DIVISION SIXTEEN

SECTION 16000 – ELECTRICAL

16001 GENERAL

05-04-2023

A. The Instructions to Bidders, General Conditions of the Contract, Supplementary General Conditions and Division 1 bound herewith are a component part of this section of the specifications and shall apply to this section with equal force and shall be consulted in detail for instructions pertaining to the work.

B. Furnish all labor, materials and equipment and incidentals required to make ready for use complete electrical systems as shown on the Drawings and specified herein.

C. It is the intent of these Specifications that the electrical systems shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Division shall be furnished at no extra cost.

D. The Electrical Contractor assumes total responsibility for any portion of the work provided by his subcontractors.

E. Each bidder (or Representative) shall, before preparing a proposal, visit all areas of the existing site. If the work includes demolition, restoration, renovation and/or addition; then existing buildings and structures should be carefully inspected. The submission of the proposal by this Bidder shall be considered evidence that the Bidder (or Representative) has visited the site and noted the locations and conditions under which the work will be performed and that the Bidder takes full responsibility for a complete knowledge of all factors governing the work.

F. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for all the proper functioning of the system and equipment. All work shall be of the highest quality; substandard work will be rejected.

G. Field verify all existing underground electrical and mechanical piping.

H. The project shall be bid based on the equipment listed in these specifications and on the Drawings. After award of the Electrical Contract the Contractor may wish to substitute equipment other than that specified, subject to approval. The Electrical Contractor shall bear the “burden of proof” for demonstrating substitute equipment equivalency and suitability.

I. The Electrical Contractor shall be required to replace installed “equivalent” equipment if the operation of this equipment does not meet the full design intent of the specified system.

J. Physical size of equipment used in the design layout are those of reputable equipment manufacturers. The Contractor is responsible for providing equipment which will fit the space provided. If the Contractor elects to use other manufacturer’s equipment, any resulting conflicts with space clearance or codes shall be the responsibility of the Contractor to correct at the Contractor’s expense.

K. The Contractor assumes all responsibility for providing code clearances. Submit a scale drawing of each electrical equipment room showing exact size and location of all proposed electrical equipment with code clearances and working space clearly indicated.

16002 SCOPE OF WORK

It is the intent and meaning of these Drawings and specifications to provide a complete and operable electrical power and lighting systems and associated related electrical systems for the work as shown on the Drawings and/or herein specified. This includes furnishing all labor, equipment, devices, appliances, materials and appurtenances as required, and in performing all functions to completion and leave ready for operation and installation of electrical work in strict accordance with these specifications and applicable Drawings and subject to the conditions of the contract.

All electrical work shall be in full compliance with NFPA 70 (specifically including Art. 517), the North Carolina State Building Code (NCSBC), the Rules and Regulations of the Division of Health Services Regulation, North Carolina Department of Human Resources (DHSR), all local Codes and Ordinances in accordance with the requirements of the local Authority Having Jurisdiction (AHJ), and the Codes and Standards listed hereinafter.

Major items of work are:

A. Electrical service from utility company transformer to service equipment.

B. Electrical service and distribution system for power, lighting, receptacles and miscellaneous power as shown on the Contract Drawings.

C. Electrical lighting system as shown on the Contract Drawings, complete with indicated switching, circuiting, etc.

D. Electrical receptacle system as shown on the Contract Drawings. Including redundant grounding paths per NEC article 517.

E. Exit and emergency lighting systems.

F. Power supplies and associated electrical work for equipment furnished by others as detailed hereinafter.

G. Standby Emergency Power System.

H. Power, grounding, raceway and box systems for telephone, data, CATV, mag lock system, Aiphone system, security camera system, and other special systems.

I. Fire Detection and Alarm System.

J. Nurse Call and Paging Systems.

K. Grounding.

L. Seismic restraint systems.

M. Other special requirements and/or systems where shown.

16003 CODES AND STANDARDS

Materials installed in this construction shall conform to the latest edition of the Codes and Standards listed below where such are applicable, and shall be new and unused, unless specifically indicated to be salvaged and reused from existing construction.

A. American Association of Edison Illuminating Companies (AEIC)
B. American National Standards Institute (ANSI)
C. American Society for Testing and Materials (ASTM)
D. Building Officials Code Administrators (BOCA)
E. Energy Code 90.1 (ASHRAE/IES)
F. Institute of Electrical and Electronic Engineers (IEEE)
G. Insulated Cable Engineers Association (ICEA)
H. International Code Council (ICC)
I. International Conference of Building Officials (ICBO)
J. National Electrical Code (NEC) 2020 edition, with emphasis on applicable portions of Article 517
K. National Electrical Contractor’s Association (NECA)
L. National Electrical Installation Standards (NEIS)
M. National Electrical Manufacturer’s Association (NEMA)
N. National Electrical Safety Code (NESC)
O. National Fire Protection Association (NFPA)
P. Occupational Safety and Health Act (OSHA)
Q. Requirements of the Americans with Disabilities Act (ADA), latest edition.
R. Underwriters Laboratories Inc (UL)
S. Toxicity Characteristics Leaching Procedure (TCLP)
T. North Carolina State Building Code (NCSBC)
U. Rules and Regulations of the Division of Health Services Regulation, North Carolina Department of Human Resources (DHSR)

16004 PERMITS AND INSPECTIONS

A. The Contractor shall obtain from the authority having jurisdiction the required construction permit and shall arrange, at the proper time, for all inspections required by such authority.

B. A certificate of approval from the Electrical Inspector having jurisdiction shall be delivered to the Architect/Engineer prior to final acceptance of the work.

C. The Contractor shall pay all fees and/or expenses accruing from all required permits and/or inspections.

16005 RECORD DRAWINGS

As the work progresses, legibly record all field changes on one set of project Contract Drawings, herein after called the "Record Drawings." The Electrical Contractor shall mark all changes, modifications, or revisions effected during construction such that the Architect/Engineer may prepare record drawings from the information contained thereon upon completion of the work.

16006 APPROVAL OF MATERIALS

A. The Architect/Engineer has, wherever possible, specified the required performance and design characteristics of all materials utilized in this construction. In some cases it is impossible to specify the required performance and design characteristics and when this occurs the Architect/Engineer has specified three or more examples of equal design or equivalent design, establishing a an acceptable range for items of equal or equivalent design. Cited examples are used only to denote the quality standard of product desired and do not restrict bidders to a specific brand, make, manufacturer or specific name and are used only to set forth and convey to bidders the general style, type, character and quality of product desired. Equivalent products will be acceptable. Substitution of materials, items, or equipment of equal or equivalent design shall be submitted to the Architect/Engineer for approval or disapproval. Equal or equivalent shall be interpreted to mean an item of material or equipment, similar to that named and which is suitable for the same use and capable of performing the same functions as that named, the Architect/Engineer being the judge of equality.

B. The Contractor shall submit to the Architect/Engineer, within 10 days following award of the contract, a list of materials and equipment for approval that he proposes to use on the project. Such list shall include the manufacturer and the trade name, type, series or model of equipment proposed. When this list is approved by the Architect/Engineer, no further substitutions will be permitted except in unusual or extenuating circumstances. If no list is submitted within the specified time, the Contractor shall supply materials and equipment as specified.

16007 SHOP DRAWINGS, SUBMITTAL DATA AND PROCEDURES

A. The Contractor shall submit shop drawings, certified prints, literature and cuts to the Architect/Engineer for all major items of equipment and materials for review and approval. Data required to be as stipulated herein and must be submitted reasonably promptly after material list above has been approved. Several items on which such data will be required are as tabulated below. All shop drawings for the project shall be submitted at one and the same time. Materials and equipment with long lead times or other materials and equipment requiring special handling, if identified and requested by the contractor, will be processed separately.

B. The Contractor shall analyze all shop drawings before submittal and certify that they meet requirements of Contract Drawings and Specifications. Certification to be in the form of suitable approval stamp placed on each shop drawing submitted for approval. Data submitted for approval without Contractor's stamp of approval will not be considered. Shop drawings are required to be submitted for the following items:

1. Circuit Breakers
2. Conductors
3. Raceways and Fittings
4. Lighting Fixtures
5. LED lamps, Light Engines and Drivers
6. Junction, Outlet and Pull Boxes
7. Nameplates
8. Panelboards
9. Switchboards
10. Safety Switches
11. Automatic Transfer Switches
12. Engine-Generator Set
13. Portable Generator Connection Panel
14. Wiring Devices and Plates
15. Fire Alarm, Paging and Nurse Call Systems

C. The Architect/Engineer will review submittal data, and if found acceptable, will return submittal review letter marked "Approved" or "Approved as Noted".

D. If the Architect/Engineer deems submittal data is either incomplete or unacceptable, a new submittal will be required.

E. At least one set of all "Approved" shop drawings, certified prints, etc., shall be maintained at the job site and available to representative of the Architect/Engineer.

F. Approval by the Architect/Engineer of shop drawings for any materials, apparatus, devices and layouts shall not relieve this Contractor from the responsibility of furnishing same of proper dimensions, size, quantity, quality and all performance characteristics to efficiently perform the requirements and intent of the contract documents. Approval shall not relieve this Contractor from responsibility for errors of any sort on the shop drawings. If the shop drawings deviate from the Contract

Documents, the Contractor shall advise the Architect/Engineer of the deviations in writing, accompanying the shop drawings, including the reason for the deviations.

G. No materials or equipment shall be placed on the job site, or installed in the work, without prior written approval by the Architect/Engineer.

H. Physical size of equipment used in the design layout are those of reputable equipment manufacturers. The Contractor is responsible for providing equipment which will fit the space provided. If the Contractor elects to use other manufacturer's equipment, any resulting conflicts with space clearance or codes shall be the responsibility of the Contractor to correct at his expense.

I. The Contractor assumes all responsibility for providing code clearances. Submit a scale drawing of each electrical equipment room showing exact size and location of all proposed electrical equipment with code clearances and working space clearly indicated.

16008 INTERPRETATION OF DRAWINGS

A. The Electrical Drawings and specifications are complementary each to the other and what may be called for by one shall be as binding as if called for by both. The Drawings are diagrammatic and indicate generally the location of outlets, devices, equipment wiring, etc. While these drawings shall be followed as closely as possible, all dimensions shall be checked and verified at the building, and any necessary changes shall be made to accord with structural conditions, equipment to be installed, other systems, etc., without additional cost. All work shall suit the finished surroundings and/or trim.

B. Where the words "furnish (or provide) and/or install" are used, it is intended that this contractor shall purchase and install completely any and/or all material necessary and required for this particular item, system, equipment, etc.

C. Where the words "the Contractor" or "this Contractor" appear in either the Drawings or specifications, it shall mean the Electrical Contractor.

D. Any omission from either the Drawings or these specifications are unintentional, and it shall be the responsibility of this Contractor to call to the attention of the Architect/Engineer any pertinent omissions before submitting a bid. Complete and working systems are required, whether every small item of material is shown and specified or not.

E. Where no specific material or equipment type is mentioned, a high quality product of a reputable manufacturer may be used provided it conforms to the requirements of these specifications. These materials shall be listed or labeled by a nationally-recognized Third Party Testing Agency accredited by the State of North Carolina to label electrical equipment.

F. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section shall be furnished at no extra cost. The Electrical Drawings show the general arrangement of raceways, equipment, fixtures, and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Some adjustment of routings and installation of conduit, boxes, fixtures, devices, etc. should be expected. The electrical work shall conform to the requirements shown on all of the Drawings. General and Structural Drawings shall take precedence over Electrical Drawings. Because of small scale of the Electrical Drawings, it is not possible to indicate offsets, fittings and accessories which may be required. The Contractor shall investigate the structural and finish conditions affecting the work and shall arrange his work accordingly, providing such fittings and accessories as may be required to meet such conditions, without additional cost to the Owner and as directed by the Architect/Engineer.

G. Each 3-phase circuit shall be run in a separate conduit unless otherwise shown on the Drawings.

H. Where circuits are shown as "home runs" all necessary fittings and boxes shall be provided for a complete raceway installation.

I. Verify with the Architect/Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

J. Any work installed contrary to or without approval by the Architect/Engineer shall be subject to change as directed by the Architect/Engineer, and no extra compensation will be allowed for making these changes.

K. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Architect/Engineer during construction. Obtain in the field all information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Architect/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

L. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

M. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of equipment.

N. All connections to the equipment shall be made as required by the equipment, and in accordance with the approved shop and setting drawings.

O. Redesign of electrical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his own expense. Redesign and detailed plans shall be submitted to the Architect/Engineer for approval. No additional compensation will be provided for changes in the work, either his own or others, caused by such redesign.

P. All floor mounted electrical equipment shall be placed on 4-inch thick concrete housekeeping pads. Edges shall be chamfered.

Q. The Contractor shall harmonize the work of the different trades so that interferences between conduits, piping, equipment, architectural, mechanical, plumbing and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required by to accomplish this shall be furnished and installed by the Contractor without additional expense to the Owner. In case interference develops, the Architect/Engineer shall decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

16009 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his materials in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitable, to insure that the tilting does not impair the functional integrity of the equipment.

16010 COORDINATION OF WORK

A. It is understood and agreed that the Contractor has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, the character, quality and quantity of the materials to be encountered, the general and local conditions and all other matters which can and may affect the work under this contract. The Contractor shall be held responsible for visiting the site and thoroughly familiarizing himself with the existing conditions and also any contractual requirements as may be set forth in the other divisions of these specifications. No extras will be considered because of additional work necessitated by obvious job conditions that are not indicated on the Drawings.

B. The Contractor shall compare the Electrical Drawings and specifications with the Drawings and specifications for other trades, and shall report any discrepancies between them to the Architect/Engineer and obtain from him written instructions for changes necessary in the electrical work. The electrical work shall be installed in cooperation with other trades installing interrelated work. Before installation, the

Contractor shall make proper provisions to avoid interferences in a manner approved by the Architect/Engineer. All changes required in the work of the Contractor caused by his neglect to do so shall be made by him at his expense.

C. Location of electrical raceways, switches, panels, equipment, fixtures, etc., shall be adjusted to accommodate the work to interferences anticipated and encountered. The Contractor shall determine the exact route and location of each electrical raceway prior to make up and assembly.
   1. Right of Way: Lines which pitch shall have the right of way over those which do not pitch. For example, steam, condensate and plumbing drains shall normally have right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
   2. Offsets and changes in direction of electrical raceways shall be made as required to maintain proper headroom and to clear pitched lines whether or not indicated on the Drawings. The Contractor shall furnish and install elbows, pull boxes, etc., as required to affect these offsets, transitions, and changes in directions. Conflicts between electrical raceways, fixtures, etc., and ductwork which cannot be resolved otherwise, will be resolved by the Architect/Engineer.

D. Installation and Arrangements: The Contractor shall install all electrical work to permit removal (without damage to other parts) of any equipment requiring periodic replacement or maintenance. The Contractor shall arrange electrical raceways and equipment to permit ready access to valves, cocks, traps, starters, motors, control components, etc., and to clear the opening of swinging and overhead doors and of access panels.

E. Do not scale Electrical Drawings. Locations shown are approximate. The contractor shall refer to the Architectural Drawings for exact measurements in the placement of equipment, fixtures, outlets, etc. The Drawings do not give exact details as to elevations and locations of various fittings, conduit, etc., and do not show all offsets and other installation details which may be required.

16011 EQUIPMENT AND MATERIALS (GENERAL)

A. All materials and equipment provided by the contractor shall be listed and labeled by a nationally-recognized, third party testing agency, acceptable to the authority having jurisdiction, for the conditions of installation. All material, equipment and devices shall be new current products of manufacturers regularly engaged in the production of such products. Equipment shall be suitable for its application (e.g. when installed outdoors, it shall be weatherproof, etc.). Materials and equipment furnished under this specification shall be essentially the standard product of manufacturers regularly engaged in the production of the required type of equipment, and shall be the manufacturer's latest approved design. Equipment, materials, etc. utilized not bearing a third party testing agency certification shall be field or factory third party testing agency certified prior to equipment acceptance and use. Equipment and materials shall bear the appropriate third party testing agency’s listing mark or classification marking.

B. Delivery and Storage: Equipment and materials shall be delivered to the site and stored in original containers, suitably sheltered from the elements, but readily accessible for inspection by the Architect/Engineer until installed. All items subject to moisture damage (such as lighting fixtures) shall be stored in dry, heated spaces.

C. Equipment and materials of the same general type shall be of the same make throughout the work to provide uniform appearance, operation and maintenance.
   1. Protection: Equipment shall be tightly covered and protected against dirt, water and chemical or mechanical injury and theft. At the completion of the work, fixtures, equipment, and materials shall be cleaned and polished thoroughly and turned over to the Owner in a condition satisfactory to the Architect/Engineer. Damage or defects, developing before acceptance of the work shall be made good at the Contractor's expense.
   2. Dimensions: It shall be the responsibility of the Contractor to insure that items to be furnished fit the space available. He shall make necessary field measurements to ascertain space requirements, including those for connections and shall furnish and install such sizes and shapes of equipment that the final installation shall suit the true intent and meaning of the Drawings and specifications.
   3. Manufacturer's directions shall be followed completely in the delivery, storage, protection, and installation of all equipment and materials. The Contractor shall promptly notify the Architect/Engineer, in writing, of any conflicts between any requirements of the Contract Documents and the manufacturer's directions and shall obtain the Architect/Engineer's written instructions before proceeding with the work. Should the Contractor perform any work that does not comply with the manufacturer's direction or such written instructions from the Architect/Engineer, he shall bear all costs arising in correcting the deficiencies.

