



Electrical Guidelines and Policies

2026

This document replaces the 2020 SCO Electrical Guidelines and Policies in its entirety.

The design criteria within these guidelines and policies are established to aid the Design Engineer during design development and specification writing. Contents herein are not to be included in Design Engineer'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 Design Engineer's part.

Projects (SD, DD, and associated CD documents) submitted by June 30, 2026, will continue to be reviewed per the 2020 SCO Electrical Guidelines and Policies unless the Design Engineer requests review per the 2026 SCO Electrical Guidelines and Policies. The intent is that projects which begin their review prior to June 30, 2026, will continue being reviewed per the 2020 SCO Electrical Guidelines and Policies.

However, these 2026 Electrical Guidelines and Policies become effective for all CD submittals received July 1, 2026, and after.

LIST OF SIGNIFICANT REVISIONS FROM 2020 ELECTRICAL GUIDELINES & POLICIES

Electrical Guidelines and Policies - 2026

Section or Appendix	Revision
All	Consistency – substitute “Design Engineer” for “Designer” - differentiate “Electrical Discipline Engineer of Record” from other discipline Engineer of Record - substitute “SCO Design Review Electrical Section” for “SCO”
26 01 00	- Added SCO Field Electrical Inspection Schedule Restriction - Added criterion from 21 NCAC 56.1103 - Edited selective coordination applications to align with NEC
26 05 00	Alterations/Demolition existing luminaires containing mercury and/or PCBs
26 05 43	Directional boring acceptability
26 05 53	Revised identification for NEC Art 701 Legally Required Standby and Art 702 Optional Standby Systems
26 08 00	- New Part B EQUIPMENT INSULATION TESTS for motors \geq 10 Hp - Added commissioning of <i>Interconnected On-Site Electrical Power Production Systems</i>
26 12 19	Monitoring gauges and drain valve shall be located in a separate compartment from the high and low voltage compartments
26 24 13	Added arc-flash hazard labeling
26 24 16	Added arc-flash hazard labeling
26 24 19	Added arc-flash hazard labeling
26 25 55	New Section “POWER FOR MARINAS, FLOATING DOCKS, AND PIERS”
26 51 00	- Recessed downlights accessibility in fixed/rigid ceilings - Require remote drivers ceilings > 12 feet and \leq 6” cans - Prohibit new fluorescent lighting installations
26 77 05	New Section “INTERCONNECTED ON-SITE ELECTRICAL POWER PRODUCTION SYSTEMS”
27 05 00	Adoption of ANSI/TIA-607-E <i>Telecommunications Bonding and Grounding for Customer Premises</i>
28 31 13	Mandate fire alarm system in all state-owned buildings
Details	- Deleted LIGHTING LIFE CYCLE COST ANALYSIS (LCCA) and REPORT OF PRIMARY VOLTAGE CABLE TESTING (STANDARD FORM) - Miscellaneous edits to current NEC Article and Table
Appendix	Added “GENERATOR LOAD MATRIX”
Appendix	Added “BENEFICIAL OCCUPANCY REQUIRED ELECTRICAL SYSTEM PROJECT RECORD DOCUMENTATION” to summarize record documentation which 2020 SCO Electrical Guidelines and Policies had previously referenced only within individual sections

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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” (e.g. non-SCO Oversight) 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 State Construction Manual.
2. The Design Engineer remains responsible for coordinating with the Owner for any Owner specific or special requirements.

26 00 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)

- 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 SCO Field Electrical Inspector; for state- owned projects, and to notify the local inspectors; for community college & county owned buildings, to schedule required inspections. For State owned projects, schedule electrical inspections with the SCO Field Electrical Inspector for Monday through Friday.
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 Manual. Adherence to these publications is expected. Please see State Construction Manual, Table 500 for the non-appropriated funds projects.
3. For project review submittals to the SCO office, all documents inclusive of electrical drawings and specifications shall be sealed by the Electrical Discipline 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 address and firm license number on each sheet of engineering drawings and the cover sheet of the engineering specifications 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. Similarly, symbols used within fire alarm and life safety drawings shall be based on those defined in NFPA 170 *Standard for Fire Safety and Emergency Symbols*.
5. On the electrical drawings, the Design Engineer 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 at N.C. General Statute 133-3 (Specifications to Carry Competitive Items, Substitution of Materials) for strict adherence thereto (for all equipment where available). A memorandum named *GS133-3 COMPLIANCE PROCEDURE* addressing this statutory requirement may be found at the SCO website www.doa.nc.gov/divisions/state-construction-office under *STATE CONSTRUCTION FORMS AND DOCUMENTS/DESIGN REVIEW* inclusive of acceptable procedure for establishing Owner Preferred Bid Alternates.
7. The Design Engineer shall provide selectively coordinated short-circuit protection where required by NEC. It is the Design Engineer's responsibility to ensure the system is fully coordinated and properly protected against short circuits, 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 NEC required performance for projects such as those involving Emergency Systems (Article 700), Legally Required Systems (Article 701), 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 Electrical Discipline Design 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 published list of Suitable Qualified Testing Laboratories as approved 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 OSFM web site <https://ncosfm.gov/third-party-testing-agencies> . The following or equivalent wording shall be included within the project documents wherever 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 Conservation Code, the Design Engineer shall include North Carolina Building Code Summary 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 Design Engineer may use North Carolina COMcheck or equivalent software to meet documentation requirements on the construction documents submittal, signed and dated by the Electrical Discipline Design 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 Electrical Discipline Design Engineer of Record with a copy also provided to the Owner.

