRAME OF THE BLDG. WHERE PROVEN TO BE SUITABLY GROUNDED, THE METALLIC WATER MAIN AND THE GROUND ROD.
5. BATTERY CHARGER & BLOCK HEATER SHALL BE FED FROM THE EMERGENCY PANEL.
6. EQUIPMENT SHALL BE GROUNDED PER 250-32E.

EMERGENCY GENERATOR INSIDE THE BUILDING
NOT 100% TRANSFER 480/277 & 208/120 THREE PHASE VOLTAGE

REVISIONS:	BY:	DATE:	STATE CONSTRUCTION OFFICE DEPARTMENT OF ADMINISTRATION 801 N. WALNUT STREET, SUITE 400 RALEIGH, N.C. 27601-9877	PROJECT NO.:	SEEST NO.:
	CD:				E-5

LOAD		DESIGNATION TYPED ON DIRECTORY	COND. GRND. (")	WIRE SIZE	BRKR. RATG. NO.	S/N	CKT. NO.	BRKR. RATG. SIZE	WIRE GRND. COND. (")	DESIGNATION TYPED ON DIRECTORY	LOAD			
KVA	OR										KW	A	B	C
1.8		LIGHTING - ROOM #	1/2"	12	20	1	2	20	1/2"	RECEPTACLE	2.0			
	1.8	LIGHTING - ROOM #	1/2"	12	20	3	4	20	1/2"	RECEPTACLE		2.0		
	2.0	SPARE			20	5	6	20	1/2"	RECEPTACLE			2.0	
7.8		TRAY WASH <3>P	1"	10	40	9	8			SPACE ONLY				
	7.8					11	10			SPACE ONLY				
7.8		TRAY WASH <3>P	1"	10	40	15	14			SPACE ONLY				
	7.8					17	16	4	1"	BOOSTER HEATER <3>H	15.0		15.0	
3.2		TRANSFORMER T	1/2"	10	25	21	20			PACKAGE AIR COND. PAC-1	4.2			
	3.4					23	22	20	1/2"			4.2		
											TOTAL RIGHT	21.2	21.2	21.2
											TOTAL LEFT	20.6	20.8	21
											TOTAL	41.8	42	42.2

PANEL TYPE: LIGHTING & APPLIANCE
 SERVICE SUPPLY: 277/480 VOLT, 3-PHASE, 4-WIRE
 BUSES/NEUTRAL: 250A
 MAINS: 250A MAIN BREAKER @ BOTTOM
 FEEDER: SEE "POWER RISER DIAGRAM"
 PROVIDE COPPER GROUND BUS
 PANEL SHALL BE RATED 25,000 AIC (INTEGRATED EQUIP. RATING)
 SPECIAL FEATURES:
 MAIN BREAKER SHALL BE CURRENT - LIMITING.

CONNECTED LOAD (KVA)	DF	DEMAND LOAD
LIGHTING = 3.4 *	100 %	= 3.4
HVAC = -- *	-- %	= --
HVAC (COOLING) = 12.6 *	100 %	= 12.6
HVAC (HEATING) = -- *	-- %	= --
LARGE MOTORS = -- *	-- %	= --
KITCHEN EQUIPMENT = 95 *	100 %	= 95
RECEPTACLES = 20 *	75 %	= 15
MISCELLANEOUS = -- *	-- %	= --
TOTALS = 131 *	%	= 126

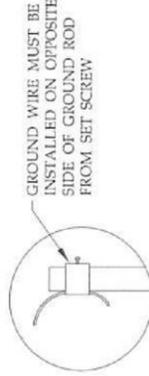
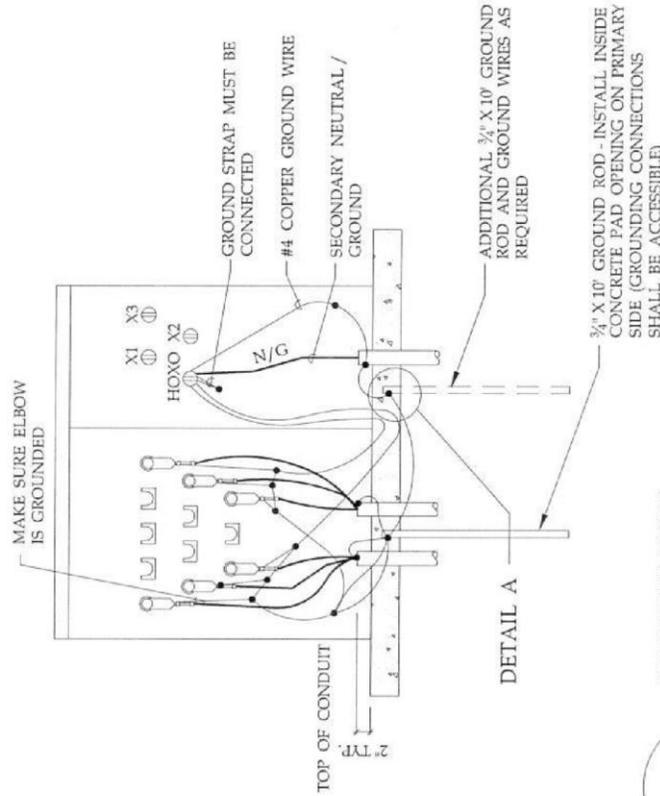
GROSS PHASE TOTALS (KVA) A=41.8 B=42 C=42.2
 * FIGURES ARE REPRESENTATIVE ONLY.