D. Seismic requirements
   1. All equipment furnished under the electrical contract shall be installed in a manner to be fully compliant with the seismic restraint requirements of the North Carolina State Building Code (NCSBC). The contractor shall provide any and all seismic restraint details and calculations that may be required by the FBC and/or the authority having jurisdiction.
   2. Requirements for restraints are detailed in the NCSBC. All tables and references shall conform to the buildings location. Restraints and required flexible connections shall be per the criteria set forth by the NCSBC. This criteria is based on the seismic design category stated on the structural drawings.
   3. The contractor shall retain the services of a Professional Engineer registered in the State of North Carolina to design seismic restraint elements required for this project. The engineer's calculations, bearing his professional seal, shall accompany shop drawings and shall demonstrate code compliance including certification that the seismic system components comply with the testing requirements of the NCSBC. Calculations and shop drawings shall be submitted for review prior to the purchasing of materials,

equipment, systems and assemblies. Internal seismic restraint elements of manufactured equipment shall be certified by a Professional Engineer retained by the manufacturer. Such certificate applies only to internal elements of the equipment. All equipment anchorage requirements shall be coordinated with the building structure and shall be compatible thereto. All such anchorages shall be subject to the review and approval of the project's structural engineer

4. The Professional Engineer retained for seismic restraint calculations shall visit the job site upon completion of the seismic restraint installation to comply with the special inspections requirement of the code. This engineer shall provide written verification of compliance of the installation with the approved seismic submittal. This verification shall be submitted as a special inspections report and shall bear the engineer’s professional seal. Job site inspections by other than this engineer are not acceptable.
5. Review of the seismic design computations and shop drawings by the engineer or his agent shall not relieve the contractor of his responsibility to comply with the seismic or any other requirements of the North Carolina State Building Code.

16012 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall provide two compilations of catalog data, bound in suitable loose leaf binders, for each manufactured item of equipment used in the electrical work. These shall be presented to the Architect/Engineer for transmittal to the Owner before the final inspection is made. Data shall include printed installation, operation and maintenance instructions for each item, indexed by product with heavy sheet dividers and tabs. All warranties shall be included with each item. Each manufacturer's name, address and telephone number shall be clearly indicated.

B. Shop drawings with Architect/Engineer's "as noted" markings are not acceptable for the above. "Approved" shop drawings are acceptable if adequate information is contained therein. Installation information packed with lighting fixtures, devices and equipment shall be retained for inclusion in the operations and maintenance manuals. Generally, shop drawings alone are not adequate.

16013 OPERATING INSTRUCTIONS

At the completion of the entire installation, the Contractor shall arrange to operate each component of the system and then the system as a whole. When all the requirements of the plans and specifications have been met, the Contractor shall then arrange to instruct the Owner's operating and maintenance personnel in the correct and proper procedures for the operation and maintenance of the systems.

16014 SLEEVES, INSERTS, OPENINGS, ETC.

Anchor bolts, sleeves, inserts, supports, etc., that may be required for electrical work shall be furnished, located and installed by the Electrical Contractor. The Electrical Contractor

shall give sufficient information (marked and located) to the General Contractor in time for proper placement in the construction schedule. Should the Electrical Contractor delay or fail to provide sufficient information in time, then the Electrical Contractor shall cut and patch construction as necessary and required to install electrical work. Such cutting and patching will be done by the General Contractor but paid for by the Electrical Contractor.

16015 CUTTING AND PATCHING

This Contractor shall do all cutting and patching as required for the proper installation of work under this contract. Cutting shall be kept to a minimum.

16016 PAINTING

A. All painting will be performed by the General Contractor for the project, unless specifically indicated otherwise.

B. The Electrical Contractor shall clean all exposed electrical work for painting. Should the Electrical Contractor delay in installing his exposed conduit and outlet installation until the General Contractor has begun painting, the Electrical Contractor shall be required to paint all exposed electrical work at his own expense. Such painting will be accomplished in accordance with the detailed painting specifications for the project.

C. Conductors exposed in boxes and cabinets shall be protected against painting. Devices, cover plates, trims, etc., for panelboards and cabinets shall not be installed until painting has been completed.

D. The Electrical Contractor shall be responsible for touch up painting that may be required for his own material or apparatus furnished with factory applied finish.

16017 LOCATIONS AND MEASUREMENTS

Outlets and appliances are shown and located on the Drawings as nearly as possible. All measurements shall be verified on the project and in all cases the work shall suit the surrounding trim and/or decoration and construction. The locations of outlets for special appliances shall be installed so that when extended, they are flush with the finished wall or ceiling and permit the proper installation of fixtures and/or devices. Heights of all outlets shown on the Drawings are approximate only. Slight relocations of outlets, devices and equipment shall be made by the Contractor as required or as directed by the Architect/Engineer at no additional cost to the Owner.

16018 WORKMANSHIP

All work shall be executed as required by this specification and the accompanying Drawings and shall be done in a workmanlike manner by skilled mechanics, and shall present a neat, trim, and mechanical appearance when completed. All work shall be performed as required by the progress of the job.

16019 ELECTRICAL IDENTIFICATION

A. Furnish and install engraved laminated phenolic nameplates for all safety switches, panelboards, switchboards, automatic transfer switches, and electrical equipment supplied under this contract for identification of equipment, controlled, served, phase, voltage, etc. Nameplates shall be securely attached to equipment with metal screws, and shall identify by name the equipment controlled, attached, etc. Letters shall be approximately 1/4-inch high minimum. Embossed, self-adhesive plastic tape is not acceptable for marking equipment. Nameplate material colors shall be:
   1. Black surface with white core for all normal (utility) power distribution equipment.
   2. Yellow surface with black core for all life safety branch power distribution equipment.
   3. Orange surface with black core for all critical branch power distribution equipment.
   4. Green surface with white core for all delayed equipment branch power distribution equipment.

B. All empty conduit runs and conduit with conductors for future use shall be identified for use and shall indicate where they terminate. Identification shall be by tags with string or wire attached to conduit or outlet.

C. Paint junction and outlet boxes and covers of accessible raceway systems the following colors:
   1. Normal Power Systems: Black.
   2. Emergency Power Systems: Life safety: Yellow, Critical: Orange, Delayed Equipment: Green.
   3. Data and Telephone: Brown.
   4. Nurse Call: Blue.
   5. Fire Alarm: Red.
   6. CATV: Field determined.
   7. Paging: Field determined.
   8. Door Locking System: Field determined.

D. Legibly mark conduits at junction boxes above accessible ceilings and in the attic with the panelboard and circuit numbers of the circuits contained in the raceway using a permanent black, bold marking pen.

E. Install approved marking tape above all underground cables and conduits.

F. Wire markers: Provide wire markers on each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection. Legend: (1) power and lighting circuits: branch circuit or feeder number as indicated on Drawings (2) control circuits: control wire number as indicated on schematic and interconnection diagrams on Drawings.

G. Receptacle circuit identification: Provide adhesive backed, laminated plastic receptacle device plate labels identifying the panel and circuit number feeding the device (i.e., RPA-24). Labels shall be label machine printed, black lettering on a clear background, to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal. Location: each receptacle device plate, centered on the lower portion below the receptacle, parallel to the lower surface.

16020 SUPERVISION

A. The Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from the beginning to completion and final acceptance. So far as possible, he shall keep the same foreman and workmen throughout the project duration.

B. During the progress of the work it shall be subject to inspection by representatives of the Architect/Engineer, the Owner, and all inspection authorities, at which time the Contractor shall furnish such required information and data on the project as requested.

16021 EXCAVATION, TRENCHING AND BACKFILLING

A. The Electrical Contractor shall do all excavating, trenching and backfilling in connection with this contract in strict compliance with Division 2 of these specifications. All such excavation shall be done in a manner as not to endanger or damage existing utility lines and other structures. If damage occurs, the Contractor shall repair damage at his expense and to the satisfaction of the Architect/Engineer.

B. It shall be the responsibility of the Contractor to investigate conditions before excavation and to exercise care during the excavation to avoid any utilities or other objects which may not be shown. Whether or not utilities, etc., are shown on the Drawings shall not relieve the Contractor from his responsibility to repair any damage caused by this work. Location of all ditching shall be laid out at grade and shall be approved by the Architect/Engineer before excavating and no work shall be done until such approval has been obtained.

C. All surplus earth shall be removed by the Contractor from the site and disposed of at his own expense.

D. Backfilling shall be in 6" layers with each layer tamped. No boulders or debris shall be used for backfill material. Where trenching passes through areas designated as streets, driveways, walkways, or parking areas, backfill shall be tamped with power tamps to 95 percent compaction.

E. Excavation shall be bid unclassified with no extra payment for removal of rock.

16022 CLOSING IN WORK

Work shall not be covered up or enclosed until it has been inspected, tested and approved by the authorities having jurisdiction over this work. Should any of the work be enclosed or covered up before such inspection and test, the Contractor shall uncover the work at his expense; after it has been inspected, tested and approved, he shall restore the work to its original condition.

16023 BASIC MATERIALS AND METHODS

A. In general, all wiring shall consist of individually insulated copper conductors installed in metallic raceways. Alternately, Type MC cable with separate green insulated ground conductor may be used in lieu of conduit and wire for branch circuits where permitted by Codes, the AHJ and DHSR. If permitted, Health Care Rated MC Cable with green insulated ground conductor may be used for branch circuits in patient care areas, as defined by the AHJ, to conform to the grounding requirements of NEC Article 517. Where the word "conduit" is used on the Drawings, or in these specifications, it shall mean rigid galvanized steel, rigid polyvinylchloride conduit or electrical metallic tubing, installed in general locations as indicated below.
   1. Rigid galvanized steel conduit shall be used for:
      a. Exposed circuits, from floor to 4'-0" above floor and for those instances where raceways are exposed to the weather or to mechanical injury of one sort or another.
      c. Branch circuits concealed in exterior masonry walls.
      d. Branch circuits in wet locations above or below grade.
   2. Electrical metallic tubing may be used for feeders, concealed or exposed, where not subject to severe physical damage and all branch circuit work not included above and as indicated in the specifications and/or on the Drawings. EMT may be used in interior walls and in the space above furred ceilings, and in exposed areas except as described in subparagraph above. EMT shall not be installed where it will be:
      a. subject to severe physical damage.
      b. installed nearer than 4 feet from finished floor in exposed areas
      c. subject to severe corrosive influence
      -or-
      d. Where tubing, elbows, couplings, and fitting would be in concrete or in direct contact with the earth.
      e. For service entrance use.
      f. Where not allowed by Codes, the AHJ or DHSR.
   3. Where conduit is installed underground, conduit may be Schedule 40 PVC.

B. Rigid galvanized steel conduit shall be installed in accordance with the NEC, except the maximum spacing of supports and/or anchorage shall be 8 feet for conduits 1/2" through one inch and 10 feet for conduits 1-1/4" and larger. EMT shall be installed in accordance with the NEC, except the maximum spacing of supports and/or anchorage shall be 8 feet for all sizes. Where concentric or eccentric knockouts are encountered, a grounding bushing shall be installed with

a copper bonding jumper securely attached to the bushing and solid metal of the box or cabinet. "Grounding wedges" or "washers" are not acceptable. Conduit ends shall be cut square with the longitudinal axis of the conduit, reamed and filed smooth, and threaded long enough to jam together in a conduit coupling, or come up hard and tight against the bushed shoulder of a cast conduit fitting. Field threads shall be of same type and have same effective lengths as factory cut threads. Raceway joints shall be made with approved couplings or unions. Bends and offsets shall be made with a hickey or power bender without kinking the raceway. Deformed raceway shall be replaced. Where metallic conduits are exposed to the weather, buried in concrete, or installed below grade, the threads shall be treated with Crouse Hinds "STL", or approved equal, before screwing up into final position. Where conduit is installed across structural expansion joints, conduit expansion joints shall also be installed.

C. Non-metallic conduit shall be installed in accordance the NEC except the maximum spacing of supports and/or anchorage shall be three feet for all sizes. Conduit ends shall be cut square with the longitudinal axis of the conduit, reamed and filed smooth, and jammed together in a conduit coupling, or come up hard and tight against the bushed shoulder of a conduit fitting. Raceway joints shall be solvent welded in accordance with the recommendations of the manufacturer and made with approved couplings and fittings. Bends and offsets shall be made with an approved bender without kinking the raceway. Deformed raceway shall be replaced. Where conduit is installed across structural expansion joints, or in lengths of 200 feet or more, conduit expansion joints shall also be installed.

D. Raceways may not be installed laterally in concrete floor slabs where the outside diameter of the conduit, measured at a coupling, exceeds one third the thickness of the concrete. Conduit shall occupy the middle third of the slab when practical and leave at least 3/4" concrete cover. Where reinforcing bars occur at the 3/4" level, the conduit shall be run inside them towards the center of the slab. Raceways shall be tied to the reinforcing rods or otherwise supported when necessary to prevent sagging when concrete is poured. Raceways shall be laterally spaced not closer than three diameters on centers to allow complete concrete coverage.

E. Raceways indicated or required to extend underground outside the building shall be extended to 5'-0" minimum beyond all paving, walks, etc., that abut the building.

F. Openings for raceways passing through outside walls, floors or roofs shall be made watertight. Pierced vapor barriers shall be made vaportight.

G. Raceways shall be installed in walls as they are erected.

H. During installation, raceway ends shall be capped or plugged to prevent the entrance of foreign matter. All raceways shall be clean and free from any foreign matter inside before any conductors are pulled in. Raceways that have been clogged shall be entirely freed or shall be replaced.

I. Where architectural construction does not permit concealed raceways and where indicated on the Drawings, raceways shall be run exposed. Exposed raceways shall be run parallel to, or at a right angle with the building walls. Outlets, junction, taps, etc., on exposed rigid metal conduit shall be cast metal conduit fittings or cast metal boxes of the type and size appropriate for the location. Sheet steel outlet boxes shall not be permitted on exposed raceway runs except at or near a ceiling for interior construction.

J. Raceways shall be sized as indicated on the Drawings and/or as required by the National Electrical Code, whichever is larger. Minimum size for raceways shall be ½".

K. All raceway systems shall be installed complete before any conductors are pulled.

L. Circuiting is shown schematically. Exact routing of branch circuits may be varied to suit building construction; however, the combination of circuits within raceways and panelboard connections shall not be changed from those shown on the Drawings.

M. All circuits shall contain an insulated, green, copper grounding conductor sized in accordance with Table 250-122 of the NEC. The grounding conductor shall be connected to the equipment ground bus in panelboards and securely attached and grounded to the device or enclosure at the other end of the run.

N. Grounding type convenience outlets and switches shall be solidly grounded to equipment grounding system with a green colored insulated conductor. Electrical connections shall be continuous from equipment ground bus in panelboard to the hex-nut on convenience outlet and/or switch.

O. Flexible metal conduit shall be installed in accordance with the NEC. When flexible metal conduit is used at any point in the electrical raceway system, an insulated, green, copper grounding conductor sized in accordance with Table 250-122 of the National Electrical Code shall be installed within the flexible conduit and securely attached and grounded to the electrical raceway system at each end of the flexible section. Flexible metal conduit may be used for work above lay-in ceilings only.

P. Liquidtight flexible metal conduit shall be installed in accordance with the NEC. An insulated, green, copper grounding conductor sized in accordance with Table 250-122 of the NEC shall be installed within the flexible conduit and securely attached and grounded to the electrical raceway system at each end of the flexible section. Liquidtight flexible metal conduit shall be used for all work except as specified in previous paragraphs.

Q. All motors with conduit connection thereon shall be connected to conduit system with short length (minimum length of 12" and maximum length of 24") of flexible liquidtight conduit utilizing hex-nut, steel fittings.

R. Interior metal framing systems, as shown and/or as required, shall be installed to support and/or to mount equipment. Framing systems shall be Unistrut P-1000 series, or approved equal, with necessary fittings and hardware for mounting. Exterior metal framing systems shall be hot dipped galvanized.