11. The Electrical Discipline Design Engineer of Record shall coordinate with the Mechanical Discipline Design Engineer of Record for all projects involving equipment with non-linear characteristics such as but not limited to variable frequency controllers. The Electrical Discipline Design Engineer of Record 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 North Carolina Electrical Code as adopted by the North Carolina Building Code Council, referenced standards, including those of the Owner/Agency, the SCO 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 Article 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 Design Engineer to thoroughly quality check their design documents for compliance with applicable Codes, SCO technical requirements, 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 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 shall be on existing systems having an installation age exceeding 20 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 circuit 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 Design Engineers 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 Design Engineer 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).

In consideration of PtD, required submittals from the Contractor that are to be reviewed by the Design Engineer shall 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 Engineer review and approval before ordering equipment. The Contractor shall maintain the factory drawing packages on the construction site for SCO Field 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 21, 22 and 23 furnished equipment shall be performed under those Divisions.
3. Electrical and Mechanical Discipline Design Engineers shall coordinate the design documents and review the equipment shop drawing submittal packages received during construction to consider electrical safety for the Owner's facility maintenance staff. Where testing standard applies, HVAC equipment shall be specified to require construction to, and certification for UL 1995 latest edition or 60335-2-40 4th edition or later, complete with third party testing and approval. Equipment shop drawing submittal requirements shall mandate approval from amongst third-party testing agencies approved by the NCBCC. Equipment shop drawing packages that have been approved by the Design Engineer must be available at all electrical inspections performed by SCO.
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.

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5. Under Division 26, power wiring shall be provided from the circuit source origin 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 fire protection, plumbing, and mechanical equipment, including final connections, shall be provided under respective Divisions 21, 22 and 23.
6. Duct smoke detectors, if required by *NC Technical Codes*, 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 rated less than 120 Volt such as 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. Any additional wiring required for controls and instrumentation not indicated in the design documents shall be furnished and installed by the Contractor under which respective Division the equipment has been furnished.
9. Equipment with built-in disconnects or outlets provided under Divisions 21, 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 disconnecting means furnished integral to the equipment from the factory of origin. In such instances, wiring from the load side of the switch to the equipment shall be under respective Divisions 21, 22 or 23. See *Appendix Detail E-18* regarding the location and wiring of disconnects for other equipment. Factory furnished disconnect switches for equipment to be installed in outdoor locations shall be in minimum NEMA 3R enclosure.
10. The sequence of control for mechanical equipment shall be as indicated in the mechanical discipline drawings and specified in appropriate Instrumentation and Control section of the Division 23 design documents.
11. Horsepower ratings for all motors shall be consistently identified in both Division 23 and Division 26 Drawings.
12. Under Division 23, the circuit conductor type from the load side of the VFD to the driven equipment shall comply with the equipment manufacturer's recommendations inclusive of VFD cable where directed (e.g. three-conductor copper tape spiral shield, galvanized steel interlocking armor cable).
13. All sprinkler flow and tamper switches shall be furnished and installed under Division 21 and terminated 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. However, as an exception, it shall be acceptable for low-voltage (≤ 30 volts) control wiring, excluding Division 28 fire alarm wiring, to employ J-Hooks or cable tray to support the low-

voltage control wiring system where installed within concealed spaces above suspended grid ceilings or exposed within IDF/Telecom Rooms with plenum rated cable where required.