TYPICAL PANELBOARD SCHEDULE

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:
			NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2967
	CHKD:		SHEET NO. E-6

NOTES:

1. THE PRIMARY NEUTRAL CONDUCTOR MUST BE BONDED CONTINUOUSLY TO THE PRIMARY CONDUIT (IF METALLIC), THE GROUND ROD, THE TRANSFORMER TANK GROUND PAD IN THE PRIMARY COMPARTMENT, AND THE HO/XO NEUTRAL BUSHING. THIS STEP SHALL BE REPEATED IF LOOP FEED TRANSFORMER.
2. THE STRESS CONES AND THE PRIMARY CABLE SHIELD MUST BE GROUNDED TO THE NEUTRAL CONDUCTOR. THIS STEP SHALL BE REPEATED IF LOOP FEED TRANSFORMER.
3. A #4 COPPER GROUND WIRE IS TO BE BONDED TO THE HO/XO BUSHING, TO THE GROUND PAD IN THE SECONDARY COMPARTMENT, TO THE SECONDARY CONDUIT (IF METALLIC), AND TO THE GROUND ROD.
4. GROUND STRAP MUST CONNECT THE HO/XO BUSHING TO THE TRANSFORMER TANK.
5. A SUITABLE FLEXIBLE #6 COPPER ARRESTER LEAD SHALL BE INSTALLED FROM EACH ARRESTER DIRECTLY TO THE GROUND ROD (NOT SHOWN).
6. THE PRIMARY & SECONDARY CONDUITS SHALL EXTEND TWO INCHES ABOVE THE CONCRETE PAD.
7. IF THE RESISTANCE OF THE GROUND ROD EXCEEDS 25 OHMS, INSTALL AN ADDITIONAL GROUND ROD AT LEAST 10' AWAY. INTER-CONNECT THE TWO USING #4 COPPER GROUND WIRE.
8. COMPLETE INSTALLATION MUST BE IN COMPLIANCE WITH THE NATIONAL ELECTRICAL SAFETY CODE, ANSI C2.



DETAIL A - 3/4" GRND. ROD
NO SCALE

TYPICAL GROUNDING DETAILS FOR THREE PHASE TRANSFORMERS

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHKD:		STATE CONSTRUCTION OFFICE	E-7
			301 N. WILMINGTON STREET, SUITE 450	
			RALEIGH, N.C. 27601-2827	

LOAD TABULATION									
LOADS IN KVA	EXIST. DEMAND		NEW CONNECTED		DIVERSITY FACTOR	NEW DEMAND		TOTAL KVA EXISTING AND NEW DEMAND	
	SINGLE PHASE	THREE PHASE	SINGLE PHASE	THREE PHASE		SINGLE PHASE	THREE PHASE	EXISTING	NEW DEMAND
LIGHTING									
AIR CONDITIONING									
HEATING									
LARGE MOTORS									
VENTILATION									
KITCHEN EQUIPMENT									
RECEPTACLES									
EMERGENCY									
MISCELLANEOUS									
FUTURE ALLOWANCE									
TOTAL									

* SEE NEC 220 FOR MORE INFORMATION

LOAD TABULATION BREAKDOWN	
REVISIONS:	DATE:
DRAWN BY:	PROJECT NO.:
CHECKED:	STATE CONSTRUCTION OFFICE 301 N. RALEIGH ST. SUITE 450 RALEIGH, N.C. 27601-2842
	SHEET NO. E-8

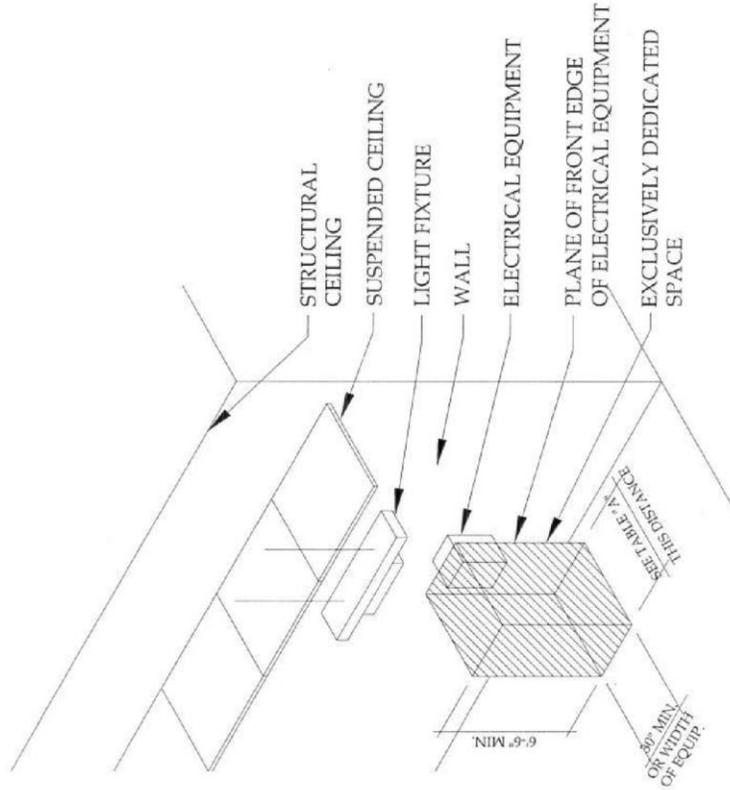
VOLTAGE TO GROUND NOMINAL	MINIMUM CLEAR DISTANCE (FEET)		
	CONDITION 1	2	3
0 - 150	3	3	3
151 - 600	3	3½	4