S. Raceways and Box Supports: Raceways and boxes shall be attached to the structure as follows with attachments spacing as indicated in subparagraph above.
   1. Conduit shall be attached to the structure with one or two hole pipe straps or minerallac clamps where raceway is run against surface.
   2. Raceways and boxes shall be fastened to masonry with lead anchors and machine screws or toggle bolts. Raceways shall be fastened to structural steel with beam clamps, conduit hangers, trapeze hangers, or other devices approved for such usage. Perforated iron shall not be used to support raceway. Threaded studs driven by a power charge are acceptable in lieu of lead anchors and machine screws, provided power charge used is recommended charge for material penetrated.
   3. Where raceway is of necessity supported horizontally away from the surface of the structure it shall be supported on threaded steel rods of sufficient diameter to carry the weight of the raceway(s), 1/4 inch being the minimum size rod permitted. In the case of single raceways, a minerallac clamp shall be attached to the end of the rod with two nuts top and bottom of the clamp. The upper end of the rod shall be attached to the structure by beam clamps or other approved hanging method. All nuts used in the assembly of a hanger shall be installed with lock or star washers.
   4. Where multiple runs of raceways are installed parallel, whether horizontally or vertically, they shall be attached to the flat side of a steel angle or channel of sufficient rigidity by any one of the methods indicated above, and the angle attached to the structure surfaces by bolting or welding. Unistrut and Unistrut clamps may be used in lieu of the above angle and clamps. Where runs are horizontal, support of the angle shall be as described above.
   5. Where runs of flexible conduit both liquidtight and non-liquidtight of necessity exceed six feet in length and permission is obtained from the Architect/Engineer to exceed six feet, the flexible conduit shall be supported in cable trays or other approved method.

T. All equipment shall be firmly and solidly secured to structural members of the building walls, floors, etc., with suitable hangers, clamps, bolts, and supports designed for service required.

U. Outlet and/or junction boxes installed in concealed locations shall be set flush with the finished surfaces and shall be provided with the proper type extension rings or plaster covers where required. Boxes shall be installed in rigid manner and properly supported. Do not install boxes back-to-back.

V. Electrical Contractor shall be responsible for locating and providing anchors, inserts, supports, etc., and maintaining them in position during construction.

W. All rotating and vibrating equipment installed under this contract shall have vibration isolators of type and loading density to prevent noise and/or vibration from being transmitted to the building.

X. Lighting Fixtures, Supports and Grounding:
   1. Each lighting outlet shall be equipped with a fixture stud for support of the lighting fixture where required.
   2. Where a recessed or downlight fixture replaces a section or part of an acoustical ceiling tile, or a section or part of a suspended gypsum board ceiling, the fixture shall be supported at two (2) diagonal corners to the steel frame of the building. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track or GWB ceiling system. Attach one end of the wire to one corner of the fixture and the other end to the building's structural system. The lay-in or flange fixture shall then be screwed to the main runners of the lay-in ceiling track or GWB ceiling system at all four (4) corners using sheet metal screws (parabolic type fixtures shall be attached to the ceiling grid with approved clips). The Electrical Contractor shall be responsible for coordination work with the ceiling contractor; however, the ceiling contractor will provide framed openings for reception of lighting fixtures. All recessed fixtures shall be furnished with all necessary mounting accessories.
   3. Surface type lighting fixtures shall be mounted against suspension type ceilings by extending bolts or rods from fixtures wireway to steel channels which in turn are to be firmly attached to the structural ceiling. All hanging accessories such as channels, bolts, rods, etc., shall be furnished by this contractor. Provide two supports per 4 foot unit; three supports per 8 foot unit; and equivalent for continuous row mounting.
   4. All lighting fixtures, without a direct rigid steel metal conduit connection thereto, shall be bonded to the conduit system with #12 AWG green grounding conductor. Fixture stems are not considered rigid conduit. All lighting fixtures shall be bonded to the green grounding conductor running within the e raceway feeding the fixture.

Y. Raceways and ducts penetrating rated floor, ceiling or wall assemblies shall be properly sealed in accordance with the corresponding Underwriters Laboratories approved method utilizing approved and listed materials.

Z. At each flush mounted panelboard location, install three empty 1" conduits from panelboard to the space above the adjacent ceiling. All empty conduits from panelboards shall be capped, tagged and left accessible.

16024 RACEWAYS AND FITTINGS

A. Rigid conduit shall be standard weight, mild steel pipe, galvanized and shall bear the Underwriter's Laboratories, Inc. label of approval.
   1. Rigid steel conduit, couplings and elbows shall be iron pipe size, threaded. All steel conduit shall be hot dipped galvanized, UL approved and meet the latest NEMA Standards.

2. Conduit fittings shall be corrosion resistant steel, threaded type as manufactured by Appleton, Crouse Hinds, Killark or O.Z. Gedney.

B. Electrical metallic tubing (EMT) shall be cold-rolled steel tubing, hot dipped galvanized, and shall bear the Underwriter's Laboratories, Inc. label of approval.
   1. Electrical metallic tubing shall meet the latest NEMA standards.
   2. EMT fittings shall be steel and of the hex-nut compression type, Series 5123 as manufactured by Thomas & Betts. Equals by O.Z. Gedney, Steel City or Raco will be accepted. EMT fittings shall have insulated throats. No pot metal, set screw, or indenter fittings shall be used.

C. Rigid polyvinylchloride conduit (PVC) shall be Schedule 40, manufactured and tested in accordance with NEMA TC-2, Federal Specification WC-1094A, UL-651 and shall be rated and labeled for use with 90 degrees C. rated conductors. PVC shall be installed in compliance with Article 347 of the National Electrical Code. Conduit shall be manufactured from a virgin polyvinylchloride compound meeting ASTM Cell Classification 13364. Smoke emissions shall be less than 6 grams per 100 grams of material when tested in a standard Araphoe Smoke Chamber. PVC conduit, fittings and cement shall be produced by the same manufacturer.

D. Flexible metal conduit and liquidtight flexible metal conduit shall bear the Underwriter's Laboratories, Inc. label of approval and shall meet all applicable NEMA standards requirements.
   1. Standard flexible steel conduit shall be as manufactured by Electri-Flex, Alflex, Anamet or Guardian. Fittings shall be "Tite-Bite" nylon insulated, as manufactured by T&B or equal by Crouse-Hinds, O.Z. Gedney or Raco.
   2. Liquidtight flexible steel conduit shall be as manufactured by Alflex, Anamet, Appleton or Electri-flex. Fittings shall be Series 6000 "Super-Tite" as manufactured by T&B or equal by Crouse-Hinds, O. Z. Gedney or Raco.

E. Junction and outlet boxes for interior use in dry locations shall be zinc coated or cadmium plated sheet steel 4" square and 2-1/8" deep, unless otherwise indicated on the Contract Drawings. Smaller and shallower outlet boxes will be permitted only by special permission of the Architect/Engineer where such boxes are necessary due to structural conditions encountered. Where larger junction boxes are required, they shall be fabricated from No. 10, 12, 14 or 16 gauge sheet steel as required by the Underwriter's Laboratories, Inc., and galvanized after fabrication. All junction boxes shall have screw fastened covers. Junction and outlet boxes exposed to the weather or in wet or damp locations shall be of cast malleable ferrous metal, or bronze with threaded connections, external mounting lugs, and gasketed covers. Ferrous metal boxes shall be galvanized. Outlet boxes shall be provided with extension plaster rings where required by structural conditions. Sheet steel boxes shall be as manufactured by Appleton, Raco, Steel City or Spring City. Cast boxes shall be by Crouse-Hinds, Appleton, O. Z. Gedney or Killark. All boxes shall be UL approved.

F. Set wall mounted boxes at elevations to accommodate mounting heights indicated and specified in section for outlet device. Boxes are shown on Drawings in

approximate locations unless dimensioned. Adjust box location up to 10 feet if required to accommodate intended purpose. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes. Use flush mounting outlet box in finished areas. Use Erico Caddy RBS series, Raco 9001 or Cooper B-Line BB8-16 box mounting brackets to support flush mounting outlet boxes between studs.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

I. Insulated bushings shall be O.Z. Gedney, Type B or equal by T&B, Appleton or Crouse-Hinds.

J. Insulated bonding and grounding bushings shall be T&B Series 3882 or equal by Appleton, O.Z. Gedney or Crouse-Hinds.

K. Pull boxes shall comply in mechanical construction and material aspects to junction boxes, subparagraph above.

L. Wiring trough shall be fabricated from No. 10, 12, 14 or 16 gauge sheet steel as required by the Underwriter's Laboratories, Inc. and galvanized after fabrication and shall have screw fastened covers. Wiring troughs exposed to the weather or located on wet or damp areas shall have gasketed covers and threaded gasketed hubs and be listed as NEMA 3R.

M. Pull boxes, troughs and junction boxes larger than 5 inches square shall have no preformed knockouts.

N. Handholes and boxes for exterior underground wiring shall be designed and identified as defined in NFPA 70, for intended location and application. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.

4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC." or other appropriate lettering.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

16025 CONDUCTORS

A. Conductors shall be single conductor copper, 600V insulated building wire. The minimum wire size for current carrying conductors, neutrals, equipment grounds and bonding jumpers shall be #12 AWG copper, maximum size 600 KCMil. Conductors No. 10 AWG copper and smaller shall be solid. Conductors No. 8 AWG copper and larger shall be stranded. Wire sizes, insulation type and manufacturer's name shall be permanently marked on conductor jacket at regular intervals. All wire and cable shall be delivered to job in complete coils and be color coded as hereinbefore specified.

B. All wire and cable shall be installed in conduit, except where MC Cable and/or free run lighting control cable, data and telephone, nurse call, paging, mag lock, CATV, Aiphone, etc. low voltage systems is specifically permitted by the AHJ and DHSR. This includes all power wiring; fire alarm, emergency systems control conductors, etc. and other electrical systems required by Codes to be installed raceways. Lighting control cable is permitted above accessible ceilings, in attics and in conduit to the switch location.

C. Conductors shall be color coded as follows:

<u>120/208 volts</u>

Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White*
Ground	Green

*Provide branch circuit neutral conductors with factory color coded markings or stripes identified for their associated phase conductor (white-black, white-blue, white-red) where individual neutral conductors are required.

D. Conductors shall be color identified at each outlet box, switchbox, junction box, pull box, cabinet, switchboard, transfer switch, distribution panel, etc.. Phase and neutral conductor sizes #6 AWG and smaller shall be factory color coded. Conductors #4 AWG and larger shall be identified by applying a 1” band of the proper colored waterproof plastic marking tape to each conductor 2" from the end of the conductor. Low voltage and/or control wiring may be color coded also, but the colors shall not be those allocated to the main wiring system.

E. <u>Common neutral branch circuits are not permitted. Provide separate, individual neutral conductors for all branch circuits, including receptacle and lighting circuits.</u>

F. Metal Clad (MC) Cable with aluminum interlocked armor, copper conductors and an internal green insulated equipment grounding conductor may be used for

branch circuits 30 amperes and less. Conductors shall be solid and stranded as specified herein, minimum #12 AWG, maximum #10 AWG with dual-rated THHN/THWN or XHHW 600V insulation, conductor color coding the same as Building Wire above. Use cable with individual neutral conductors where specified and/or required. Cable with individual neutral per phase design neutral conductors shall be provided with factory color coded neutral markings or stripes identified for their associated phase conductor (white-black, white-red, white-blue). MC cable with integral power and low voltage cable for lighting control is permitted. Connectors shall be zinc plated malleable iron or steel body with locknut, dual cable gripping saddle design with set screw and insulated throat. Pressure cast (pot metal) connectors are not permitted.

G. MC cable may be used exposed in electrical equipment rooms where branch circuits originate at panelboards, but cable shall be supported and neatly arranged above panelboards on steel ladder rack, width as required. Cable shall be strapped to ladder rack using approved, UV resistant plastic cable ties. Alternately, MC cable shall be transitioned to building wire and metallic raceway outside of the electrical equipment rooms in a junction box or wiring trough concealed above an accessible ceiling. If this method is utilized to convert MC cable to building wire and metallic raceway, provide screw connection, feed-through, modular type DIN rail terminal blocks for termination and extension of circuit conductors. Terminal blocks shall be rated 30A, 300VAC minimum, and higher as required by circuit ampacity and voltage, quantity as required for phase, neutral and equipment ground conductors. Wirenut and similar terminations are not permitted in splice boxes or panelboard interiors. All splices shall be clearly labeled and neatly trained as judged acceptable by the Engineer.

H. MC cable shall be supported in straight lines using approved supporting means and in compliance with the NEC. Dedicated support wires may be used above finished ceilings and shall be painted red prior to installation. Do not support cable with ceiling grid supports wires. Do not drape cable over ceilings, lighting fixtures, conduit, ductwork, piping or equipment. Do not “daisy-chain” connect lighting fixtures with MC cable.

I. Lighting control cable for dimming and occupancy sensor control shall be provided as required. Lighting control cable may be provided integral to MC cable, or discrete, as approved by the lighting controls manufacturer and as required by NEC Article 725. If discrete, cable shall be NEC Type CMP, in raceway from the switch outlet box to the accessible ceiling cavity, then free run to follow the lighting power system raceways to the fixtures controlled, be secured to the structure to the plane of the lighting power raceway system, then supported by the lighting power raceway system using NEC approved cable ties installed on no more than six foot intervals, or less if required by Codes and the AHJ. Lighting control cable shall be plenum rated and be approved by the lighting controls manufacturer. It shall consist of a 2#18 AWG solid, violet and gray insulated conductors minimum with an outer jacket rating of 600V minimum. Cable outer jacket shall not be red. Cable shall be daisy chain connected to lighting fixtures or be taped in junction boxes installed at the same plane of the lighting power raceway system. Do not

support cable with ceiling grid supports wires. Do not drape cable over ceilings, lighting fixtures, conduit, ductwork, piping or equipment. Daisy chaining cable at the ceiling level is not permitted.

J. The Contractor may provide aluminum conductors for service entrance and large feeders. Such conductors shall result in equal ampacity to the copper service entrance and feeders they replace. The contractor is responsible for obtaining written approval from the Architect/Engineer for all proposed changes prior to installation. Raceways shall be upsized and quantities increased as required to maintain service entrance and feeder ampacity. Installation shall conform to conductor and connector manufacturer's recommendations including oxide inhibitor use and properly torqued connections. Maintain all NEC required spacing inside cabinets at terminations.
   1. AA-8000 series aluminum conductors may be substituted for copper service entrance and feeder conductors in size #1/0 AWG and larger (i.e.; #3 AWG copper replaced with #1/0 AWG aluminum. Copper conductors in size #4 AWG and smaller shall remain copper.). Note typically smaller circuit conductors such as equipment ground conductors may be required to be copper.
   2. The maximum aluminum conductor size shall be 750 KCMil.
   3. All aluminum conductor terminations shall be made with machine applied compression connectors and individually field verified and certified in writing by the contractor to be installed per the conductor and equipment manufacturer's recommendations. Insulation shall be removed by "penciling" or using a manufacturer-approved insulation removal tool that does not nick the underlying conductor. Do not "ring cut" insulation. Wire brush the conductor and apply conductor manufacturer approved oxide inhibitor prior to terminating, unless the compression connector is prefilled with inhibitor, all as recommended by the manufacturer.

K. Do not bundle metal clad cable in a manner that requires the conductors be derated.

L. Conductors shall be spliced and tapped as follows:
   1. Solid branch circuit conductors shall be spliced in junction boxes and lighting fixtures using Ideal "Wing Nuts", T&B "Piggy" connectors or equal by Buchanan or AMP. Connectors rated at 150 degrees C. shall be used for recessed lighting fixture lead splices to branch circuit conductors. All compression type connectors shall meet requirements of applicable NEMA standards and shall be UL approved. Crimp type connectors are not permitted.
   2. Conductors #8 AWG and larger shall be stranded and joined by approved compression connectors. Joints shall be smoothly covered and shaped with rubber gum tape with a final cover of vinyl plastic electrical tape. In lieu of rubber gum and vinyl plastic tape, factory fabricated heat shrink tubing may be used. Connectors and insulating materials shall be Underwriter's Laboratories, Inc. approved. Compression lugs may be used in lieu of mechanical connectors on circuit breaker terminals, panelboard and

switchboard line connections, etc., provided they are installed with properly sized Belleville type compression washers. In cases where long shank connectors extend from the point of connection and present a sizable amount of energized metal, a length of 90 degrees C. heat shrink tubing shall be installed to completely insulate the connector body. Taps may be insulated with adhesive insulating covers in lieu of rubber gum and vinyl plastic tape. Compression connector installing tools and dies, of hexagonal or circumferential type and made by the connector manufacturer, shall be used for installation. Tooling with color coded or die/connector coding systems for inspection purposes shall be used. Where UL listing is applicable for the connectors, the manufacturer's recommended tooling shall be used. Connector installing methods and compression pressure shall be as recommended by the connector manufacturer.

3. Joints in stranded conductors shall be spliced by approved mechanical connectors and insulated with vinyl mastic tape and covered with vinyl electrical tape, 3M Scotch Vinyl Mastic Tape 2210 and Scotch Vinyl Electrical Tape Super 88, respectively, or approved equal. Solderless mechanical connectors for splices and taps, provided with UL approved insulating covers, may be used instead of mechanical connectors plus tape.
4. Conductors shall not be spliced or tapped in interior wiring systems of any description using "split bolt" connectors. All conductors in interior wiring systems shall be continuous without splice between junction, outlet, or switch boxes. No splicing will be permitted in panelboard cabinets, safety switches, etc.