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. The Contractor providing kitchen or elevator equipment shall then be responsible for installation of the remainder of the supply circuit to the equipment from the termination point.
16. Division 26 Contractor shall provide disconnect means, if needed, wiring, and equipment connections for Owner furnished equipment
17. The use of combination starters is recommended in lieu of the use of separately enclosed individual starters and disconnect switches. Unless confirmed otherwise with the Mechanical Discipline Design Engineer, typical pump and fan applications have variable load profiles where the use of VFD for pump and fan motors rated five (5) 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 optimally 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 within both the Electrical and the fire protection, plumbing, and mechanical discipline drawings. (See *Appendix, Detail E-18*)
19. Reports showing the sizes of the maximum overcurrent protection (MOCP), minimum circuit ampacity (MCA), and motor overload setting for all motors; shall be provided by the respective discipline Contractor providing the equipment to the Electrical Discipline Design Engineer of Record as a pre-requisite for Final Acceptance of the project.
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 Division 26 Contractor complete to the door outlet. The Design Engineer shall coordinate with the Project Architect when specifying fire shutters and magnetically held doors installed in rated walls and barriers 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 at source and load terminations 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.
5. Where removing and/or demolishing existing luminaires containing mercury or ballast containing PCB's, the Contractor shall coordinate legal disposal with current procedures (collection, safe storage, and recycling) adopted by the respective state agency or institution of higher learning (Reference NCGS § 130A-310.0).

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,

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- 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.
 - 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 and 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, conductor size and voltage rating, identification of insulation and jacket material, date of manufacture, footage, and label from a NCBC approved third-party testing agency.

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.
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 be 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 Electrical Design Review Section, the use of Type MC Cable may be approved for certain applications. The Type MC Cable shall comply with the following characteristics: 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, the Design Engineer may specify Type MC Cable to minimize damage to structure. The Design Engineer may allow MC Cable for short connections to luminaires (e.g., fixture whips) Other uses may be considered where the use of MC cable does not exceed 30 feet in circuit length from the final junction box within the respective circuit and termination at a switch, outlet or power pole connection.
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 Design Engineer and SCO Design Review Electrical Section find it to be beneficial. Prior to its implementation, SCO Design Review Electrical Section approval must be obtained and shall be documented formally for project record. Design Engineer shall perform life cycle evaluation including annual maintenance costs and Owner must certify their commitment to provide annual maintenance (inclusive of re-torquing) on the aluminum conductor terminations.
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, the Design Engineer may specify up to 750-Kcmil with prior approval from SCO Design Review Electrical Section.
3. Fire alarm and control wiring shall have stranded copper conductors. See the SCO Fire Alarm Guidelines and Policies available on the State Construction Office website www.doa.nc.gov/divisions/state-construction-office .
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%).
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.
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 Design 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 and additional requirements as described herein.
2. Conduit shall be supported by approved conduit straps or clamps.
 - a) Conduits installed on the interior surface of exterior building walls shall be spaced off the wall surface a minimum of 1/4 inch using "clamp-backs" or strut.
3. Conduit straps or clamps or supports 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 which terminus are within 10-feet of building exterior (such as those routed to outdoor condensers), 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 steel reinforcing within the wall at building entrances and at cast-in-place (non-precast) manholes.
2. Direct buried (i.e. non-concrete encased) branch circuits run underground external to building foundation walls shall be run in raceway installed in accordance with the NEC and shall be of a type approved by the NEC as "suitable for direct burial." Minimum underground raceway size shall be 3/4 inch.
3. All underground raceways, except direct buried 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 as risers on 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 and approval from the SCO Design Review Electrical Section, 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. Raceway 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, Type FMC 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 Type LFMC liquid tight flexible metallic conduit in wet locations.
2. Raceways exposed and concealed (except "in-slab") shall be neatly installed parallel to, or at right angles to beams, walls and floors of buildings.
3. Raceways installed exposed indoors and outdoors shall be rigid metal conduit (RMC) as permitted by the NEC; permissible types include GRC (galvanized rigid conduit) and IMC (intermediate metal conduit). Aluminum raceways are not acceptable unless specifically approved by SCO Design Review Electrical Section with approval obtained and documented for SCO records prior to inclusion within the project design documents.
4. EMT raceway may also be utilized as permitted by the NEC as an alternative to RMC. 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 corrosive environments and/or severe physical damage as defined in the NEC.
 - d) Encased in concrete.

For transition between EMT and rigid conduits, use junction boxes.

5. The raceway system shall not be relied upon for grounding continuity. Section 26 05 26 Grounding and Bonding for clarification.
6. EMT raceway provided below roof deck shall be installed minimum 1-1/2 inches away from the deck to avoid screws penetrating the EMT raceway during reroofing.
7. 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 Design Review Electrical Section approval. Raceways, junction boxes, troughs, and enclosures mounted outside on the walls, shall be mounted off the walls by minimum one inch.
8. The use of "LB's" fittings shall be limited where possible. Where field conditions necessitate use of "LB's" fittings sized larger than 2 inches, mogul units shall be installed.
9. 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 Discipline Design Engineer of Record. 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 Discipline Design 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 Discipline Design Engineer of Record. 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 Discipline Design Engineer of Record. Related slab reinforcement or slab reconfiguration could require a credit from the Contractor.