WHERE THE "CONDITIONS" ARE AS FOLLOWS:

1. EXPOSED LIVE PARTS ON ONE SIDE AND NO LIVE OR GROUNDED PARTS ON THE OTHER SIDE OF THE WORKING SPACE, OR EXPOSED LIVE PARTS ON BOTH SIDES EFFECTIVELY GUARDED BY SUITABLE WOOD OR OTHER INSULATING MATERIALS. INSULATED WIRE OR INSULATED BUSBARS OPERATING AT NOT OVER 300V SHALL NOT BE CONSIDERED LIVE PARTS.
2. EXPOSED LIVE PARTS ON ONE SIDE AND GROUNDED PARTS ON THE OTHER SIDE.
3. EXPOSED LIVE PARTS ON BOTH SIDES OF THE WORK SPACE (NOT GUARDED AS PROVIDED IN CONDITION 1) WITH THE OPERATOR BETWEEN.

NOTE:

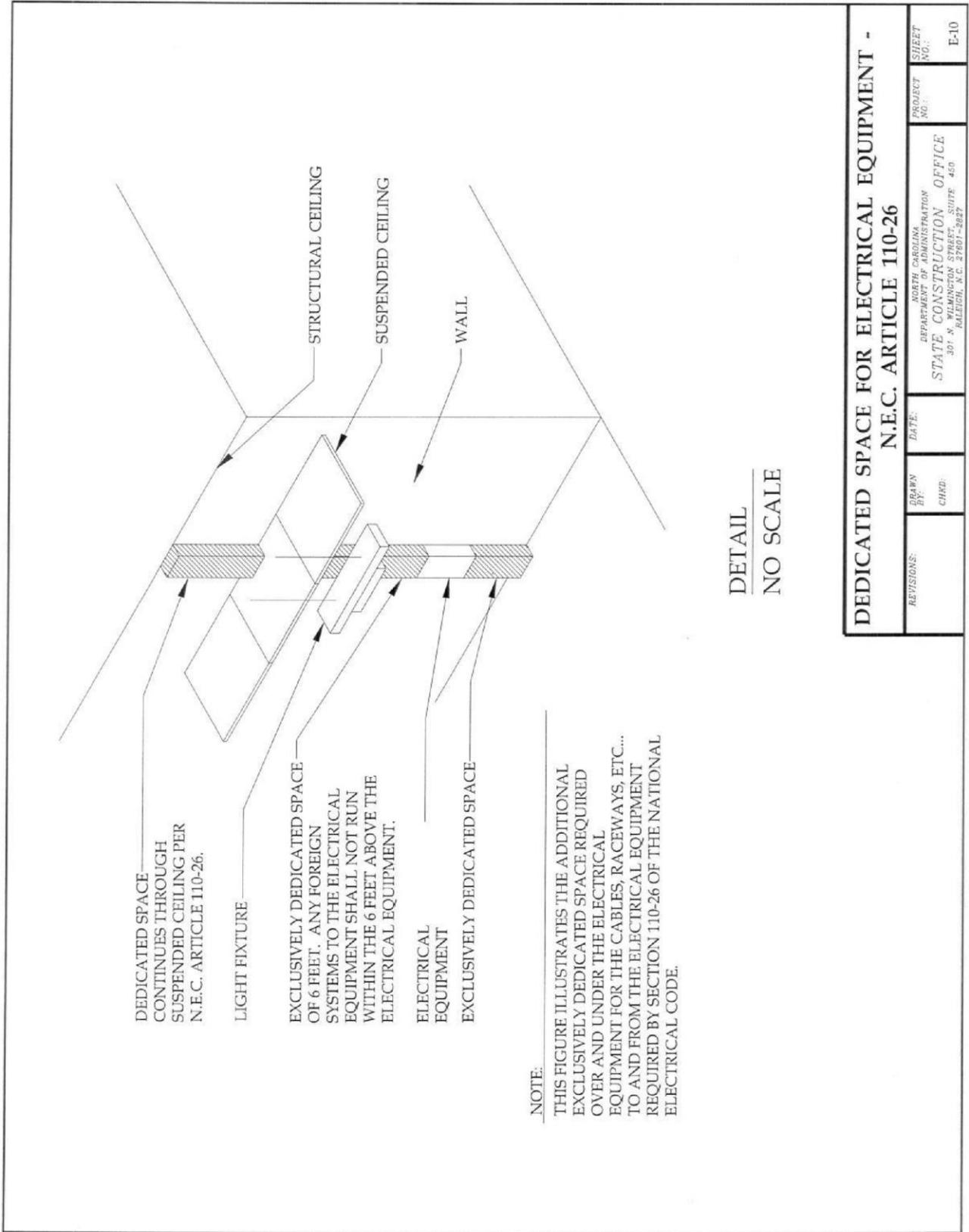
THIS FIGURE ILLUSTRATES THE WORKING SPACE IN FRONT OF THE ELECTRICAL EQUIPMENT REQUIRED BY SECTION 110-26 OF THE NATIONAL ELECTRICAL CODE.