M. Wire and cable shall meet the latest requirements of NEMA and IPCEA and shall be approved by the Underwriter's Laboratories, Inc.

N. Conductors in switchboards, panelboards, junction boxes, etc., shall be grouped together and laced with plastic cable ties in neat, substantial and approved manner. Do not tightly bundle conductors. Each conductor in junction boxes, etc., shall be permanently marked showing panelboard and circuit number in panelboard, room served, etc., with wire markers.

O. Conductors shall not pass through cabinets, switch enclosures, etc., unless intended for specific use within the cabinet or enclosure. Junction boxes or auxiliary gutters shall be used in such cases.

P. Junction and/or pull boxes shall be furnished and installed where necessary to avoid excessive runs and/or too many bends between outlets. Not more than the equivalent of two (2) 90 degree bends will be allowed in any feeder circuit run or more than the equivalent of three (3) 90 degree bends will be allowed in any branch circuit run without junction or pull boxes being installed.

Q. Where any conduit run passes a building expansion joint, furnish and install an expansion fitting, complete with copper bonding jumper.

R. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

S. A pull wire shall be left in each run of empty conduit. Pull wire shall be 14 gauge steel or approved nylon cord.

T. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

U. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.

V. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

W. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

X. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

Y. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

16026 ELECTRICAL SERVICE SYSTEMS

Electrical service to the facility shall be 120/208 volts, three phase, four wires from the local utility company. Coordinate connections, location of utility company facilities, metering arrangement, etc. with the utility company.

16027 GROUNDING SYSTEMS

A. The neutral of each secondary electrical distribution system shall be grounded at one point only which shall be at the main disconnecting device(s). From the main disconnecting device(s), a copper grounding conductor sized in accordance with the NEC shall be extended to the earth electrode. Main grounding conductors #8 AWG through and including #4 AWG shall be insulated and identified by a green colored insulation. All grounding conductors shall be installed in conduit sized in accordance with the NEC. Conduit carrying a grounding conductor shall also be grounded at the earth electrode.

B. The earth electrode shall be:
   1. The metallic domestic water piping system of the building. Install insulated copper grounding conductors, in conduit, from building's main service ground bar, to main metal water service entrances to building. Connection of the grounding conductor shall be made by an approved grounding clamp. The point of connection to the water system shall be within 6 inches of the

entrance of the pipe inside the building or structure. Where dielectric unions are used in the water piping system, the grounding connection shall be made on the "street side" of the first such union in the system. A bonding jumper the same wire size as the grounding conductor shall be installed across the water piping connection such that the water meter may be removed without interrupting the grounding system continuity. Where no metallic domestic water piping system exists, the earth electrode shall be a ground rod with supplemental ground electrodes as defined below.

2. Ground Rods: ¾" Copper-clad steel, driven 11 feet into the earth where shown on the contract drawings or as required. The rods shall be connected to the system ground point on the water pipe by an insulated, green copper jumper in conduit. The jumper shall be sized in accordance with the NEC and the connection at the rod shall be brazed or exothermically welded. The points of connection to the earth electrode system shall be visible and accessible upon completion of construction. Sectional rods of the same size and length shall be used in multiple rod installations, if required by soil conditions.
3. The building steel and slab reinforcing steel as shown and as required by the NEC. Connection points shall be as directed by the Architect/Engineer.

C. The ground resistance of the earth electrode shall not exceed 5 ohms. The Electrical Contractor shall test the earth electrode using a standard three point ground resistance tester and shall advise the Architect/Engineer of the results of such tests in writing. Where tests show the resistance to ground exceeds 5 ohms, appropriate action shall be taken to reduce the resistance to 5 ohms, or less, by driving additional ground rods or other approved methods. Compliance shall be demonstrated by retesting.

D. Grounding conductors shall be installed as to permit the shortest and most direct path from equipment to ground. All connections to ground conductors shall be accessible for inspection and made with approved solderless connectors, brazed or bolted to the equipment or structure to be grounded. All contact surfaces shall be thoroughly cleaned before connections are made to insure good metal to metal contact.

E. Equipment grounding continuity shall be maintained through flexible conduit as required in previous sections.

F. All wiring devices equipped with grounding connections shall be permanently and securely connected to the enclosure in which they are mounted with a copper grounding jumper.

G. The frame of all lighting fixtures shall be securely grounded to the equipment ground system with grounding conductors.

H. An equipment ground bus shall be installed in each panelboard for terminating equipment grounding conductors.

I. All equipment housings and/or enclosures, and all non-current carrying metallic parts of electrical equipment, raceway systems, etc., shall be effectively and adequately bonded to ground.

J. Provide separate, insulated conductor within each feeder and branch circuit raceway.

K. Equipment Grounding Conductor: The raceway system shall not be relied on for ground continuity. A green grounding conductor, properly sized per the NEC shall be run in all raceways. Terminate each end on suitable lug, bus, or bushing.

L. Boxes with concentric, eccentric or over-sized knockouts shall be provided with bonding bushings and jumpers. The jumper shall be sized per the NEC and lugged to the box. All metallic raceways entering or leaving panelboards (branch circuits less than 30 amperes in lighting and appliance branch circuit panelboards excepted), switchboards, transfer switches, enclosed circuit breakers, safety switches, transformers, pull boxes, splice boxes, etc. shall be provided with insulated grounding and bonding bushings and each separate piece of raceway shall be individually bonded to the equipment ground bus or metallic enclosure, as applicable, by means of copper conductor sized in accordance with the NEC.

M. Bonding bushings shall be steel or malleable iron, insulated, threaded type, zinc plated for interior use and galvanized for exterior use. Provide with dual rated tin plated saddle for use with bonding conductors and resilient plastic insulation throat liner with 150°C rating molded on over the metallic stop. All bushings shall be third party testing agency approved and listed. Die cast zinc bushings are not acceptable.

N. An equipment ground bus shall be installed in each switchboard, panelboard, safety switch, etc. for terminating equipment grounding conductors.

O. Electrical Power Grounding Busbars: Third party testing agency listed and labelled. Grounding busbars shall be provided for single point termination of power distribution system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a NEMA hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

P. Telecommunications Grounding Busbars: Comply with TIA-607-C and BISCI Standards. Grounding busbars shall be provided for single point termination of telecommunications system grounding and bonding conductors as shown on the Drawings. Grounding busbars shall be tin plated solid copper factory drilled with a BISCI hole size and pattern for termination of two hole lugs, quantity as required with 25% spare, and be of the minimum dimensions shown on the Drawings. Provide with 600V standoff insulators, stainless steel mounting brackets and stainless steel hardware. Provide clear Lexan cover over connections.

Q. Patient Care Areas Grounding: Wiring methods used patient care areas (bedroom and bathrooms of each patient unit, patient treatment and exams rooms, etc.) shall be as defined and as required by NEC Article 517 with redundant grounding paths. Where Type MC cable is utilized in these areas, HCF Type MC cable shall be used.

R. Bond grounding terminal buses of the normal and essential branch circuit panelboards in accordance with NEC Art. 517.14.

S. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

16028 FEEDER CIRCUITS

Feeder circuits shall be installed in conduit with 600V insulated conductors, size and number as indicated on the Contract Drawings. Conductors sizes #8 and larger are considered feeders.

16029 BRANCH CIRCUITS

Branch circuits shall be installed in conduit with 600V insulated conductors, size and number as indicated on the Contract Drawings. Conductor sizes #10 and smaller are considered branch circuits.

16030 WIRING DEVICES

A. Toggle switches shall be single pole, three way or four way as indicated on the Contract Drawings. Switches shall be the grounding type, rated 20A, 120/277V, AC only. Switches shall be in color selected by Owner, coordinate device and device plate colors with other wiring devices, including telecom outlets, receptacles, etc. Devices on generator power shall be red in color. All switches shall have quiet operating mechanisms without the use of mercury switches. All switches shall be UL approved for the voltage and amperage indicated. Switches shall be Hubbell Model 1221/2/3/4 Series, Leviton 1221/2/3/4 or Pass and Seymour PS20AC1/2/3/4.

B. Wall box type rocker/decorator (Decora) style white plastic rocker switch with 0-10V dimmer preset slider for LED loads. Decora style white plastic with preset slider. Ratings: 120 277 volts AC, 8A minimum. Provide with 16A power pack for loads greater than 8A. Lutron DVSTV and DVTV or equal by Sensor Switch or Wattstopper.

C. Receptacles:
   1. Duplex receptacles in interior finished areas shall be in color selected by Owner, coordinate device and device plate colors with other wiring devices, including switches, telecom outlets, etc. (devices on generator power shall be red in color), of the grounding type, arranged for back and side wiring,

with separate single or double grounding terminals. Receptacles shall be straight blade, rated 20A, 125V, and the face configuration shall conform to the NEMA Standard No. WDI.1-1968 and shall be UL approved.

2. Self grounding or automatic type grounding receptacles are not acceptable in lieu of receptacles with separate grounding screw lugs and a green jumper connection to the grounding system.
3. Receptacles shall be specification grade, mounted vertically and shall be Hubbell HBL5362, Leviton 5362 or Pass and Seymour 5362A. Receptacles in patient care areas shall be hospital grade, Hubbell #8300 series or equal by Leviton or Pass and Seymour. Ground fault circuit interrupting receptacles shall be Hubbell GFRWRST20, Leviton GFWT2 or Pass and Seymour 2097TRWR. Receptacles installed over counters, back-splashes, etc., shall be mounted horizontally.
4. Provide tamper proof receptacles where required by Codes.

D. Occupancy Sensors: The Occupancy Sensor system shall sense the presence of human activity within the spaces indicated and fully control the “On” / “Off” function of the lighting loads automatically. Sensors shall turn “On” the load upon entrance into the room and shall not initiate “On” outside of entrance. Occupancy sensors shall utilize dual technology sensing. Acceptable technology is passive infrared (PIR), ultrasonic and microphonic. Dual technology is required utilizing PIR and one of the other technologies. Sensors shall automatically adjust time delays and sensitivity based on the activity level in the space. All switches shall be approved by a third party agency and approved for the voltage and current indicated. Sensors shall be compatible with all load types, including LED, electronic and compact fluorescent ballasts and incandescent and require no minimum load. Match device body and handle type and colors specified above. Lutron, Sensor Switch or Wattstopper.

1. Wall switch line voltage sensors for small areas: Line voltage, single gang, wall mounted occupancy sensor switch with one override switch. Sensor shall recess into single gang switch box and fit a standard GFI receptacle plate opening. Provide in same colors as toggle switches. Switches shall be compatible with standard three and four-way toggle switches. Provide hard lens switches in storage rooms and other location subject to abuse. Adjustable time delay of 20 minutes, 180 degree field of view, minimum coverage area of 900 sf. Voltage: 120-277 volts ac, minimum load rating 800 watts at 120 vac, 1200 watts at 277 vac.
2. Ceiling mounted low voltage sensors for large areas: Low voltage, recess ceiling mounted occupancy sensor switch shall operate in conjunction with a line voltage power pack to control the connected lighting loads. Sensors shall operate on a Class 2, three-conductor cable system. Multiple sensors shall be connectable to a single power pack. Sensor shall recess into a two gang outlet box. Adjustable time delay of 1 - 15 minutes. Power packs shall be rated 20A at 120-277 volts and shall be compatible with all load types including LED, electronic and compact fluorescent ballasts and incandescent and require no minimum load. . They shall have the capacity to power additional remote heads or additional relays. Power packs may be paralleled to accommodate extra load or more than three heads or

additional relays. Additional relay shall be used where there is more than one circuit being controlled or where there is a need to control multiple voltages.

3. Wall box low voltage sensor/dimmer switches for small areas: Low voltage, single gang, wall mounted occupancy sensor switch 0-10v dimmer with one override or two (as shown) switch(es). Switch shall recess into single gang switch box and fit a standard GFI receptacle plate opening. Switches shall be compatible with standard three and four-way toggle switches. Provide hard lens switches in storage rooms and other location subject to abuse.

E. Cover plates for flush mounted wiring devices and for telephone outlets shall be single and combination, of types, sizes and with ganging and cutouts as indicated. Provide plates which mate and match with wiring devices to which attached. Material shall be white smooth nylon as manufactured by the device vendor. Cover plate mounting screws shall be slotted head oval and shall match the finish of the plate.

F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets. Use cast box covers and plates on cast boxes.

G. Exterior mounted receptacles, and those noted to be weatherproof, shall be provided with weatherproof PVC transparent cover plates, standard size, and shall be single or ganged as indicated on the contract drawings. Weatherproof plates shall be “approved” third party listed as “raintight while in use”. Special wiring devices shall be as shown on the Drawings.

H. Connect receptacles by utilizing back wiring provisions only. Do not use side wire terminals.

I. Provide adhesive backed, laminated plastic receptacle device plate labels identifying the circuit feeding the device. Labels shall be label machine printed to indicate panel and circuit number and shall be Casio, Brother, T&B or approved equal.

J. All wiring devices shall be installed at heights as required by the ADA.

K. All wiring devices on Life Safety or Critical power shall be red in color.

L. Patient locations. Receptacles at the bed locations, patient room headwalls, patient treatment areas and exam rooms shall be hospital grade.

16031 SAFETY SWITCHES AND MOTOR CONTROL DEVICES

A. Safety switches shall be general duty (residential plug-type not acceptable) and heavy duty where noted, and shall be sized as indicated on the Contract Drawings. Fusible switches shall have rejection clips when fuses are specified to be rejection type. Current carrying components, lugs, bus, etc. shall be copper, brass, bronze

or similar alloy. Aluminum material is not acceptable. Fusible disconnect switches supplying motor loads shall be provided with dual element fuses, and all fuses shall be sized as indicated on the Contract Drawings or as required by the load. Fuses in switches supplying power to mechanical equipment shall be furnished and installed by the Mechanical Contractor. Switches shall be so designed that the access door cannot be opened with the switch in the "on" position. This safety lock on the access door shall be provided with an override mechanism arranged to release the door when operated with a screwdriver or knife blade. The exterior operating handle shall be provided with a means of padlocking in either the "off" or "on" positions. Safety switches shall be UL approved for the voltage and amperage of the circuit on which they are used and shall be as manufactured by ABB/General Electric, Eaton, Siemens or Square D Schneider.

B. Where a safety switch or an enclosed circuit breaker is installed ahead of a motorized piece of equipment having a separate source of power for the control circuit, the safety switch or circuit breaker shall be equipped with an auxiliary contact (interlock) for the control circuit.

C. Motor controls shall be as indicated on the Drawings and as manufactured by ABB/General Electric, Eaton, Siemens or Square D Schneider. Each controller shall have a replaceable bimetallic thermal overload relay of proper rating in each phase leg. Furnish and install push buttons, pilot lights, HOA switches, auxiliary contacts, control circuit transformers, etc., as shown and/or required. Control voltage shall be 120 VAC unless otherwise noted.

D. Fractional horsepower motor disconnect and starter switches shall be flush mounted and/or surface mounted and shall have steel cover plates. The switch enclosure shall be NEMA Type 1. The switches shall be one or two pole and shall be provided with overload motor running protection if required by the equipment. Overload relay units shall be furnished and installed by Electrical Contractor to suit the motor controlled. An indicating pilot light shall be provided in the cover plate of the voltage to suit the circuit on which the switch is used. Switches shall be motor rated and shall be UL approved and as manufactured by ABB/General Electric, Eaton, Siemens or Square D Schneider.

16032 SWITCHBOARDS

A. Switchboards shall comply with UL 891 and NEMA PB 2. Switchboards shall be dead front type, completely metal enclosed, self-supporting structure independent of wall supports. Ratings shall be as indicated on the Drawings. They shall consist of the required number of vertical sections bolted together to form one rigid switchboard. Engraved nameplates shall be furnished for all main and feeder circuits. All bus bars shall be tin-plated copper. All bus work shall be rated to withstand maximum short-circuit stresses when connected to a supply system having fault capacity of indicated on the Drawings. Provide full capacity neutral and ground bus. Furnish cable pull sections or top cable pull boxes, where required, complete with cable tie down supports.

B. Main Circuit Breakers, the Portable Generator Circuit Breaker and Circuit Breakers 1200A and larger shall be solid-state trip insulated case type, stationary mounted, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
   1. Adjustable instantaneous trip.
   2. Adjustable long time pickup and delay.
   3. Adjustable short time pickup and delay.
   4. Arc energy reduction mode with external switch and indicator (all 1200A circuit breakers in compliance with NEC Art. 240.87).
   5. Include shunt trip, undervoltage release, and other accessories where indicated. See Section 16036.
   6. Display line currents and cause of trip.