10. 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.
11. In corrosive locations or coastal environments, Design Engineer may use Schedule 80 PVC with appropriate supports where permitted by NEC, allowed by Owner, and with prior approval from SCO Design Review Electrical Section.

C. TERMINATIONS

1. Type IMC and GRC raceways 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 raceway terminations shall be provided with insulated throat.
4. EMT terminations shall be made utilizing plated steel or cast metal hexagonal compression connectors. No pot metal, set screw, indented type or aluminum 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 Type IMC, GRC and PVC raceways shall be in accordance with the NEC.
3. EMT couplings shall be of the plated steel or cast metal hexagonal compression type. No pot metal, set screw, indented type, or aluminum 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 shall be cut neatly and uniformly, sloping uniformly to required pitch.
3. Ducts shall 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 shall 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 shall be secured to the earth to prevent floating during placement of concrete. Steel shall 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), shall 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 manholes should be in accordance with both NEC and 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.
9. Subsequent to approval of construction documents, State Construction Office may consider a proposal seeking approval for allowing directional boring in lieu of constructing underground concrete encased-steel reinforced duct bank subject to inclusion in the Designer's transmittal to the State Construction Office of the following:
 - a Documentation of this proposal complying with the "substitution" procedures stated in the contract documents for changes to specified materials and methods.
 - b Evaluation by the Design Engineer and recommendation to the Owner for approval or disapproval.
 - c Approval should be based upon benefit to the Owner to permit other than contractual requirements such as but not limited to contract cost or time deduction.
 - d Owner acknowledgment and approval of the Design Engineer's recommendation.
 - e The change, if approved, must be included in the project record documents.

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 Design Engineer 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. Except for renovation projects where other color conventions may exist, 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 as defined by NEC Article 700.

...Green Surface with red core for all equipment related to legally required systems as defined by NEC Article 701.

...Green surface with black core for all equipment related to optional stand-by systems as defined by NEC Article 702.

.... 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.

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 criterion. Therefore, the Design Engineer shall be responsible for confirming any identification system that differs from current guidance and obtaining agreement from SCO Design Review Electrical Section 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 25 megaohms (25,000,000) or more for #6 AWG wire and smaller; 50 megaohms (50,000,000) 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 25 megaohms, 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 25 megaohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnected.
 - c) Reconnect all conductors properly after completing successful insulation and continuity tests.
 - d) During conduct of SCO Final or Beneficial Occupancy inspection, the Contractor shall, upon request, furnish a copy of the feeder insulation tests to the SCO representative.

B. ELECTRICAL EQUIPMENT INSULATION TESTS

1. Test insulation of motors larger than or equal to 10 Horsepower. Test voltages shall follow NETA maximum voltage guidance for testing equipment where equipment manufacturer's test data is unavailable.

Nominal Equipment Voltage	Minimum Insulation Test Voltage	Minimum Insulation Resistance Megohms
250	500	25
600	1000	100
1000	1000	100
5000	2500	1000
15000	2500	5000

C. 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.)

D. 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 all circuit breakers capable of trip setting \geq 1000 amperes within the normal distribution system as well as separately derived source distribution system. 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).

E. GROUND FAULT PROTECTION SYSTEM

1. Provide ground-fault protection of equipment for solidly grounded wye electric services and feeder disconnecting means 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.

F. 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 most current revision of ANSI/NETA ECS *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 Beneficial Inspection.
3. Upon completion of all commissioning activities, documentation required by ANSI/NETA ECS shall be included in final project operation and maintenance manuals which shall be reviewed, stamped approved and dated by the Electrical Discipline Design Engineer of Record; if requested, the commissioning documents shall be submitted to SCO Design Review Electrical Section for verification but at minimum shall be made available for review by SCO at the Beneficial Inspection.
4. Electrical commissioning shall be performed on those projects with any of the following characteristics:
 - a) Low voltage systems rated 1000A or greater.
 - b) Power sources and equipment supplying emergency or legally required systems.
 - c) Medium voltage systems.
 - d) SCADA systems.
 - e) Interconnected On-Site Electrical Power Production Systems

G. 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 Design 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. Provide minimum 10'-0" between the transformer and generators and gas regulators.