DETAIL
NO SCALE

**WORKING CLEARANCE FOR ELECTRICAL
N.E.C. ARTICLE 110-26 EQUIPMENT-**

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHKD:		NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2827	E-9



**DEDICATED SPACE FOR ELECTRICAL EQUIPMENT -
N.E.C. ARTICLE 110-26**

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHD:		STATE CONSTRUCTION OFFICE	E-10
			NORTH CAROLINA DEPARTMENT OF ADMINISTRATION 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2827	

REPORT OF PRIMARY VOLTAGE CABLE TESTING

PROJECT ID#: _____

INSTITUTION: _____

DATE OF CABLE INSTALLATION: _____

DATE OF ENERGIZATION: _____

MANUFACTURER: _____

VOLTAGE RATING: _____

OPERATING RATING: _____

CONDUCTIVITY (AWG OR KCM): _____

INSULATION EPR: YES() NO()

CONDUCTOR MATERIAL: COPPER: _____

STRAND SHEILDING: TAPE: _____ EXTRUDED: _____

CONDUCTOR SHIELDING: TAPE: _____ EXTRUDED: _____

METALLIC SHIELDING: COPPER TAPE: _____

HIGH - POTENTIAL TESTING: OPERATING VOLTAGE (5 15 25)
KV
TEST VOLTAGE dcKV (27 48 75)

ELECTRICAL EQUIPMENT INSULATION RESISTANCE TEST - M OHM	NORMAL OPERATING VOLTAGE V	TEST VOLTAGE V dc
100	5001 - 13,000	2500
300	ABOVE 13,000	2500