C. Branch Circuit Breakers (less than 1200A and where required by the Coordination Study) shall be solid-state trip molded case type, panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
   1. Adjustable instantaneous trip.
   2. Adjustable long time pickup and delay.
   3. Adjustable short time pickup and delay.
   4. Include shunt trip, undervoltage release, and other accessories where indicated. See Section 16036.
   5. Display line currents and cause of trip.

D. All circuit breakers shall be fully rated.

E. Line and Load Terminations: Accessible from the front of the switchboard for maintenance and suitable for the conductor materials and sizes indicated. Provide auxiliary sections as shown or as required for terminations.

F. Ground Bus: Extend full length of switchboard.

G. Provide Kirk Key interlocks as shown on the Drawings.

H. Future Provisions: Fully equip spaces for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Provide continuous current rating as indicated.

I. Enclosure: Type 1 - General Purpose.
   1. Align sections at front only.
   2. Switchboard Height: 96 inches, excluding floor sills, lifting members and pull boxes.

3. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and finished with gray enamel over a rust-inhibiting phosphatized coating. Color shall be ANSI 61 gray.
4. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
5. Mimic Bus: Show bussing, connections and devices in single line form on the front panels of the switchboard using blue color factory painting, or approved equivalent means.

J. Switchboards and switchboard circuit breakers shall be manufactured by ABB/General Electric, Eaton, Siemens or Square D Schneider.

K. Connections: Tighten field connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

L. The switchboard shall be provided with a front mounted, digital power quality meter / analyzer package connected to the main service conductors. The metering shall include a lighted LCD display of voltage, current, power, kVA, kVAR, power factor, frequency, total harmonic distortion, kW demand, amperes demand, kWH, kVARH, auxiliary voltage input and neutral current. Phase switching shall be provided and the display shall indicate the phase being displayed. The meter shall have an RS485 Modbus port for Owner interface. Provide all voltage and current transformers required to provide the above data. The metering/analyzer package shall be Eaton PXM 1000 or equivalent by General Electric/ABB, Siemens or Square D/Schneider. Install at 60" AFF to bottom of the meter case or, if the meter is to be installed above 60" AFF but no more than 78" AFF, provide an angle adapter to lower the meter viewing angle. Angle adapter shall be acceptable to the Architect/Engineer.

M. Adjust circuit breaker trip and time delay settings to values as prescribed by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

16033 PANELBOARDS

A. GENERAL

1. Panelboards shall be of the totally enclosed, dead front type provided with main disconnecting and protective devices and/or lugs only as indicated on the Contract Drawings or as required. Panelboard bus bars shall be of copper, rated as indicated on the Contract Drawings, and one and two and three pole branch circuit breakers shall be provided as indicated in the panel schedules.

2. Panelboard cabinets shall be fabricated from materials meeting the requirements of the NEC and UL and shall be so marked or labeled. Cabinets shall not have pre-punched concentric or eccentric knockouts. Trims shall be designed for flush or surface mounting, as noted in the panel schedules, be of the hinged door-in-door type, and shall be provided with flush latches and locks.

3. All panelboards shall have locks and all locks shall be keyed alike. Deliver all keys to the Owner at the time of final inspection.

4. A typewritten schedule shall be provided for and installed in each panelboard. Schedule shall indicate location and usage of circuits such as "Receptacles Room 101", "Lobby Lights", "Exhaust Fan EF-1-3/4 HP", etc. The schedule shall be installed in a framed clear plastic holder permanently attached to the back of the hinged access door. Final typed panelboard directories installed in the panelboard door pocket shall include final actual room names and numbers in addition to the general description shown on the panel schedules on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

5. Ground and bond panelboard enclosure per NEC Art. 517.

6. Description: NEMA PB 1, circuit breaker type.

7. Service Conditions:
    1. Temperature: 104º F. (40º C.).
    2. Altitude: N/A.
    3. Terminal Rating: 75º C. minimum.

8. Panelboard Bus: Copper, ratings as indicated. Provide 100% copper ground and neutrals buses in each panelboard. Provide insulated ground bus where scheduled.

9. Minimum integrated short circuit rating: 10,000 amperes rms symmetrical for 208 volt panelboards, or as indicated.

B. Distribution Panelboard Circuit Breakers: NEMA AB 1, bolt-on or plug-on (Square D I-Line and similar only) type.
    1. Circuit breakers in distribution panelboards shall be fully rated.
    2. Solid-state Trip Molded Case Main and Branch Circuit Breakers (100 amperes and larger): Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
        a. Adjustable instantaneous trip.
        b. Adjustable long time pickup and delay.

c. Adjustable short time pickup and delay.
d. Arc energy reduction mode with external switch and indicator (all 1200A circuit breakers in compliance with NEC Art. 240.87).
e. Include shunt trip, undervoltage release, and other accessories where indicated.
f. Display line currents and cause of trip.

3. Molded Case Circuit Breakers: Circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
4. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

C. Branch Circuit Panelboard Circuit Breakers: NEMA AB 1, bolt-on type.
1. Circuit breakers shall be fully rated.
2. Solid-state Trip Molded Case Main Circuit Breakers: Panel mounted, NEMA AB 1, with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
a. Adjustable instantaneous trip.
b. Adjustable long time pickup and delay.
c. Adjustable short time pickup and delay.
d. Include shunt trip, undervoltage release, and other accessories where indicated.
e. Display line currents and cause of trip.
3. Molded Case Branch Circuit Breakers: Thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits and Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers. Provide arc fault circuit breakers as indicated and/or required by Codes.

D. Enclosure: NEMA PB 1, Type 1 or Type 3R.

E. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.

F. Cabinet Front: Flush and Surface cabinet front door-in-door type with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel. Distribution panelboards larger than 400 amperes are not required to have door-in-door trims.

G. Panelboards and panelboard circuit breakers shall be manufactured by ABB/General Electric, Eaton, Siemens or Square D Schneider.

H. Adjust circuit breaker trip and time delay settings to values as prescribed by the Coordination Study. Prior to final settings, adjust circuit breaker trip and time delay settings to minimum values that do not cause false tripping.

16034 ENCLOSED CIRCUIT BREAKERS

A. Circuit breakers shall be molded case, UL and CSA listed, IEC 157-1 rated and shall meet NEMA Standard AB1-1975 and Federal Specification W-C-375B/GEN as applicable. Circuit breakers shall be rated as shown on the Drawings with appropriate withstand ratings and current limiting characteristics as required to safely function and protect the distribution system. Breakers shall be ABB/General Electric, Eaton, Siemens or Square D Schneider.

B. Enclosed circuit breakers shall be sized as indicated on the Contract Drawings. Enclosures shall be NEMA-1 for interior use and NEMA-3R galvanized for exterior applications, unless noted otherwise. Interior enclosures in finished areas shall be provided with flush trim.

C. Enclosed circuit breakers shall be molded case type with overcenter toggle type mechanisms, providing quick make, quick break action. Breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Each circuit breaker shall have trip indication by handle position and shall be trip free. Two and three pole breakers shall be common trip. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Circuit breakers with frame sizes greater than 100 amperes shall have variable magnetic trip elements set by a single adjustment. A push-to-trip button shall be provided on the cover for mechanically tripping the circuit breaker. The circuit breaker shall have reverse connection capability and be suitable for mounting and operating in any position.

D. Where required by the Coordination Study, enclosed circuit breakers shall be solid state trip molded or insulated case type with electronic sensing, timing and tripping circuits for adjustable current settings. Electronic trip units shall be provided with external, permanently-mounted power supplies in the gear where required to program trip units while the breakers are deenergized. Trip units shall be field-programmable with an internal display for programming and display and have:
   1. Adjustable instantaneous trip.
   2. Adjustable long time pickup and delay.
   3. Adjustable short time pickup and delay.
   4. Arc energy reduction mode with external switch and indicator (all 1200A and larger circuit breakers in compliance with NEC Art. 240.87).
   5. Include shunt trip, undervoltage release, and other accessories where indicated.
   6. Display line currents and cause of trip.

E. Provide with arc flash reduction mode with external switch and indicator (all 1200A circuit breakers in compliance with NEC Art. 240.87).

F. Circuit breakers shall have removable lugs. Breakers shall be UL listed for installation of mechanical or compression type lugs.

G. Accessories shall be provided as noted or required and shall be UL listed and field installable.

16035 ENGINE-GENERATOR SET

A. Provide a packaged diesel engine-generator set in a sound-attenuating, weather-protective enclosure. The set shall be UL 2200 listed and the installation shall comply with NFPA 70, NFPA 99, NFPA 101 and NFPA 110. The Engine-Generator Set shall be manufactured by Caterpillar, Cummins or MTU.

B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, electrical diagrams including schematic and interconnection diagrams. Also provide:
   1. A complete Bill of Materials for all components.
   2. Dimensioned plan and elevation drawings of the engine-generator set.
   3. Dimensioned plan and elevation drawings of the sub-base fuel tank.
   4. Dimensioned plan and elevation drawings of the gen set enclosure. Provide dimensions from the centerline of the top control panel switch and the output circuit breaker handle(s).
   5. Dimensioned plan, details and elevation drawings and proposed materials of the access platform and stairs, if required.

C. Product Data: Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, exhaust silencer, vibration isolators, sub-base fuel tank, weather resistant housing, remote annunciator, etc.

D. Test Reports: Indicate results of performance testing.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

G. The engine-generator set shall have been manufactured and successfully operated in similar service for a period sufficient to thoroughly establish its reliability.

H. The engine-generator set shall provide back-up power for the emergency and normal power distribution systems during utility power outage. Power outage sensing, generator starting, transfer of load, re-transfer to normal power and engine cool-down running time shall be completely automated and shall not require attended operation.

I. Engine:
   1. Type: Water-cooled inline or V-type, two or four stroke compression ignition Diesel engine.
   2. Fuel System: No. 2 diesel fuel oil (ASTM D396).
   3. Engine speed: Not to exceed 1800 rpm.
   4. Governor: Isochronous type to maintain engine speed within 0.25 percent, steady state, and 5 percent, no load to full load, with recovery to steady state within 2 seconds following sudden load changes.
   5. Engine shutdown on high water temperature, low water level, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.
   6. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
   7. Engine Jacket Heater: Thermal circulation immersion type water heater with integral thermostatic control, contactor in a NEMA rated enclosure, sized to maintain engine jacket water at 120°F, and suitable for operation on 120 or 208 volts AC as shown. Heater shall be disconnected while the engine is running.
   8. Radiator: Provide a closed recovery cooling system with sufficient capacity to cool the engine when the generator set is delivering full rated load at a minimum ambient temperature of 110°F (43°C). Radiator, fan, engine driven centrifugal water pump and thermostatic valve shall be provided and the system protected against freezing and corrosion. Radiator air flow restriction 0.5 inches of water (1.25Pa) maximum, external to the radiator.
   9. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, manual fuel priming pump, fuel shut-off solenoid, gear-driven water pump, a fuel transfer pump (if needed to lift the fuel from the fuel tank) and a replaceable fuel filter element conveniently located for servicing. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.
   10. Lubricating System: The engine shall have a lubricating oil pump for supplying oil under pressure to the main bearings, crank pin bearings, pistons, piston 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.
   11. Mounting: Provide unit with manufacturer’s designed vibration isolation for mounting on structural steel base, which shall allow mounting to a raised concrete pad or to a sub-base fuel tank. Anchor bolts and vibration isolators shall be used to mount the steel base to the concrete pad. Vibration isolators shall be one piece units, resistant to corrosion and environmental degradation. When sub-base fuel tanks are specified, vibration isolators shall be located between the generator set and the sub-base fuel tank.

J. Generator: NEMA MG1, three phase, four wire, reconnectible brushless synchronous generator with brushless exciter, revolving field type, close coupled

or directly coupled to the engine flywheel. The generator shall have a single ball bearing support for the rotor and the rotor shall be dynamically balanced up to 25% overspeed.

1. Standby rating: No less than 750 kW/937.5 kVA, at 0.8 power factor, 208/120 volts, 60 Hz at 1800 rpm.
2. Insulation Class: H.
3. Temperature Rise: 125°C Standby.
4. Enclosure: NEMA MG1, open drip proof. Provide with anti-condensation heater.
5. Voltage Regulator: Shall be of solid state design and provide voltage-per-hertz operation to match engine and generator characteristics, with voltage regulation plus or minus 1 percent from no load to full load. Steady state voltage modulation shall not exceed one cycle per second. For any addition of load up to and including 90% of rated, the voltage shall recover to and remain within the steady band in not more than 1.5 seconds. Frequency regulation from no load to rated load shall conform with engine governor performance. For any addition of load up to 90% of rated load, the frequency shall recover to the steady state frequency within 5 seconds. Include manual controls to adjust voltage droop, voltage level (plus or minus 5 percent) and voltage gain. Regulator to be mounted on top or side of the generator and enclosed in a NEMA rated enclosure. An isolation transformer in the voltage regulator circuit shall be provided, or a permanent magnet exciter.

K. The minimum rating of the engine-generator set specified is estimated. The Contractor shall provide an engine-generator set of sufficient capacity for starting and continuous operation of the loads shown in the Engine-Generator Set Load Summary on the Drawings in three steps (Step 1: all Life Safety loads, Step 2: all Delayed Critical loads, Step 3: Equipment loads, not to exceed twenty (20) percent voltage dip and without set overload. Provide detailed documentation of set capacity and voltage dip calculations with shop drawings.

L. Sound attenuated, weather protective enclosure: UL2200 listed, non walk-in, reinforced, 14 gauge minimum aluminum powder painted housing with locked, hinged side (and end, if required) access panels providing maintenance access to the engine and generator, output circuit breakers, control panel and all service points, with tamper resistant, lockable side and rear doors and panels.

1. Include fixed louvers, battery rack, and internally-mounted silencer. Provide non-hydroscopic sound insulated interior panels with metal perforated skin. Provide thermal Insulation, manufacturer's standard materials and thickness selected in coordination with block heater to maintain winter interior temperature within operating limits required by engine-generator-set components.
2. Enclosures shall be primed and finish painted in a color as selected by the Architect. Hardware, latches and hinges shall be stainless steel. Roof shall be peaked to allow drainage of rain water. Unit shall have sufficient guards to prevent entrance by rodents and small animals.
3. Sound attenuation shall be Level II (maximum of 73 dbA maximum at 7

meters). Exhaust gasses and cooling air shall be discharged vertically.

4. Provide exterior emergency stop pushbutton and exterior oil and coolant drains with interior valves.
5. Provide a minimum of three watertight, impact-resistant, general illumination, LED lighting fixtures with a minimum 5,000 lumens output each, a weatherproof GFCI convenience receptacle and a weatherproof switch for the lighting. Position the lighting fixtures to illuminate the housing interior and controls. Power from the circuits indicated on the Drawings.
6. Provide permanent access platform, stairs and handrails for access to controls and circuit breakers to maintain no greater than 6'-7" to top of any control device or circuit breaker handle, and for maintenance access via enclosure access panels. Stair and platform shall be hot dip galvanized, aluminum and/or fiberglass and shall comply with OSHA and all local jurisdiction requirements. Platform shall provide for 180 degree "full swing opening" of all side (and end, if required) service doors and at least 135 degree opening of the control panel door.
7. Enclosure housing and sub-base fuel tank shall be suitably constructed to withstand debris impact and 150 mph wind loads. Provide documentation of wind rating with shop drawings.

M. Skid-Mounted Sub-base Fuel Tank: UL 142 listed, welded steel tank, with fill and vent, minimum capacity 72 hours engine-generator run time at estimated demand load, or 5,200 gallons, whichever is greater. The tank shall be factory installed, piped and connected in accordance with the manufacturer's installation instructions, NFPA 37 and the North Carolina State Building and Mechanical Codes. Provide all Code-required accessories. The unit shall have the structural integrity to support the generator set and associated components. It shall include, but not be limited to, the following: heavy gauge steel double wall tank with all welded construction, prime coated and non-corrosive finished gloss black painted outside, 110% primary tank capacity secondary containment, internal baffles to separate hot fuel return from the engine from cooler fuel supplied to the engine, fuel fill containment device, lockable fuel filler cap, low fuel level alarm switch, fuel level gauge, inter-tank leak detection alarm switch, fuel line check valve, tank drains for primary and containment, threaded pipe connections and all other accessories required for proper operation. Normal and emergency venting ports. Tank shall have proper number and size fittings with proper overhead clearance to accommodate the remote fill system, tank probe, and remote vents. Tank shall have a minimum interior height of 18" and shall have a tank extension a minimum of 18" beyond the footprint of the generator and be the full width of the tank. Also, all vents and other required fittings shall be located in this tank extension area with no internal bracing or other interior obstructions below the fill and probe fittings. Provide and install a spill containment device at the end of the fill pipe in accordance with North Carolina State Building Code (NCSBC).

N. Exhaust Silencer: Super critical grade silencer to reduce engine exhaust noise in accordance with dBA requirements listed above, with muffler companion flanges and seamless flexible stainless steel exhaust connector, sized in accordance with engine manufacturer's instructions. The silencer shall be all-welded heavy duty

carbon steel construction and shall include a compressed thermal/acoustical insulation packed shell. In addition to its acoustical values, the two (2) inch minimum thick packed shell shall be provided to reduce the outer surface temperature.