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, 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 Design Engineer 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 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.
 - g) All monitoring gauges and drain valve shall be located in a separate compartment isolated from the low and high-voltage terminations to ease future inspection and maintenance and as a Prevention thru Design enhancement feature. Otherwise, if located within the terminal section of the transformer, calculated incident arc energy levels are of such magnitude that the transformer doors cannot be opened to perform inspections without necessitating cumbersome Category 4 PPE protection or alternatively completely deenergizing the transformer.

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

26 18 00 LOADBREAK INTERRUPTER AND PADMOUNT SECTIONALIZING SWITCHES

1. Manual air interrupter 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 cutout switches, 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 transformers 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 transformers 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 transformers shall be energy efficient, 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's instructions which typically require anchorage for floor mounted installations with anchor size and depth determined by the Design Engineer.
4. Winding material shall be either aluminum or copper; terminals shall be marked CU/AL to identify their acceptability for both aluminum or copper wiring.
5. Transformers 75 KVA and larger shall be floor mounted.
6. 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 an 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 1000 ampere or larger buses 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 rated 600 ampere and larger to be solid state trip type.
11. Arc-flash hazard labels shall be calculated and labeled for new switchboards in accordance with Section 260100 of these guidelines with label information to include (1) nominal system voltage; (2) arc flash boundary; (3) available incident energy or minimum required level of personal protective equipment; and (4) date the assessment was completed. As an addition to the project scope the Owner shall be consulted to potentially include the evaluation and labeling of existing switchboards.
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 new installations involving circuit breakers of frame rating equal to or larger than 1200-amps, provide switchboard or switchgear incorporating drawout circuit breakers. Additionally, incorporate remote racking and switching (OPEN-CLOSE) functions for each circuit breaker.

26 24 16 PANELBOARDS

1. Panelboards identified for use as service equipment shall be so labeled.
2. Panels rated 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 rated 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 Design Review Electrical Section, 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.

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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 SCO Design Review Electrical Section.
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 Detail E-6*.
13. Arc-flash hazard labels shall be calculated and labeled for new panelboards in accordance with Section 260100 of these guidelines with label information to include (1) nominal system voltage; (2) arc flash boundary; (3) available incident energy or minimum required level of personal protective equipment; and (4) date the assessment was completed. As an addition to the project scope the Owner shall be consulted to potentially include the evaluation and labeling of existing panelboards.
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, but not less than the available fault current.

5. The main horizontal and vertical busses shall be tin-plated or silver-plated copper.
6. The main horizontal bus 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.
14. Arc-flash hazard labels shall be calculated and labeled for new motor control centers in accordance with Section 260100 of these guidelines with label information to include (1) nominal system voltage; (2) arc flash boundary; (3) available incident energy or minimum required level of personal protective equipment; and (4) date the assessment was completed. As an addition to the project scope the Owner shall be consulted to potentially include the evaluation and labeling of existing motor control centers.

26 25 55 POWER FOR MARINAS, FLOATING DOCKS, AND PIERS

A. Emergency Power Off

1. Where a feeder provides power to a pier, fixed dock, or floating dock, provide an emergency power off switch accessible to the public that will shunt-trip the feeder circuit breaker. The switch shall be a red minimum 2-inch mushroom head with maintained contacts activating the shunt-trip when pressed. Provide a label at the switch stating: *"EMERGENCY ELECTRICAL POWER SHUT-OFF"*.
2. Install the switch at an approved location acceptable to the SCO Field Electrical Inspector near the point where the dock or pier connects to shore.
3. Provide a minimum 75 dBA audible horn or bell which shall activate when the switch is pressed.

4. Provision of the switch is exempted for installations not exceeding ten (10) single GFCI protected 120-volt branch circuits.

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 NCBC approved third-party testing agency for the voltage and amperage indicated.
2. Consult with SCO Design Review Electrical Section before designing automatic lighting controls for the interior emergency egress and exit lighting. If automatic lighting controls are used for interior emergency lighting, the Design Engineer 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 listed and labeled by a NCBC approved third-party testing agency. 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 NEC 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 listed and labeled by a NCBCC approved third-party testing agency 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 designated portion of the facility power distribution system during utility or normal power outage. Generator capacity shall be sufficient for the connected load using assigned load factors from the GENERATOR LOAD MATRIX (See Appendix). 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 preferably mounted on top of the weatherproof enclosure; however, installations with the silencer within the enclosure interior are also acceptable. 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.
3. When an existing generator is replaced the existing exhaust system (if retained) shall be evaluated as to appropriateness of the components for the expected temperatures. Designers are cautioned that new generators typically create a much higher exhaust temperature and require replacement of the exhaust system and the addition of protective insulation.