CIRCUIT PROTECTED BY LIGHTNING ARRESTORS: YES: _____ NO: _____

COMMENTS: _____

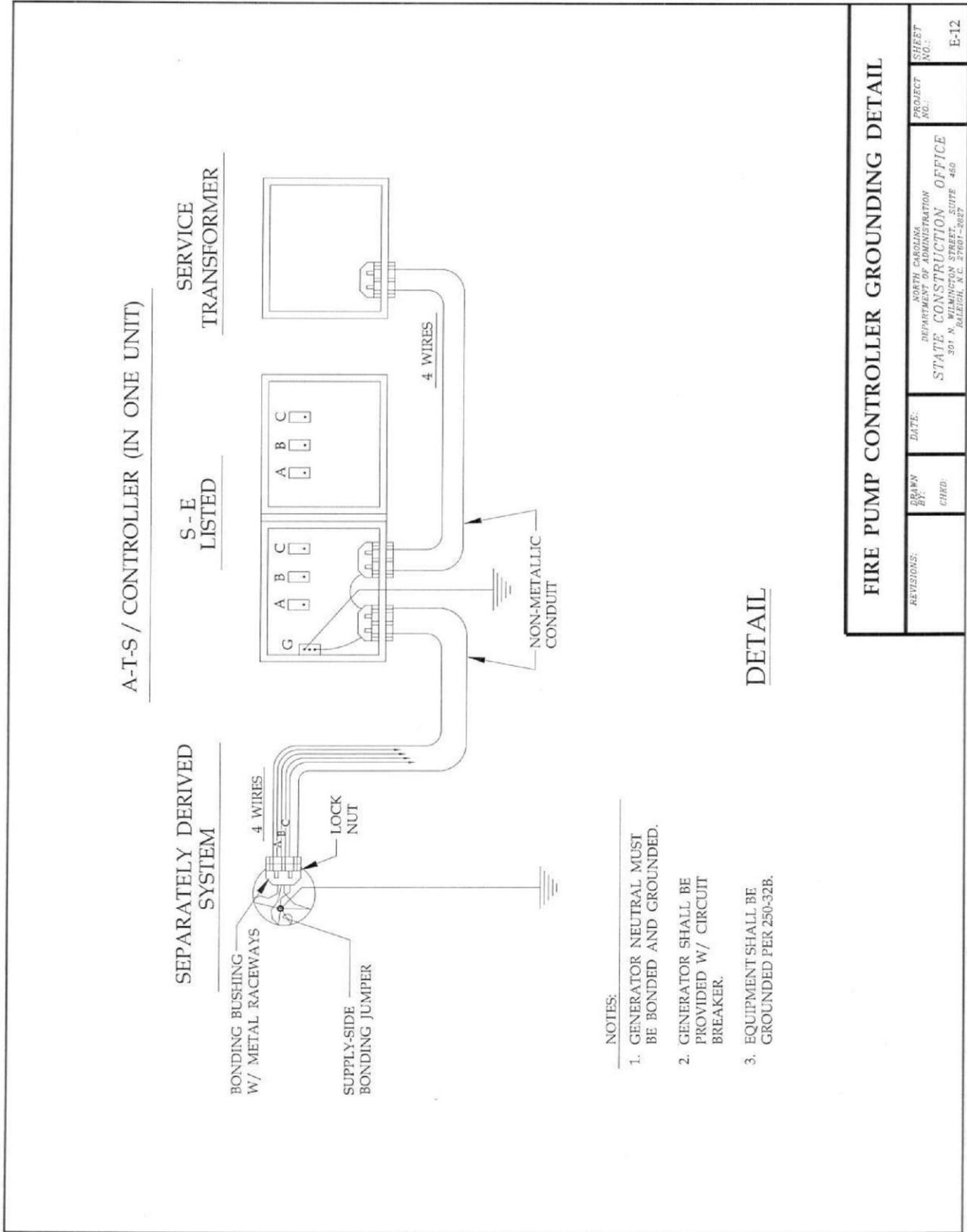
ENGINEER'S SIGNATURE: _____

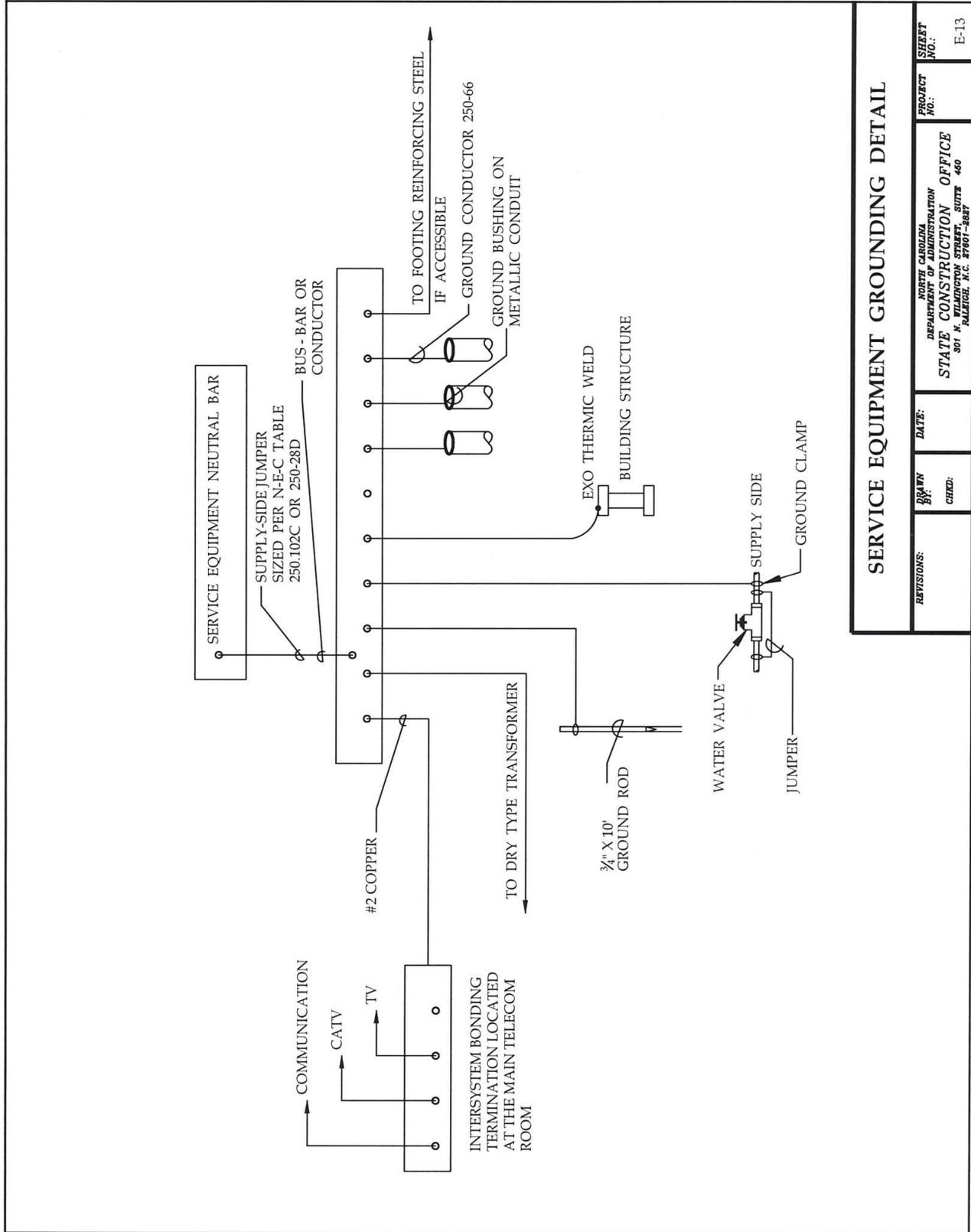
TESTING COMPANY: _____

CONTRACTOR'S LICENSE #: _____