O. Exhaust Piping: Manufacturer's standard for factory supplied enclosure.

P. Batteries: Heavy duty, diesel starting type lead-acid storage batteries capable of four 15 second cranks followed by a 15 second rest period at 0°F. Match battery voltage to starting system. Include necessary cables and clamps. Provide battery heater with integral thermostatic control sized to maintain battery at manufacturer recommended temperature. Heater shall be disconnected while the engine is running.

Q. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.

R. Battery Charger: Automatic solid state, current limiting, float equalizing type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Minimum continuous output of 10 amperes DC. Charger shall be capable of recharging a completely discharged battery in a maximum of 8 hours. Include overload protection, voltage surge suppressors, full wave rectifier, DC voltmeter and ammeter, low DC voltage alarm relay, malfunction alarm contact, and 120 volt AC fused input. Provide in NEMA-1 enclosure installed inside the generator set enclosure.

S. Remote Emergency Stop Switch: Weatherproof, surface wall mounted, unless otherwise indicated, remote from and in sight of the engine-generator set and labeled with an engraved, three layer, laminated plastic nameplate "GENERATOR EMERGENCY STOP". Push button shall be protected from accidental operation. The switch and installation shall be compliant with NFPA 110, section 3-5.5.6

T. Line Circuit Breakers: A single insulated case circuit breaker on generator output, as shown on the Drawings, with integral LSI solid state trip unit, sized in accordance with NFPA 70. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure and as commanded by the automatic transfer switches (see Section 16036). Provide with Kirk Key interlock with Portable Generator Connection Cabinet and arc energy reduction mode with external switch and indicator for 1200A and larger circuit breakers in compliance with NEC Art. 240.87. Unit mount circuit breaker in enclosure to meet NEMA 250, Type 1 requirements.

U. Provide systems to electrically supervise starting controls as required by Codes.

V. Engine-Generator Control Panel: NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment, features and functionality:
   1. Frequency Meter: Digital, 45-65 Hz. range.
   2. AC Output Voltmeter: Digital, 2 percent accuracy, with phase selector

switch.

3. AC Output Ammeter: Digital, 2 percent accuracy, with phase selector switch.
4. AC wattmeter, digital.
5. Output voltage adjustment.
6. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, low water level, overspeed, and overcrank.
7. Engine start/stop selector switch.
8. Engine running time meter.
9. Oil pressure gauge.
10. Water temperature gauge.
11. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
12. Additional visual indicators and alarms as required by NFPA 110.
13. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions required by NFPA 110 for a Level 1 system.
14. Load shed and load restore of ATS #4 load at user programmable, adjustable time delayed setpoints to comply with NEC Article 700.4(B). See Section 16036.

W. Remote Annunciator Panel: NFPA-110 compliant, flush mounted panel with painted finish and silk-screened lettering, in manufacturer's standard color. Provide alarm horn, and indicators and alarms as follows:

1. High battery voltage (alarm).
2. Low battery voltage (alarm).
3. Low fuel.
4. Intertank leakage.
5. Battery charger malfunction.
6. System ready.
7. Anticipatory-high water temperature.
8. Anticipatory-low oil pressure.
9. Low coolant temperature.
10. Mode switch not in auto position (alarm).
11. Overcrank (alarm).
12. Emergency stop (alarm).
13. High water temperature (alarm).
14. Overspeed (alarm).
15. Low oil pressure (alarm).
16. Line power available.
17. Generator power available.
18. Lamp test and horn silence switch.
19. Emergency stop switch.
20. Additional visual indicators and alarms as required by NFPA 110 for a Level 1 system.

X. Load Bank Test: Comply with NFPA 110 testing requirements and sequence. Provide a full load test utilizing a portable resistive load bank for four hours minimum for each engine-generator set. Each test shall be performed at the job

site in the presence of the Owner and Architect. The capability of the system to pick up full standby service load within 10 seconds of power outage shall also be demonstrated. After testing is complete:

1. A copy of the generator test report shall be submitted to the Architect/Engineer and the Owner.
2. Test results shall record the following parameters in 20 minute intervals during four hour test:
    1) Kilowatts.
    2) Amperes.
    3) Voltage.
    4) Coolant temperature.
    5) Ambient temperature.
    6) Frequency.
    7) Oil pressure.
    8) Fuel flow.

Y. Building Loads Test: Comply with NFPA 110 testing requirements and sequence. Simulate power outage, including operation of the automatic starting cycle, and automatic shutdown and return to normal, by interrupting normal source, and demonstrate that system operates with actual building loads to provide standby power. The test shall demonstrate the capability of the engine-generator set to operate the loads stated on the Drawings. Test all alarm and shutdown circuits by simulating conditions. Test duration shall be one hour minimum.

Z. A full tank of fuel shall be provided, replacing any fuel used for testing. Diesel fuel shall be treated with an alcohol-free additive to disperse water and clean injectors.

AA. Demonstrate NEC required supervision of generator sets starting circuits.

BB. Training: Prior to final acceptance, the manufacturer's authorized representative shall provide comprehensive training and thoroughly and competently instruct the Owner's designated personnel in proper operation of the system and in all required periodic maintenance. Training shall include, but not be limited to, operation (all aspects including normal and emergency modes), maintenance and troubleshooting of the equipment. A minimum of eight (8) hours on-site time, in addition to load bank testing, shall be allocated for this purpose.

CC. Documentation: Upon final completion of the system, a documentation package shall be provided and shall include three (3) bound (in three ring binders with index tabs) copies of complete manufacturer’s operation and instruction manuals. Provide one bound original (no photocopies) and two additional bound copies (photocopies are acceptable) of the total documentation package. The manuals shall include operation and maintenance procedures, complete parts lists, dimensional drawings, unit wiring diagrams and schematics, and interconnection wiring drawings. Include instructions for routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures. The following shall also be provided:

1. System record drawings.
2. Instruction manuals as supplied by the manufacturer for all components and electronics.
3. Product specification sheets for all equipment without instruction manuals.

DD. Cleaning: Clean installed work under provisions of the General and Supplemental General Conditions and Division 1 Specifications Sections.
1. Touch up scratched or marred surfaces to match original finish.
2. Clean engine and generator surfaces. Replace oil and fuel filters.

EE. Warranty: The Contractor shall provide the following minimum manufacturers factory warranty for each engine-generator set and associated equipment:
1. All equipment shall be new and warranted free of faulty workmanship and damage.
2. The warranty shall include all parts, labor (including travel with no travel time or distance limitations), expenses and equipment necessary to perform replacement and/or repairs.
3. The total system (parts and labor) shall be warranted free of defects for a period of one (1) year from date of final acceptance.
4. Replacement of defective materials and repair of faulty workmanship shall take place within 48 hours of notification by Owner and shall be guaranteed at no cost to the Owner during the warranty period.
5. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer's warranties.
6. The printed warranty shall be included in the O&M manual.

FF. Final Acceptance: The installation shall be supervised, checked and tested by a qualified representative of the engine-generator set manufacturer. Written certification, by the qualified manufacturer's representative, verifying manufacturer's startup procedures were followed and full system functionality was achieved shall be submitted to the Architect and Owner prior to final acceptance.

GG. Maintenance service: Provide service and maintenance of generator set for one year from date of substantial completion. A minimum of two visits to site for inspection of unit shall be completed during this time period. A written report of these visits shall be provided to the owner.

16036 AUTOMATIC TRANSFER SWITCHES

A. Automatic transfer switches shall be electrically operated, mechanically held, closed transition. Switches shall conform to the requirements of UL 1008, NFPA 70, NFPA 99, NFPA 110, IEEE 446 and NEMA Standard ICS10-1993. Automatic transfer switches shall be manufactured by ASCO, ABB/Zenith or by the generator set manufacturer.

B. Transfer switches shall be closed transition and operate in a make before break fashion. The transfer switch logic will limit the source parallel time to less than 100 ms. Closed transition transfer switches shall include a time delay utility parallel

relay, external to the controller, to shunt trip the source 1 breaker in the event that the transfer switch remains closed on both sources for a period greater than 0.5-1 second. Closed transition transfer switches shall have the option to default to an open in-phase and/or delayed transition.

C. Ratings: As shown on the Drawings (continuous duty). UL 1008 listed. Three pole, solid neutral. Interrupting capacity: 600 percent of continuous rating. Three cycle withstand current rating shall be as defined by UL 1008. Withstand rating shall exceed available fault current values determined by the Short Circuit and Coordination Study. Transfer time: Not to exceed 1/6 second. NEMA-1 floor or wall mounted enclosure as indicated.

D. Service conditions: NEMA ICS 1.

E. The transfer switch manufacturer shall be responsible for providing the coordinating wiring diagrams showing the electrical connections between the transfer switch, electrical distribution equipment and the engine-generator set for use by the E-G set service personnel during installation and checkout of the equipment.

F. Construction: Transfer switches shall be rigidly constructed to close into and withstand the bolted fault current available at the switch. All transfer switch coils, springs, and control elements shall be easily inspected and conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductors. All feeder lugs, relays, timers, control wiring and accessories shall be front accessible. The control module and transfer switch shall be physically separated. Main contacts shall be of silver alloy composition.

G. Controls: Microprocessor type with user control switches; front panel mounted. Provide with rechargeable battery backup, serial communications port, non-volatile eprom storing setup and calibration data, self-diagnostics, etc. The control module shall have a password protected access to programming of switch.

1. Test switch: Mount in cover of enclosure to simulate failure of normal power source.
2. Return to normal switch: mount in cover of enclosure to initiate manual transfer from alternate source to normal source.
3. Transfer switch auxiliary contacts: 2 normally open; 2 normally closed.
4. Normal source monitor: monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 hertz from rated nominal value.
5. Alternate source monitor: monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 hertz from rated nominal value.
6. In-phase monitor: inhibit transfer until source and load are within 15 electrical degrees.
7. Normal and emergency position push-to-test indicating lights.
8. Engine exerciser: fully programmable, solid state type. Start engine every 7 days (programmable); run for 30 minutes (programmable) before shutting

down. Bypass exerciser control if normal source fails during exercising period. Provide load/no-load switch. Only one exerciser shall be connected on multiswitch installations.

H. Automatic sequence of operation
   1. Initiate time delay to start alternate source engine generator: upon initiation by normal source monitor when source drops below range of 70-95% of rated voltage (factory set at 85%). Time delay to start alternate source engine generator: 0.05 to 6 seconds (factory set at 3 seconds) to allow for momentary dips.
   2. Initiate transfer load to alternate source: upon initiation by normal source monitor and permission by alternate source monitor. Generator voltage has reached range of 75-100% of rated voltage (factory set at 90%) and generator rated frequency of 85-100% (factory set at 90%).
   3. Time delay before transfer to alternate power source: 0 to 10 seconds, adjustable.
   4. Initiate retransfer load to normal source: upon permission by normal source and in phase monitors.
   5. Time delay before transfer to normal power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.
   6. Time delay before engine shut down: 0 to 15 minutes, adjustable, of unloaded operation. To allow engine to cool before shutdown.
   7. Time delay between transfer switches: Step 1 shall be ATS-LS, Step 2 shall be ATS-C and Step 3 shall be ATS-EH.
   8. Start Stop Circuit Monitoring: Provide start circuit monitoring as required by NFPA 70 Article 700.10 (D)(3). Circuit monitoring by 3 wire circuit configurations are not aceptble.

I. Testing: Demonstrate operation of transfer switch in normal and emergency modes.

J. Maintenance service: Provide service and maintenance of transfer switches for one year from date of substantial completion. A minimum of two visits to site for inspection of ATS shall be completed during this time period. A written report of these visits shall be provided to the Owner.

K. Warranty: The Contractor shall provide the following minimum manufacturers factory warranty for each automatic transfer switch:
   1. All equipment shall be new and warranted free of faulty workmanship and damage.
   2. The warranty shall include all parts, labor (including travel with no travel time or distance limitations), expenses and equipment necessary to perform replacement and/or repairs.
   3. The total system (parts and labor) shall be warranted free of defects for a period of one (1) year from date of final acceptance.
   4. Replacement of defective materials and repair of faulty workmanship shall take place within 48 hours of notification by Owner and shall be guaranteed at no cost to the Owner during the warranty period.

5. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturer's warranties.
6. The printed warranty shall be included in the O&M manual.

L. Final Acceptance: The installation shall be supervised, checked and tested by a qualified representative of the automatic transfer switch manufacturer. Written certification, by the qualified manufacturer's representative, verifying manufacturer's startup procedures were followed and full system functionality was achieved shall be submitted to the Architect and Owner prior to final acceptance.

16037 DUAL PURPOSE PORTABLE GENERATOR CONNECTION CABINET

A. Provide a portable generator connection cabinet for connection of a portable standby engine-generator set to support the facility during maintenance or a failure of the permanently installed engine-generator set and provide load bank testing connections.

B. Panels shall be third party listed to UL 1008 standards as a Transfer Switch Accessory. The cabinet shall be rated 2,500 amperes, 120/208 volts, three pole, four wires and ground. Provide 100% neutral and ground connection capability. Short circuit current rating shall be 100kA RMS symmetrical minimum. The cabinet shall be pad mounted in a NEMA Type 3R weatherproof enclosure and the Type 3R rating shall be maintained with temporary cables installed with or without cables connected. Cabinet shall have tamper resistant lockable doors to prevent unauthorized entry, phase rotation monitor and 2 wire auto start terminals. Provide systems to electrically supervise starting controls as required by Codes.

C. Cabinet shall include two sets of 16 Series Camlocks (Male and Female). Female camlocks shall be enclosed behind a pad-lockable door. Male camlocks shall be enclosed behind a trap key interlocked door. Provide with Kirk Key locks installed on outer door housing male quick connects and permanent generator breaker to serve as an interlock between the permanent generator and portable generator. Dual Purpose Portable Generator Connection Cabinet shall be ASCO 300 Series (3QCD) or approved equal.

D. Enclosure shall be finished in ANSI 61 gray powder coat. Provide AL/CU compatible lugs adequate to accommodate conductor sizes and quantities shown on the Drawings. Enclosure shall be suitably constructed to withstand 150 mph wind loads. Provide documentation of wind rating with shop drawings.

E. Bus:
1. All bus bars shall be tin-plated copper. Bus ampacity shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
2. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
3. A copper ground bus (minimum 1/4 x 2 inch).

4. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

F. Shop Drawings: Indicate electrical characteristics and connection requirements. Show dimensioned plan and elevation views with overall and interconnection point dimensions, electrical single line diagram. Also provide:
1. A complete Bill of Materials for all components.
2. Nameplate schedule.
3. Conduit entry/exit locations.
4. Short circuit, voltage and continuous current ratings.
5. Cable terminal sizes.
6. Product data sheets.
7. Seismic certification and equipment anchorage details.

G. Wiring and Terminations
1. The cabinet shall be provided with both mechanical lugs and cam-type receptacle assembly for connection of generator power phases (A, B, C), neutral and grounding conductors. All connections for phases, neutral, ground, etc., shall be clearly marked via permanent labeling
2. Each Series 16 recessed male single pole cam-type receptacle shall be rated for no less than 400 amps at 90 deg. C. Provide multiple receptacles per phase, neutral, and ground as required. Receptacle contact material shall be brass. Cam-type receptacles shall be suitable for use in outdoor environments and be UL 498 listed for Attachment Plugs and Receptacles and UL 1691.
3. Small wiring, necessary fuse blocks and terminal blocks within the cabinet shall be furnished as required. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
4. Where applicable all control wire shall be type SIS, bundled and secured with nylon ties. Insulated locking spade terminals shall be provided for all control connections, except where saddle type terminals are provided integral to a device. All groups of control wires leaving the panel shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

16038 SURGE PROTECTION DEVICES (SPDs)

A. SERVICE ENTRANCE SPDs

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Basis of Design: Eaton SPD Series.
   b. ABB.
   c. Siemens.
   d. Square D.
2. Surge Protection Devices:

a. Comply with UL 1449, 5th Edition.
b. Thermally protected MOVs.
c. LED indicator lights for power and protection status of each phase and neutral.
d. Audible alarm, with silencing switch, to indicate when protection has failed.
e. Six-digit transient event counter with reset button and nonvolitile memory to totalize transient surges.

3. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
4. Peak Single-Impulse Surge Current Rating: 400 kA per phase/200 kA per mode.
5. Short circuit current rating: 200 kA.
6. NEMA-1 enclosure.

B. PANELBOARD SPDs: Same as Service Entrance SPDs, but with a Peak Single-Impulse Surge Current Rating: 320 kA per phase/160 kA per mode.

C. SPDs shall be the external type.

D. Install SPD at service entrance on load side, with ground lead bonded to service entrance ground.

E. Install SPD with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

F. SPD circuit breaker and feeder conductors shall be as recommended by the device manufacturer, or #8 AWG copper, whichever is greater. Install in metallic raceway.