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 extending 50 miles inland), provide a corrosion-resistant enclosure with motorized louvers to limit salt air intrusion. 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 where installed indoors. For a generator installed in an outdoor generator enclosure, include a switched light that is connected to the generator battery if permitted by the generator manufacturer.

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) The 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.
3. For generator applications supplying NEC Art 700 emergency systems where a manual transfer switch or camlock connectors are used as the switching method for connection of the required temporary power source, the installation shall incorporate outdoor while-in-use rated receptacles of appropriate characteristics to supply the temporary source battery charger and engine jacket water heater and to facilitate compliance with NEC Art 700.3(F)(2).

N. GENERATOR SET MAIN CIRCUIT BREAKERS

1. Molded case with solid state trip unit circuit breakers in suitable enclosures for generators 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 for the fire pump, 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 short circuit fault current available 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 Fire Protection Discipline Design Engineer of Record, the Electrical Discipline Design Engineer of Record shall obtain the required electrical information from the Fire Protection Discipline Design Engineer of Record to perform TCC coordination.
 - e) The TCC coordination shall be sealed and signed by the Electrical Discipline Design 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 Design Review Electrical Section 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 Design Engineer shall evaluate all generator designs in coordination with the SCO Design Review Electrical Section 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 ratings 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 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 for SCO review at Beneficial and Final Inspection.

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 Design Engineer 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, unit wiring diagrams and schematics, and interconnection wiring drawings. All configured parameter settings shall be provided inclusive of final accepted timer settings, for both the generator and the transfer switch.
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 listing and label from a NCBCC approved third-party testing agency 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 an outage of the emergency power source should occur during the time delay period, then 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 Design Engineer prefers closed transition, the Electrical Discipline Design Engineer of Record 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 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 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 SCO Design Review Electrical Section during the Advanced Planning and Schematic Design phases 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 Design Engineer and approved by the SCO Design Review Electrical Section. A lightning protection system shall be required where the evaluated annual lightning threat occurrence (N_d) 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 Design Review Electrical Section 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) Overvoltage Protection

1. The System shall meet the following standards: IEEE C62.34, C62.41& C62.45, NEMA LS 1, UL 1449 (latest edition), NEC Article 242. 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 Project Architect and lighting Design Engineer 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 adopted by the NC State Legislature.
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 or installed in a suspended ceiling, 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 grid 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 Design Engineer'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. Carefully evaluate applications involving recessed downlight luminaires installed in gypsum or other inaccessible fixed ceilings. Although listed as accessible through the aperture, after installation the downlight apertures are being discovered too small to allow access to the junction box. The NEC requires that all junction boxes and equipment located above a ceiling are accessible. Therefore, unless equipped with remote drivers, recessed downlights ≤ 6 -inch are prohibited as are any size recessed downlight in fixed/rigid ceilings > 12 feet in height. For all other recessed downlights, coordinate with the architect to provide access hatches (minimum 18-inches square) where required to access boxes and equipment in the ceiling cavity. To conclude, where possible, SCO recommends inclusion of remote drivers within the lighting design for all recessed downlight luminaires in fixed ceilings with low voltage only wiring subsequently needed at each recessed downlight luminaire.
8. To save energy, the lighting illumination levels shall be designed in accordance with the North Carolina Energy Conservation Code and the IES standards. Lighting systems 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, photocells, 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.
9. Calculations regarding point by point symmetrical and asymmetrical lighting distribution shall be provided to SCO Design Review Electrical Section upon request.
10. Where a 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 that an integral disconnecting means is provided at the ballast.
11. Provide a table or a drawing showing the designed illumination levels in footcandles for each functional area of the facility. The lighting levels provided 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 N.C.G.S § 143-64.15(a).
12. Install battery operated unit equipment in the following locations in addition to egress illumination noted in paragraph E below (Note that these requirements mandating unit-battery

powered emergency illumination are in addition to and supplement emergency illumination requirements within the NC Technical Codes):

- 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.
13. In high ceiling areas (above 12-foot) such as atrium spaces and vertical exit stairwells, drivers (for LED lighting) and ballasts (for fluorescent lighting) shall be remotely located in accessible areas. Appropriate remote locations include suspended grid ceilings adjacent to the high ceilings or within nearby electrical rooms.

B. Fluorescent Lighting

1. All new and retrofit lighting applications shall specify LED luminaires. Consult with SCO Design Review Electrical Section before any proposed use of fluorescent lighting in new or retrofit applications.
2. If fluorescent luminaires are agreed to by SCO Design Review Electrical Section, then specifying energy efficient luminaires is required. Where electronic ballasts are specified, they shall 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.
 - 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 SIGNAGE

1. GENERAL

- a) It shall be completely self-contained, provided with maintenance-free battery, automatic charger, and additional features described below. No battery is required if the fixture is fed from a generator, or any other emergency power source. Luminaires must be listed and labeled by a NCBCC approved third-party testing agency 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. The 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 (unless not unit battery powered)

- 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 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 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. The warranty shall be included in the contract document.