MEDIUM VOLTAGE CABLE TEST REPORT FOR 5 KV, 15 KV, AND 25 KV

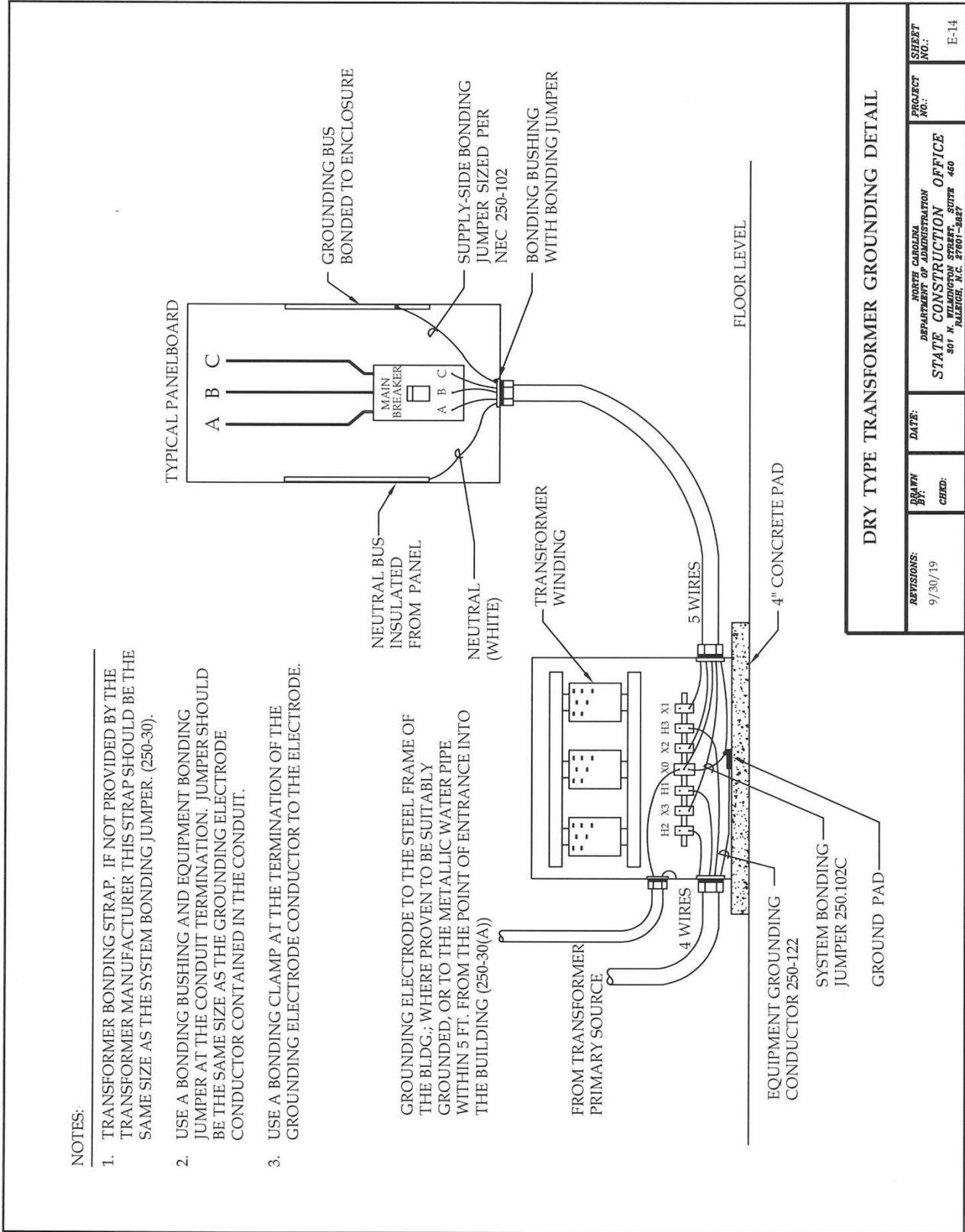
REVISIONS:	DRAWN BY:	DATE:	SHEET NO.:
	CHKD:		E-11
NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2827			