G. Coordinate SPD circuit breaker rating with actual SPD provided.

H. Do not perform insulation resistance tests of the distribution wiring equipment with the SDP installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

16039 LIGHTING FIXTURES AND LAMPS

A. Lighting fixture types shall be furnished as required by the Lighting Fixture Schedule as indicated on the Drawings. Catalog numbers are provided as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers listed will be acceptable upon approval of the Architect/Engineer. The Contractor shall verify from the Contract Drawings the type ceilings or walls the fixture is to be used with and shall provide compatible mounting attachments and trim. Provide all accessories or additional materials required to maintain the ceiling fire rating as required by regulatory authorities.

B. All lighting fixtures shall be approved by UL and NFPA and shall bear their label. Fixtures shall have a stock, or standard finish unless otherwise specified. Fixtures subject to corrosive or damp environments shall have corrosion resistant hardware and finishes.

C. All fixtures shall be installed complete with lamps or LED sources/light engines and shall be new and unused at time of final inspection of the project for acceptance. LED sources/light engines shall be field replaceable with common hand tools.

D. LED sources shall be high intensity white, single color or as noted. Provide white LEDs in the color temperature(s) specified. The color temperature in all lamps of the same type shall be consistent and remain so over the life of the lamp. Color consistency between lamps shall conform to ANSI NEMA ANSLG standard C78.377-2008. The contractor shall replace lamps/fixtures exhibiting inconsistent lamp color. Minimum lumen maintenance shall be 70% of rated initial lumen output at 50,000 hours of operation. Measurement of lumen maintenance shall be in accordance with IES LM-80-08. The lamp and/or luminaire manufacturer shall provide a minimum of five year warranty from the date of Final Acceptance against premature failure, discoloration and defects. The color or color temperature of replacement LED lamps shall match those of the same lamp types that remain in operation. The minimum color rendering index of white LEDs shall be 80. Electrical and photometric performance of LED assemblies and luminaires shall conform to IES LM 79-08.

E. LED Drivers: Provide high frequency electronic type with secondary voltages matching those required by the led source they operate. Drivers shall operate within a 0ºF – 140ºF ambient temperature range and shall comply with FCC Class A Standards for EMI. Minimum driver specifications:

1. Power factor ≥ 90%.
2. Efficiency ≥ 90%.
3. Current crest factor – 1.5 minimum.
4. Total harmonic distortion < 20%.
5. Rated life – 50,000 hours.
6. For indoor and building mounted fixtures, provide minimum 2-kv surge suppression integral with the driver (5-kv preferred if available).
7. For outdoor fixtures, provide minimum 10.0-kv surge suppression integral with the driver.

Manufacturers shall have been manufacturing LED drivers for at least ten years with a documentable low failure rate. The contractor shall provide a written warranty against defects in material and workmanship, including replacement for five years from the date of final acceptance.

F. Acrylic prismatic lens shall have nominal minimum lens thickness of 0.125 inch.

G. Emergency and exit lighting fixtures shall be as shown on the lighting fixture schedule on the Contract Drawings.

H. Install suspended luminaires using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.

I. Where a recessed or downlight fixture replaces a section or part of an acoustical ceiling tile, or a section or part of a suspended gypsum board (GWB) ceiling, the fixture shall be supported at two (2) diagonal corners to the steel frame of the building. Supports shall be provided with the same type of wire as used to support the lay-in ceiling track or GWB ceiling system. Attach one end of the wire to one corner of the fixture and the other end to the building's structural system. The lay-in or flange fixture shall then be screwed to the main runners of the lay-in ceiling track or GWB ceiling system at all four (4) corners using sheet metal screws (parabolic type fixtures shall be attached to the ceiling grid with approved clips). The Electrical Contractor shall be responsible for coordination work with the ceiling contractor; however, the ceiling contractor will provide framed openings for reception of lighting fixtures. All recessed fixtures shall be furnished with all necessary mounting accessories.

J. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

K. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prevent movement.

L. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure. Provide auxiliary members spanning ceiling grid members to support surface mounted luminaires. Fasten surface mounted luminaires to ceiling grid members using bolts or screws.

M. Install recessed luminaires to permit removal from below.

N. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

O. Install wall mounted luminaires, emergency lighting units and exit signs at height as indicated on Drawings.

P. Install accessories furnished with each luminaire.

Q. Connect luminaires, emergency lighting units and exit signs to branch circuit outlets provided under Section 260534 using flexible conduit.

R. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

S. Bond products and metal accessories to branch circuit equipment grounding conductor.

T. Clean photometric control surfaces as recommended by manufacturer. Clean finishes and touch up damage.

U. Relamp/replace luminaires that have failed lamps at Substantial Completion. Replace LED modules in which more than 5% of the LEDs have failed lamps at Final Acceptance of the Work.

16040 FIRE ALARM SYSTEM

A. Provide an NFPA 72, addressable, manual and automatic, Class A, local fire alarm system with connections to central station. The system shall be nominal 24 vdc operating voltage, non-coded, and supervised (including control circuits). All equipment supplied shall be listed for the purpose for which it is used, and installed in accordance with any instructions included in its listing. It shall also be new, with a full warranty (parts and labor) of at least one year from the date of final acceptance. The Contractor shall furnish all parts, materials, and labor required for a complete and operating system in accordance with all applicable requirements, even if each needed item is not specifically shown or described on the contract drawings or specifications. The system shall have multiple access levels to permit the disablement of individual alarm inputs or normal system responses (outputs) for alarms without changing the system's executive programming or affecting operation of the remainder of the system. The system shall be a non-proprietary system as manufactured by Notifier, Siemens or Edwards.

B. As a minimum, provide catalog cuts for all components and wiring/cable; control panel modules and configuration; system wiring diagram / floor plan showing each device and wiring connection required; wire types, sizes, numbers of conductors; transient protection devices; detailed battery capacity calculation and a description/sequence of system operation matrix. Verify and coordinate all voltage, relay, contact, etc., requirements with other equipment before submitting shop drawings. Provide electrical characteristics and connection requirements. The installing contractor's technicians shall, hold current (within previous 24 months) certifications issued by the manufacturer. These certifications shall be submitted to the engineer prior to installation showing name, photo identification, date of training and date of certification.

C. Provide detailed operation and maintenance instruction and training. Furnish four hours of instruction each for four persons, to be conducted at project site with manufacturer's representative. Use submitted operation and maintenance manual as reference during training. Supplement with training materials as required. System shall have a manufacturer warranty for a period of one year following acceptance. The warranty shall include all parts, labor, field service, travel expenses, etc.

D. Installer: Company specializing in installing the products specified in this section with minimum three years documented experience. The fire alarm contractor shall be authorized by his respective factory to ensure proper specification adherence, final connection, test, certification, warranty compliance, and service. Additionally, the fire alarm contractor shall submit a letter of authorization on official letterhead

of the company product he represents stating he is an authorized distributor of that product. He shall maintain a service organization with adequate spare parts inventory within 75 miles of the installation site. He shall have training certification by the fire alarm control equipment manufacturer he represents that is not more than two (2) years old, to ensure up-to-date product and application knowledge.

E. Control Panel: The Fire Alarm Control Unit (FACU) shall be the modular type, with surface or flush wall mounted enclosure as shown, for ease of future system expansion or modification. The FACU shall display a steady “Power On” light (green), and each zone shall have separate “Alarm” (red) and “Trouble” (amber) lights. Provide additional FACU modules, or a larger capacity FACU, as required by the quantity of devices shown on the Drawings. FACU shall have a minimum of 25 percent spare capacity installed. The system shall have multiple access levels to permit the disablement of individual alarm inputs or normal system responses (outputs) for alarms without changing the system’s executive programming or affecting operation of the remainder of the system.

F. Power supply: Adequate to serve control panel modules, remote detectors, remote annunciators, door holders, smoke dampers, relays, and alarm signaling devices. Include battery operated emergency power supply with capacity for operating system in standby mode for 24 hours followed by alarm mode for 5 minutes. A battery sizing calculation shall be submitted with the shop drawings. The battery manufacturer’s battery discharge curve shall be used to determine the expected battery voltage after 24 hours of providing standby power. The calculated Notification Appliance Circuit current draw in the alarm mode shall be used to determine the expected voltage drop at the end of the line (EOL). This calculation shall be based on conductor resistance per manufacturer’s data sheet of NEC 2011, Table 8; with due allowance for the voltage drop in the system’s power supply and the double length of the circuit conductors. The voltage drop at EOL shall not exceed 14% of the expected battery voltage, after the required standby time plus alarm time. The resultant voltage shall not be less than the minimum listed operating voltage for the appropriate alarm notification appliance. The contractor shall use power outage testing to verify that the Notification Appliance Circuit (NAC) is compliant with design. Note if the contractor elects to provide additional remote power supplies, 120 VAC circuits required by the power supplies shall be provided by the contractor at no additional cost to the Owner.

G. System Supervision: The system shall be electrically supervised for open or (+/-) ground fault conditions in initiation, notification, and control circuits. Disconnection or removal of any initiating device, alarm notification appliance, plug-in relay, system module, or standby battery connection shall also result in a trouble signal. Fire alarm signal shall override trouble signals, but any pre-alarm trouble signal shall reappear when the panel is reset.

H. Initiating Device Circuits: Supervised zone module with alarm and trouble indication; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from initiating an alarm.

I. Indicating Appliance Circuits: Supervised march time signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable that circuit from signaling an alarm.

J. Remote Station Signal Transmitter: Electrically supervised dual line digital alarm communicator transmitter (DACT), 4-channel (minimum), capable of transmitting alarm, supervisory and trouble signals over cellular modem to central station receiver, and integral to FACU enclosure. The Contractor shall provide a type of DACT which is compatible with the Owner's alarm receiving equipment, or the Supervising Station selected by the owner, as applicable. The Contractor shall also program the PROM, connect each DACT to the cellular modem, and verify proper signal receipt by the Supervising Station.

K. Auxiliary Relays: Provide sufficient SPDT auxiliary relay contacts for each detection zone to provide accessory functions specified.

L. Provide TROUBLE ACKNOWLEDGE, DRILL, and ALARM SILENCE switch.

M. Trouble Sequence of Operation: System or circuit trouble places system in trouble mode, which causes the following system operations:
1. Visual and audible trouble alarm indicated by device at fire alarm control panel.
2. Trouble signal transmitted to central station.
3. Manual acknowledge function at fire alarm control panel silences audible trouble alarm; visual alarm is displayed until initiating failure or circuit trouble is cleared.

N. General Alarm Sequence of Operation: Actuation of initiating device places circuit in alarm mode, which causes the following system operations:
1. Sound and display local fire alarm signaling devices with march time signal.
2. Transmit non-coded signal to central station.
3. Indicate location and identification of alarm device on fire alarm control panel and remote annunciator.
4. Transmit signal to building mechanical systems to initiate shutdown of fans and damper operation.
5. Manual acknowledge function at fire alarm control panel silences audible alarm devices; visual alarm devices remain energized until alarm reset is activated.

O. Equipment:
1. Manual Station: Semi-Flush mounted, non-coded, addressable type, double action manual station without break-glass rod. Provide manufacturer's standard backbox. Provide a protective cover with piezo sounder, and clear spacer if required, on each manual station, Safety Technology International Stopper II or equivalent.
2. Spot Heat Detector, low temperature (hostile environments only): Conventional fixed temperature type with plug-in base, rated 135°F (57°C).

Provide intelligent/addressable monitor module for each detector, mounted remote from the detector in a conditioned space at 80" AFF.

3. Spot Heat Detector, high temperature (hostile environments only): Conventional fixed temperature type with plug-in base, rated 190°F (88°C). Provide intelligent/addressable monitor module for each detector, mounted remote from the detector in a conditioned space at 80" AFF Spot Heat Detector (conditioned environments): Intelligent/addressable type, combination rate-of-rise and fixed temperature type with plug-in base, rated 135°F (57°C), and temperature rate of rise of 15°F (8.3°C).
4. Ceiling Mounted Spot Smoke Detector: NFPA 72, analog/intelligent/addressable photoelectric, low profile type with separate plug-in base and visual indication of detector actuation, suitable for mounting on 4 inch (102 mm) outlet box.
5. Ceiling Mounted Spot Carbon Monoxide Detector: UL 2075, analog/intelligent/addressable, low profile type with separate plug in base and visual indication of detector actuation, suitable for mounting on 4 inch (102 mm) outlet box. CO detector operation shall initiate a fire alarm system supervisory signal and alarm via notification appliances distinctive from the fire alarm system.
6. Monitor Module. NFPA 72, addressable type with visual indication of module actuation, suitable for mounting in 4 inch (102 mm) outlet box.
7. Control Module. NFPA 72, addressable type with visual indication of module actuation, suitable for mounting in 4 inch (102 mm) outlet box.
8. Isolation Module. NFPA 72, with visual indication of module operation, suitable for mounting in 4 inch (102 mm) outlet box.
9. Aural Horn/Visual Device (non-resident areas only where specifically shown): NFPA 72 (ANSI S3.41), flush type fire alarm electronic audible signal/strobe. Minimum sound rating: 87 dB at 10 feet. Provide integral synchronized, strobe lamp and flasher with clear lens and red lettered “FIRE” on case. Provide strobe output as shown or as required by NFPA 72 and conditions. Install surface mounted devices using the manufacturer’s surface mount backbox.
10. Aural Chime/Visual Device: NFPA 72 (ANSI S3.41), flush type fire alarm electronic audible signal/strobe. Provide with a minimum of 12 field selectable tones, each with 3 volume settings. Minimum sound rating at high volume: 60 dB at 10 feet (3M). Provide integral synchronized, strobe lamp and flasher with clear lens and red lettered “FIRE” on case. Provide strobe output as shown or as required by NFPA 72 and conditions. Install surface mounted devices using the manufacturer’s surface mount backbox.
11. Visual Only Device: NFPA 72 (ANSI S3.41) flush type, synchronized, strobe lamp and flasher with clear lens and red lettered "FIRE" on case. Provide strobe output as shown or as required by NFPA 72 and conditions. Install surface mounted devices using the manufacturer’s surface mount backbox.
12. Provide supervised LCD alphanumeric remote annunciators, at locations shown on the Drawings, including audible and visual indication of fire alarm by device, location and zone, and audible and visual indication of system trouble. Install in flush wall-mounted enclosures.

13. Cable:
    a. Fire Alarm Power Branch Circuits: Building wire as specified. Wire shall be 14 AWG minimum, stranded copper THHN/THWN. All junction boxes that are visible or accessible shall be painted red, unless in finished areas. NOTE: Conduits that penetrate outside walls or ceilings from conditioned space shall be effectively sealed to prevent condensation from infiltrating humid air.
    b. Addressable loop (signaling line) circuits shall be wired with type FPL/FPLR/FPLP fire alarm cable, AWG 18 minimum, low capacitance, twisted shielded copper pair (unless unshielded cable is recommended by the system manufacturer). Cable shield drain wires shall be connected at each device on the loop to maintain continuity, taped to insulate from ground, and terminated at the FACU. Acceptable cables include Atlas 228-18-1-1STP, Belden YQ28541, BSCC S1802s19 (same as EEC 7806LC), West Penn D975, D991 (AWG 16), D995 (AWG 14), or equal wire having a capacitance of 30pf/ft maximum between conductors. The cable jacket color shall be red, with red (+) and black (-) conductor insulation.
    c. Indicating Appliance and Door Hold-open Device Circuits: Power limited fire-protective signaling cable (type FPLR) classified for fire and smoke characteristics, twisted, unshielded copper conductor, 300 volt insulation rated 105°C, red exterior insulation. Minimum size: 2 C # 14 AWG for indicating appliance, door release and control circuits. Use larger conductors as required by the manufacturer or for voltage drop compensation.
    d. Fire alarm circuit cables in areas designated as requiring Survivability Level 2 Pathways shall utilize Type CI circuit integrity cable or equivalent approved means of fire resistance for cables as required by NFPA 72, Section 12.4.

P. Installation:
1. On AC Input: EFI E100HW120, Leviton 51020-OWM, Emerson/Northern-Technologies TCS-HWR, Transtector ACP100BW SERIES, or equal UL 1449 – 3rd Edition Listed device approved by Architect/Engineer. Install in a listed enclosure near the electrical panelboard, and trim excess lead lengths. Wind small coil in the branch circuit conductor just downstream of the suppressor connection. Coil to be 5 to 10 turns of about 1” diameter, and securely wrapped with plastic cable ties.
2. Provide an engraved label inside the FACP identifying its 120vac power source, as follows: Panelboard location, panelboard identification, and branch circuit number.
3. Alarm notification appliances (audible and visible) shall comply with NFPA 72, the North Carolina State Building Code (NCSBC), and ANSI 117 criteria for intensity and placement. The audible evacuation signal shall be the ANSI S3.41 three-pulse temporal pattern. All strobe lights installed in a single space shall be synchronized.
4. Addressable interface modules (used to monitor all contact type initiating devices) shall be located in conditioned space, unless they are tested,

listed, and marked for continuous duty across the range of temperatures and humidity expected at their installed location.