6. LED

- a) The use of LED exit lights 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) The 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. An alternative method by measuring beginning and ending foot-candle output is acceptable.

E. EMERGENCY EGRESS LUMINAIRE

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 additional features described below. Luminaire shall be listed and labeled by a NCBCC approved third-party testing agency 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 battery voltage as recommended by luminaire manufacturer for LED lamps.

2. ADDITIONAL FEATURES (unless not unit battery powered)

- 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 relay.

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. The 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. The warranty shall start from the date of project final acceptance. Warranty shall be included in the contract document.

6. UNIT TEST

- a) The 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. A copy of the test report shall be presented at final inspection and included in Owner's Operation and Maintenance Manual.

26 56 00 SITE and EXTERIOR LIGHTING

1. Pole bases for site lighting shall be detailed on the construction documents. The Design Engineer shall verify that the base detail is adequate to sustain wind loads for the specific project location with the specified pole and luminaire. See *Appendix Detail E-17 TYPICAL EXTERIOR POLE BASE DETAIL*.
2. Lighting poles more than 12 feet in height shall have listing and labeling from a NCBCC approved third-party testing agency. 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 each specified luminaire shall be LED; metal halide, high pressure sodium vapor, or any source other than LED must have prior approval documented for SCO records from SCO Design Review Electrical Section before inclusion within the project documents.
6. Lighting fixtures mounted outside, such as in parking deck, shall be listed for the location and be installed according to the listing.
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 the SCO Design Review Electrical Section upon request.
10. Provide and bond each pole with 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.

26 77 05 INTERCONNECTED ON-SITE ELECTRICAL POWER PRODUCTION SYSTEMS

1. Interconnected On-Site Electrical Power Production (IOEPP) systems consist of two or more sources of power connected in parallel to supply electrical power to one or more buildings. Installations shall comply with all applicable requirements of North Carolina Building Codes and North Carolina Electrical Code (NEC as adopted by NC Building Code Council).
2. Power production sources may include generator(s), photovoltaic systems, battery energy storage systems, fuel cells, etc.
3. If the IOEPP is connected in parallel with the public electric utility, receive written approval from the public utility and comply with all public utility requirements. One such utility is Duke Energy and the latest version of Duke Energy's "SERVICE REQUIREMENTS MANUAL" is available on-line at <http://www.duke-energy.com/-/media/pdfs/partner-with-us/service-requirements-manual.pdf>
4. A single building with an IOEPP shall have disconnecting means to isolate each energy source and disconnect all energy sources from the building. Each disconnecting means shall be labeled. Provide a clear diagram at each disconnect means indicating the location of all disconnecting means. The diagrams shall be permanently attached and shall withstand the environment. If all disconnecting means are closely grouped, only one diagram is required.
5. If the IOEPP is designed for "Islanding", it may have "grid forming" capability so it can operate independently from the electric utility. If so, provide all necessary controls and means to isolate the IOEPP from the utility.

6. Some agencies have a campus electrical distribution system. Before connecting an IOEPP to a campus electrical distribution system, provide written approval from the Director/Manager of the Distribution System. Approval from the campus project manager or institution of higher learning Capital Projects Coordination is not an acceptable substitute for the campus electrical distribution system Director/Manager. An IOEPP connected to a campus distribution system shall also have approval from the local electric utility and have means to isolate the IOEPP from the electric utility.

27 05 00 TELECOMMUNICATIONS AND INFORMATION TECHNOLOGY

1. The document known as STS-1000, *TELECOMMUNICATIONS WIRING GUIDELINES* published by the NC Department of Information Technology (NCDIT), previously offered NCDIT guidance for all information and communication technology (ICT) infrastructure within state owned facilities. This document issued originally in year 1996 is no longer in effect, therefore, SCO requires Design Engineers to follow general industry accepted practices for ICT as adopted within the most current revisions of (1) NFPA 75 *Standard for the Fire Protection of Information Technology Equipment*; and (2) ANSI/TIA-607-E *Telecommunications Bonding and Grounding for Customer Premises*.
 - a The scope of ANSI/TIA-607 bonding standard applies to the following ICT elements:
 - i Spaces containing ICT equipment and/or ICT infrastructure
 - ii Conveyance (cable trays, conduits, non-continuous pathways)
 - iii Cables and associated connecting hardware (fiber, copper) inclusive of ICT structured cabling (e.g. outside/inside building), backbone cabling, horizontal cabling, and balanced twisted-pair
 - iv Bonding infrastructure (busbars, bonding conductors, bonding connections, such as bonding lugs and clamps)
 - v Electrical power grounding interface to ICT bonding infrastructure (i.e. known as Intersystem Bonding Terminal (IBT) within NEC)
 - b See following table for key component nomenclature changes resulting from adoption of TIA-607 standard that differ from those within the obsolete standard STS-1000:

Terminology within TIA-607	Terminology within STS-1000
Backbone Bonding Conductor (BBC)	Grounding Equalizer (GE)
Primary Bonding Busbar (PBB)	Telecommunications Main Grounding Busbar (TMGB)
Rack Bonding Busbar (RBB)	Rack Grounding Busbar
Secondary Bonding Busbar (SBB)	Telecommunications Grounding Busbar (TGB)
Telecommunications Bonding Conductor (TBC)	Bonding Conductor for Telecommunications (BCT)

28 31 13 FIRE ALARM SYSTEMS

1. Provide a fire alarm system for new construction in all occupiable NC State owned buildings having more than one occupiable floor or 3000 square feet and larger. If the NC Building Code and/or the NC Fire Code do not require a fire alarm system, the owning agency may submit a request to the State Construction Office seeking approval to exclude a fire alarm system for the building.
2. The owning agency may require a fire alarm system in buildings where the NC Building Code nor Fire Code do not require a fire alarm system.
3. Refer to *State Construction Office Fire Alarm Guidelines and Policies* for fire alarm system requirements.

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	Fire Alarm Listed Red MC Cable	For universities, can only be use if permitted in University Guidelines
Services and Feeders	Aluminum > #1 AWG	Copper	Copper clad aluminum is preferred to standard aluminum conductors
Main Distribution Panel	Load-center Panels	Copper Bus, Bolt-on Breakers	
Transformers	Aluminum windings	Copper	
<p>Note: Apply only to privately funded projects such as Foundation projects and single-family dwellings such as Chancellors' residences and Park Rangers residences.</p>			

GENERATOR LOAD MATRIX

This is a sample of a Generator Load Matrix to be followed on each project for allocation of loads across each branch of the generator supplied distribution system.

Edit associated loads appropriately within the matrix for those included within each specific project that are not listed.

Associated Loads	Generator Power Load Factor
NEC Article 700 System	
Exit and Egress Lighting	100%
Fire Alarm System	100%
Elevator Cab Lighting, Communications & Controls	100%
Fire Pump	125%
Generator Set Accessories	100%
NEC Article 701 System	
Emergency Responder Radio Coverage System	100%
Two-way Communication System	100%
Ventilation System if legally required	100%
Building automation if legally required	100%
Sewage Ejectors	100%
Powered Doors in Path of Egress	100%
One Elevator per Elevator Bank	100%
NEC Article 701 System	
Access Control	100%
Telecommunication System	100%
Building Automation	100%
Jockey Pump	100%
Sump Pumps	100%
List all other optional equipment	100%

BENEFICIAL OCCUPANCY REQUIRED ELECTRICAL SYSTEM PROJECT RECORD DOCUMENTATION

1. Unit Battery Powered Emergency Illumination Tests (NEC)
2. Emergency Generator NFPA 110 Test
3. Service Ground Test Report (NEC)
4. Motors MOCP, MCA, Overload Settings (SCO Electrical Guidelines and Policies Section 26 02 15)
5. Circuit Breaker Performance Tests (SCO Electrical Guidelines and Policies Section 26 08 00)
6. Ground Fault System Performance Tests (SCO Electrical Guidelines and Policies Section 26 08 00)
7. Lighting Controls Tests (NCECC)
8. Medium Voltage Equipment Connections Thermal Imaging Results (SCO Electrical Guidelines and Policies Section 26 01 00)
9. Medium Voltage Cable VLF Tests (SCO Electrical Guidelines and Policies Section 26 05 13)
10. Low Voltage Cable Tests (SCO Electrical Guidelines and Policies Section 26 05 19)
11. Electrical Equipment Insulation Tests (SCO Electrical Guidelines and Policies Section 26 08 00)
12. Medium Voltage Cable Warranty (SCO Electrical Guidelines and Policies Section 26 05 13)
13. Generator and Transfer Switch Warranty (SCO Electrical Guidelines and Policies Section 26 32 13)
14. Battery Operated Exit Sign & Egress Lighting Warranty (SCO Electrical Guidelines and Policies Section 26 51 00)
15. Lightning Protection UL Master Label (SCO Electrical Guidelines and Policies Section 26 41 00)