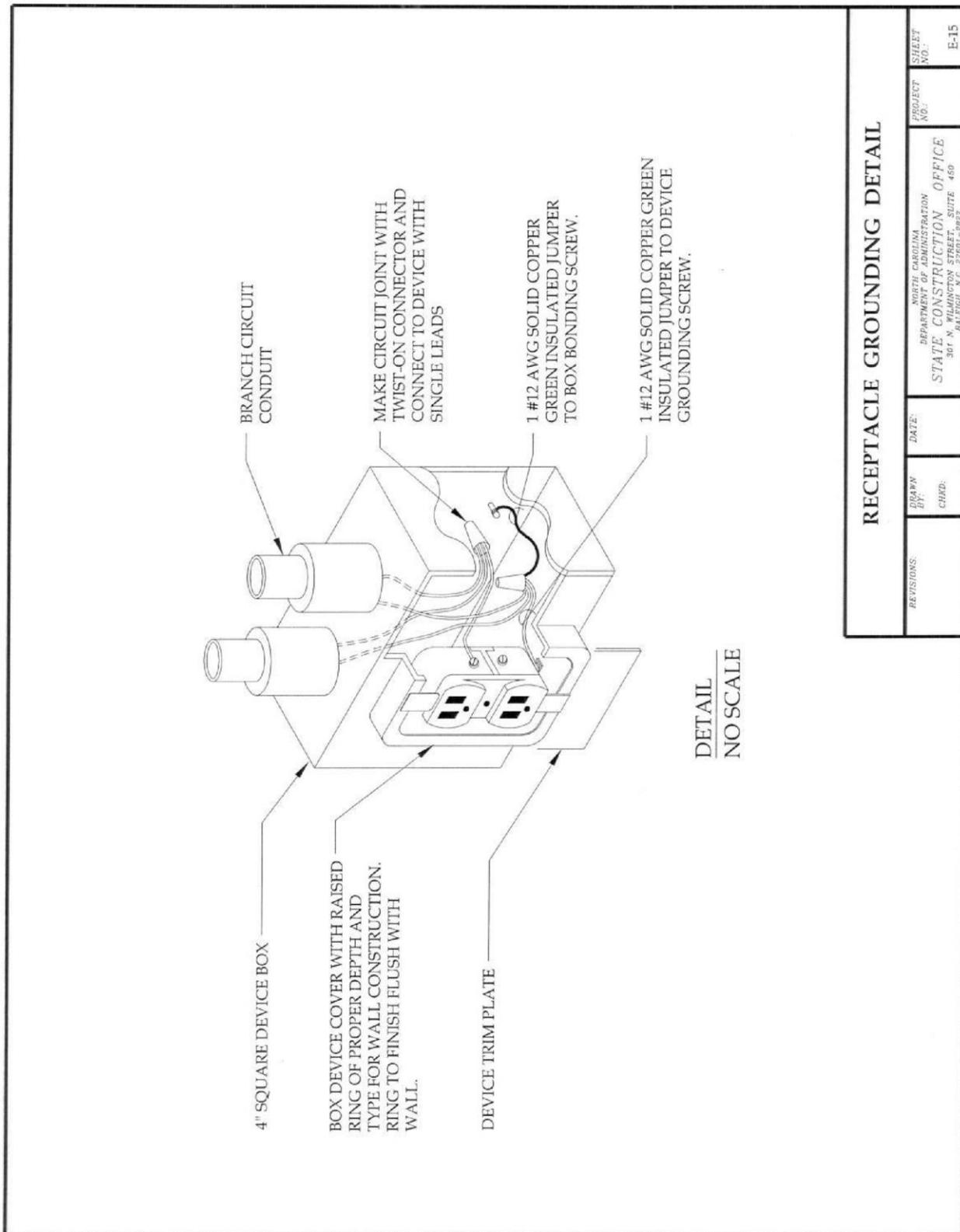
SERVICE EQUIPMENT GROUNDING DETAIL

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHECKED:		STATE CONSTRUCTION OFFICE	E-13
			301 N. RALPH WALKER BLVD., SUITE 400	
			RALEIGH, N.C. 27607-2887	



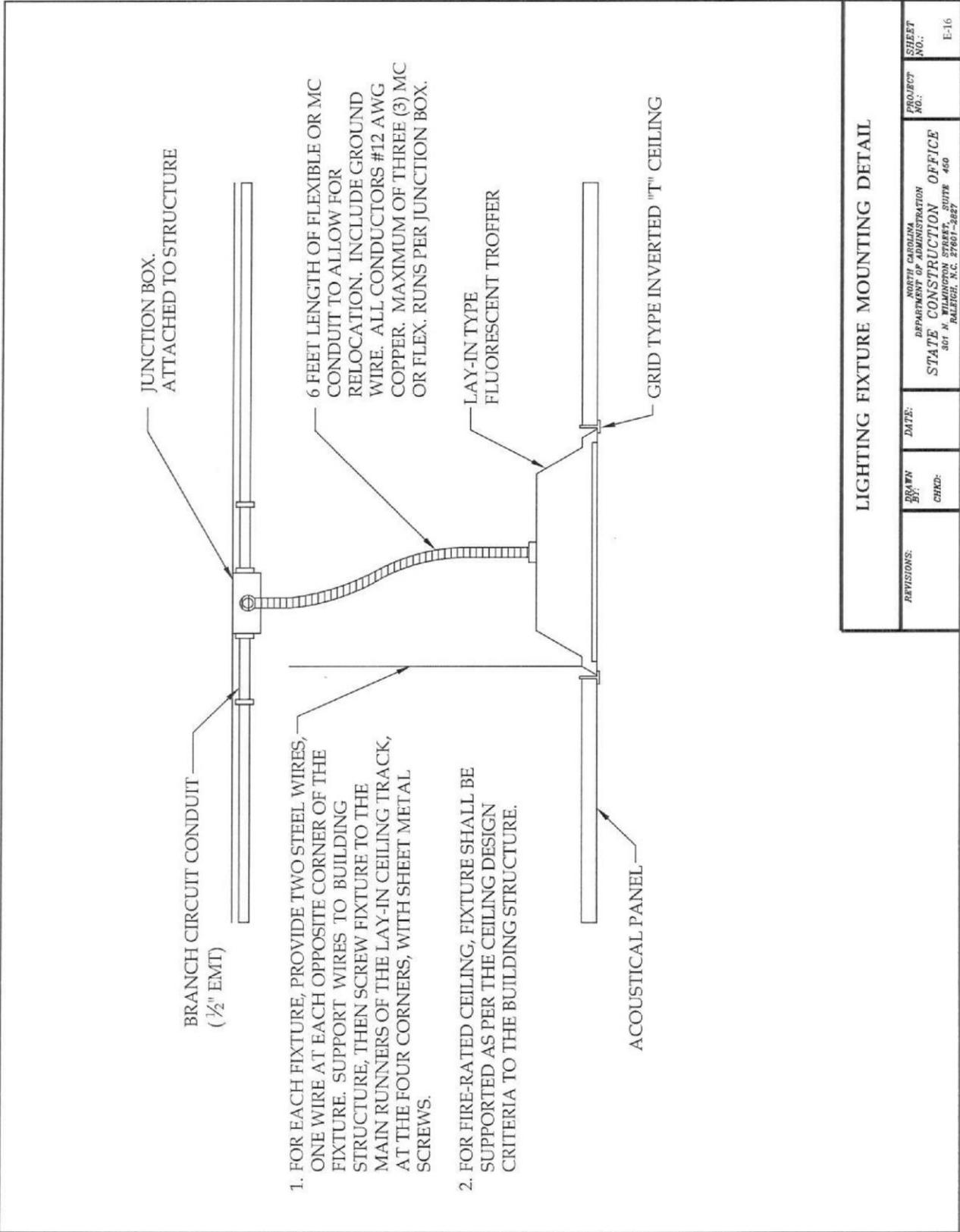
REVISIONS:		DATE:	PROJECT NO.:	SHEET NO.:
9/30/19				E-14
NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 460 RALEIGH, N.C. 27601-9887				

DRY TYPE TRANSFORMER GROUNDING DETAIL



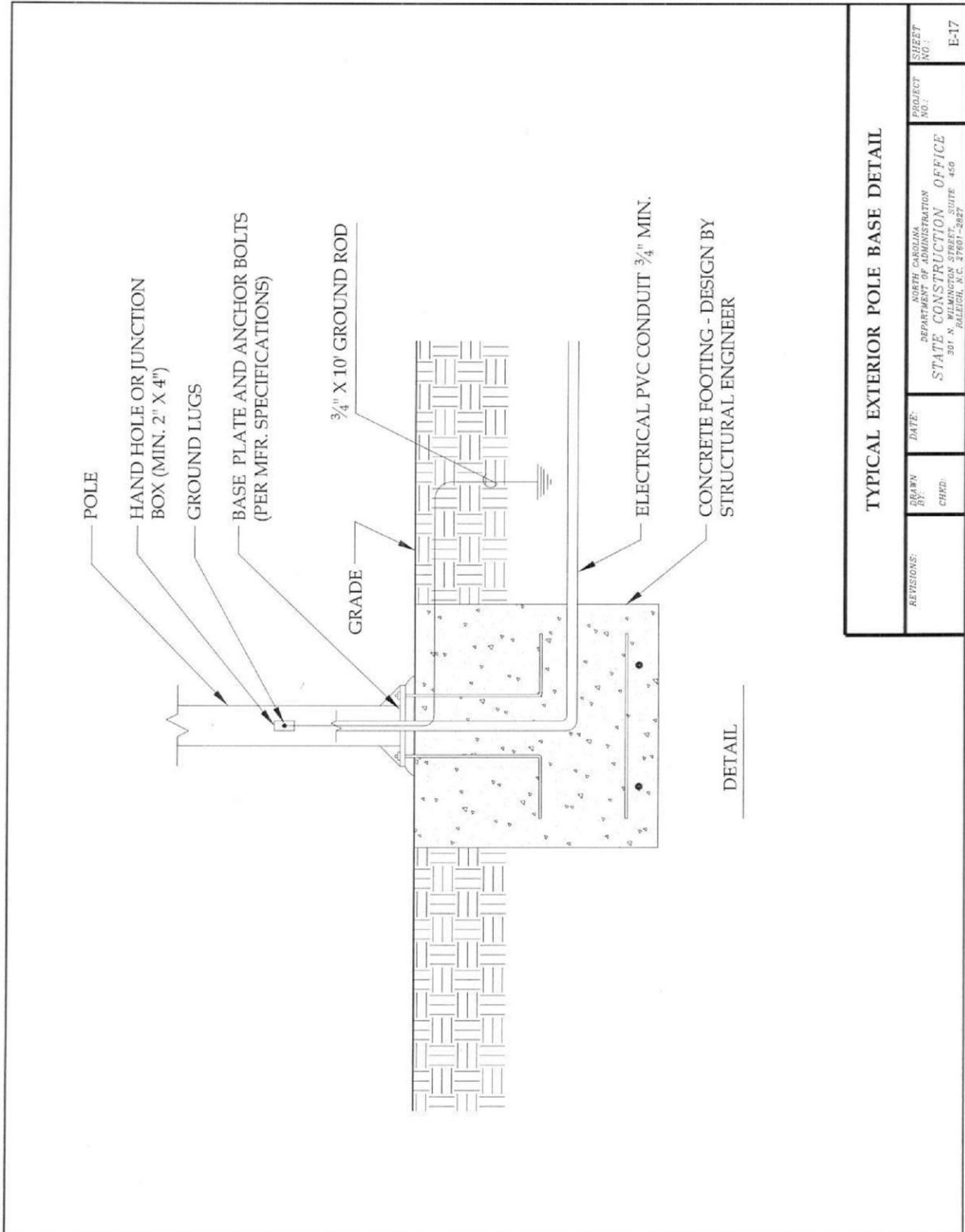
RECEPTACLE GROUNDING DETAIL

REVISIONS:	DRAWN BY:	DATE:	SHEET NO.:
	CHKD:		E-15
NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 400 WALENHIGH, N.C. 27701-3927			



LIGHTING FIXTURE MOUNTING DETAIL

REVISIONS:	DRAWN BY: CHAD:	DATE:	STATE CAPITAL DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. RALEIGH, N.C. 27601-2827	PROJECT NO.:	SHEET NO.:
					E-16



TYPICAL EXTERIOR POLE BASE DETAIL

REVISIONS:	DRAWN BY:	DATE:	PROJECT NO.:	SHEET NO.:
	CHKD.:		NORTH CAROLINA DEPARTMENT OF ADMINISTRATION STATE CONSTRUCTION OFFICE 301 N. WILMINGTON STREET, SUITE 450 RALEIGH, N.C. 27601-2827	E-17