5. One module may serve as many as 3 sprinkler system valve supervisory switches in a single space; otherwise provide one module per switch.
6. One module may serve as many as 6 heat detectors in a single space
7. Sprinkler system supervisory circuits for monitoring valve position, air pressure, water temperature, pump status, etc., shall cause distinct audible and visible indications at the FACP. The audible supervisory signal shall either be a 4" diameter bell or a pulsing piezo-electric alarm. Provide the following engraved label adjacent to the bell/alarm: "SPRINKLER STATUS ABNORMAL". If only valve position is supervised, provide an engraved label reading: "SPRINKLER VALVE CLOSED"
8. The fire alarm system shall control and monitor 120VAC power to shunt trip breakers used in conjunction with fire suppression systems. Examples include a shunt trip used for cooking appliance power shut-off when the kitchen hood fire suppression system is activated, or primary elevator power shut-down upon sprinkler flow in any elevator equipment space or shaft. Use addressable control and monitor modules, for trip and supervision, respectively, with a System Sensor RE-20 multi-voltage relay, or equivalent, to accomplish the trip and supervisory functions.
9. The exterior of all junction boxes containing fire alarm conductors shall be painted red; box interiors shall not be painted. Box covers for junction boxes containing fire alarm conductors shall be painted red on both sides.
10. Box covers shall be labeled to indicate the circuit(s) or function of the conductors contained therein. Lettering shall contrast with the box cover paint and shall be neatly applied using machine generated white lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.
11. All fire alarm system wiring shall be in installed in metal conduit and, if permitted by the AHJ and DHSR, cable may be free run on J hooks in the attic.
12. There shall be no splices in the system other than at device terminal blocks, or on terminal blocks in cabinets. "Wire nuts" and crimp splices shall not be permitted. Permanent wire markers shall be used to identify all connections at the FACP and other control equipment, at power supplies, and in terminal cabinets. All terminal block screws shall have pressure wire connectors of the self-lifting or box-lug type.
13. When installed in a room, detectors shall be oriented so their alarm light is visible from the nearest door to the corridor, unless Remote Alarm Indicator Light (RAIL) equipped.
14. Spot-type smoke detectors shall secure the head to the base thru the built-in locking device. For detector mounted within 12 feet of the floor, activate this lock after the system has been inspected and given final acceptance.
15. Unless suitably protected against dust, paint, etc., spot type smoke detectors shall not be installed until the final construction clean-up has been completed. In the event of contamination during construction, the detectors shall be replaced by the contractor at no additional cost to the Owner. Covers supplied with smoke detector heads do not provide protection

against heavy construction dust, spray painting, etc., and shall not be used for that purpose. They are suitable only during final, minor cleanup or touchup operations.

16. A detector installed where accidental damage or deliberate abuse is expected shall be provided with a guard that is listed for use with it and is acceptable to the AHJ.
17. Identification of individual detectors is required. Assign each a unique number as follows, in sequence starting at the FACP: (Addressable Loop # -- Device #) Show on the as-built plans, and also permanently mount on each detector's base so that it's readable standing on the floor below without having to remove the smoke detector. Exception: For detectors with housings (i.e., air duct, projected beam, air sampling, flame), apply the identification to a suitable location on exterior of their housing. Device labels may not be affixed to the device. Identification labels for white detector bases, control/monitor modules and other light colored devices shall be printed labels with black lettering on a clear background. Identification labels for red notification appliance housings and other dark color devices shall be printed labels with white lettering on a clear background. Handwritten labels or labels made from embossed tape are not acceptable.

Q. Final Inspection: The fire alarm system shall be inspected, with portions of it functionally tested. This shall normally include the use of appropriate means to simulate smoke for testing detectors, as well as functionally testing the system interface with building controls, fire extinguishing systems and any off-premises supervising station. Operation of any smoke removal system shall be checked as instructed by the AHJ. This statistical (sampling) inspection is intended to assure that the contractor has properly installed the system and performed the 100% operational test as required by NFPA 72. The electrical contractor shall provide two-way radios, ladders, and any other materials needed for testing the system, including a suitable smoke source. Upon successful completion of the Inspection and after the correction of all efficiencies, the manufacturer’s authorized representative shall issue a test report to the Architect/Engineer and Owner, detailing and certifying the test.

16041 PAGING SYSTEM

A. Provide a complete, zoned public address system, and coordinate required zones with the Owner. Provide a minimum of one zone per Nurse Station plus one zone for Administrative/Kitchen area. See Drawings for zoning and control locations. The system shall be complete with preamplifiers, power amplifiers, power supplies, volume limiter/compressors, equipment racks, telephone paging adapters, tone generator, flush ceiling mounted loudspeakers, volume controls, exterior horn type loudspeakers, conductors and cables and raceways.

B. Shop Drawings: Include plans (showing coordinated zones), elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.

2. Console layouts.
3. Control panels.
4. Rack arrangements.
5. Calculations: Provide to demonstrate system coverage and sizing backup battery. Determine speaker taps.
6. Wiring Diagrams: For power, signal, and control wiring.
    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project. Personnel certified by manufacturer.

D. Comply with NFPA 70.

E. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

F. System Functions:
1. Selectively connect any zone to any available signal channel.
2. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
3. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
4. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
5. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

G. Conductors and Cables: Jacketed, twisted pair and twisted multipair, untinned solid copper.

H. Wiring Method: Install cables in metallic raceways except in the attic where cable may be free run on J hooks.

I. Installation
1. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
2. Wall-Mounted Outlets: Flush mounted.
3. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

4. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

J. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

K. Operational Tests: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

L. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

M. Public address systems will be considered defective if they do not pass tests and inspections.

N. Prepare test and inspection reports.

O. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

P. Engage a factory-authorized service representative to perform startup service.

Q. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

R. Complete installation and startup checks according to manufacturer's written instructions.

S. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

T. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

U. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment.

16042 NURSE CALL SYSTEM

A. Provide a two-way voice and tone visual Nurse/Patient Communication System with central control and power supply equipment, single and two patient bed stations with pillow speaker(s), staff stations, duty stations, emergency pull cord stations, room dome lights and corridor LED alphanumeric annunciator displays in compliance with this specification and the Owner's requirements. Also provide capability for system to communicate with Owner's remote central system for monitoring. System shall be compliant with NFPA 70 - National Electrical Code, NFPA 99 – Health Care Facilities and Underwriters Laboratories Inc. Standard 1069, latest edition.
   1. Two-way voice communication is required between the patient bed stations and nurse stations, duty stations and staff stations.
   2. Tone/visual annunciation only is required between the patient toilet and shower/tub stations and nurse stations, duty stations and staff stations.
   3. Tone/visual annunciation only is required between the public toilet stations and nurse stations, duty stations and staff stations.

B. Provide shop drawings including electrical characteristics and connection requirements; cable routing; connection diagrams; and equipment arrangement. Submit catalog data showing electrical characteristics, connection requirements, component quantities, equipment manufacturer, model number, description of each component, and complete description of system operation. Certify products meet or exceed specified requirements and certify that that the supplying contractor is an authorized distributor. Provide certification showing that the installing technician(s) has completed training school for the proposed equipment.

C. Provide detailed operation and maintenance instruction and training. Furnish four hours of instruction each for four persons, to be conducted at project site with manufacturer's representative. Use submitted operation and maintenance manual as reference during training. Supplement with training materials as required. System shall have a manufacturer warranty for a period of one year following acceptance. The warranty shall include all parts, labor, field service, travel expenses, etc.

D. Cable: As recommended by the system manufacturer.

E. Wiring Method:
   1. Install cables in raceways except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces. Install plenum cable in environmental air spaces, including plenum ceilings. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
   2. Provide junction and outlet boxes for nurse call devices as shown using 4" square x 2-1/8" minimum deep boxes with an empty 3/4" minimum conduit to the accessible ceiling cavity. Coordinate back box and raceway size and locations with the system vendor. Provide power sources as shown and as required.

F. Installation
   1. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
   2. Wall-Mounted Outlets: Flush mounted.
   3. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

G. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

H. Operational Tests: Perform tests that include originating calls at all locations and verify proper annunciation.

I. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

J. Prepare test and inspection reports.

K. Engage a factory-authorized service representative to perform startup service.

L. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.

M. Complete installation and startup checks according to manufacturer's written instructions.

N. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance.

O. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

P. Demonstration: Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the system and equipment.

16043 TELEPHONE AND DATA

Combination telephone and data outlets shall be provided as shown and shall consist of a 4" square x 2-1/8" minimum deep box with an empty 1-1/4" minimum conduit to the accessible ceiling cavity. Coordinate power requirements, back box and raceway size and locations with the Owner’s system vendor. Devices, equipment, cabling and jacks

will be installed by the Owner's vendor. Provide pull strings in all empty raceways. Provide power sources and grounding as shown and as required.

16044 MAG LOCK RACEWAY SYSTEM

Provide junction and outlet boxes as shown for the mag lock system using 4" square x 2-1/8" minimum deep boxes with an empty 3/4" minimum conduit between devices at each door as required and to the accessible ceiling cavity. Coordinate power requirements, back box and raceway size and locations with the Owner's system vendor. Devices, equipment and cabling will be installed by the Owner's vendor. Provide pull strings in all empty raceways. Provide power sources as shown and as required.

16045 CABLE TELEVISION RACEWAY SYSTEM

Provide CATV junction and outlet boxes as shown using 4" square x 2-1/8" minimum deep boxes with an empty 3/4" minimum conduit to the accessible ceiling cavity. Coordinate power requirements, back box and raceway size and locations with the Owner's system vendor. Devices, equipment and cabling will be installed by the Owner's vendor. Provide pull strings in all empty raceways. Provide power sources as shown and as required.

16046 SECURITY CAMERA RACEWAY SYSTEM

Provide junction and outlet boxes as shown for security cameras using 4" square x 2-1/8" minimum deep boxes with an empty 3/4" minimum conduit to the accessible ceiling cavity. Coordinate power requirements, back box and raceway size and locations with the Owner's system vendor. Devices, equipment and cabling will be installed by the Owner's vendor. Provide pull strings in all empty raceways. Provide power sources as shown and as required.

16047 AIPHONE SYSTEM RACEWAY SYSTEM

Provide junction and outlet boxes as shown for the Aiphone system using 4" square x 2-1/8" minimum deep boxes with an empty 3/4" minimum conduit to the accessible ceiling cavity. Coordinate power requirements, back box and raceway size and locations with the Owner's system vendor. Devices, equipment and cabling will be installed by the Owner's vendor. Provide pull strings in all empty raceways. Provide power sources as shown as required.

16048 TESTS

A. Test all systems furnished under Division 16 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

B. Make the following minimum tests and checks prior to energizing electrical equipment:

1. Mechanical inspection, testing and settings of all circuit breakers, disconnect switches, motor starters, control equipment, etc., for proper operation.
2. Check all wire and cable terminations. Verify to the Architect/Engineer that connections meet the equipment torque requirements.
3. Check rotation of motors, obtain permission from other contractors to start motor, and proceed to check for proper rotation. If the motor rotates in the wrong direction, correct it. Take all necessary precautions not to damage any equipment.
4. Provide all instruments and equipment for the tests specified herein.

C. All testing shall be scheduled and coordinated by the Contractor. Notify the Owner at least two (2) weeks in advance of conducting tests. The Contractor shall have qualified personnel present during all testing.

D. All tests shall be completely documented with the time of day, date, temperature, and all other pertinent test information. All required documentation of readings indicated shall be submitted to the Architect/Engineer prior to, and as one of the prerequisites for, final acceptance of the project.

E. Electrical Distribution System Tests: All current carrying phase conductors and neutrals shall be tested as installed, and before connections are made, for insulation resistance and accidental grounds. This shall be done with a 500 volt megger. The following procedures shall be as follows:
1. Minimum readings shall be one million (1,000,000) or more ohms for #6 wire and smaller, 250,000 ohms or more for #4 wire or larger between conductors and between conductor and the grounded metal raceway.
2. 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 megger reading between the neutral bar and grounded enclosure. If this reading is less than 250,000 ohms, the Contractor shall disconnect the branch circuit neutral wires from this neutral bar. He shall then test each one separately to the panel and until the low reading ones are found. The Contractor shall correct troubles, reconnect and retest until at least 250,000 ohms from the neutral bar to the grounded panel can be achieved with only the neutral feeder disconnect.
3. The Contractor shall send a letter to the Architect/Engineer certifying that the above has been done and tabulating the megger readings for each panel. This shall be done at least four (4) days prior to final inspection.
4. At inspection, the Contractor shall furnish a megger and show Architect/Engineer's representative that the panels comply with the above requirements. He shall also furnish a hook on type ammeter and a voltmeter and take current and voltage readings as directed by the representatives.
5. At inspection, the Contractor shall furnish ladders, required tools, and men to open fixtures, boxes, panels, or any other equipment to enable the Architect/Engineer's representatives to see into any parts of the installation he may request.

F. Electrical Grounding System Tests: Provide documentation showing values of earth ground impedance for the system ground. See Specifications Section 16027 for testing requirements.

G. Patient Environment Electrical Grounding System Tests: Provide documentation showing values of impedance and equipotential voltage for each grounded point in a patient care area and showing the value of current leakage (with grounds in place and lifted) of each piece of fixed electrical equipment. Grounding systems shall be tested to the extent required by the NEC, the Guidelines for Design and Construction of Health Care Facilities, by the Facilities Guidelines Institute and all local codes and ordinances. Provide written certification of tests and results in triplicate to the Owner, DHSR and the Architect/Engineer prior to final inspection. All testing shall be accomplished by competent personnel appropriately certified, accredited, and accepted by the State of North Carolina to perform the required testing. Provide testing personnel credentials to the Architect/Engineer for approval prior to commencing tests. All tests shall be performed in the presence of the Owner and Architect/Engineer.

16049 ELECTRICAL WORK IN CONNECTION WITH OTHER CONTRACTS

A. The Electrical Contractor shall provide a source of power for mechanical, plumbing, sprinkler, food service, laundry, low-voltage systems, General Contractor-furnished and Owner-furnished systems and equipment shown on the Drawings. Provide pigtails, flexible connections, conductors, raceways, circuit breakers, safety switches, receptacles, junction boxes, panelboards and/or wiring troughs as detailed in this section and/or as shown on the Drawings.

B. The locations of safety switches and other electrical equipment and devices shown on the Electrical Drawings are approximate only and some adjustment of their locations should be anticipated. The locations of local disconnecting means furnished by other divisions are shown on the respective division's Drawings. Coordinate exact locations with the entity (vendor, contractor or Owner) providing the equipment. Coordinate and verify all electrical requirements, final connections, phasing and rotation, overcurrent and overload protective device sizes with the entity providing the equipment. Fuses, variable speed drives, magnetic motor starters, magnetic motor starter overload elements, control devices and sensors and control wiring and raceways for such equipment will be provided and installed by the entity providing the equipment. See other specifications divisions for further explanation of contractor responsibility. Do not apply power to equipment without the permission of the entity providing the equipment.

C. The Electrical Contractor shall coordinate with the plumbing, mechanical and general contractors, and the Owner, prior to ordering or installation of any equipment, to verify equipment requirements are provided in the electrical design. The contractor will not be compensated for costs associated with changing the electrical systems to match utilization equipment, even if the electrical work is installed per the electrical drawings.

D. The electrical contractor shall provide branch circuit power sources (designated 20A circuit breakers in selected branch circuit panelboards) as indicated in the panel schedules on the Drawings. The HVAC contractor shall extend power from these circuit breakers as required for control power, damper power, and power for unscheduled HVAC equipment. If additional circuits are required, the contractor may use circuit breakers designated as “spare”.

E. Heating, Ventilating and Air Conditioning Equipment:
   1. Air Handlers and Cassettes; Energy Recovery Units; Kitchen Exhaust Hood; Dishwasher Exhaust Hood; DOAS Unit; Chillers, Boilers, Pumps, etc.: The Electrical Contractor shall provide a safety switch as shown and make power connections to the line and load side of the switch terminals and to the equipment. If the equipment is supplied with an integral disconnecting means, the Electrical Contractor shall make final connections to the line side of the disconnecting means. All control wiring will be by the Heating and Air Conditioning Contractor. See kitchen hood Reference Drawings for additional requirements.
   2. Thru-wall Heat Pumps with cord sets: The Electrical Contractor shall provide a properly sized receptacle adjacent to the unit as shown and make power connections to the receptacle. All control wiring will be by the Heating and Air Conditioning Contractor.
   4. Exhaust Fans: The Electrical Contractor shall make power connections to the line and load side of the fan’s integral disconnect switch terminals. All control wiring will be by the Heating and Air Conditioning Contractor.
   5. Fuses and control wiring for heating, ventilating and air conditioning equipment will be provided and installed by the Mechanical Contractor.
   6. See Mechanical Specifications Section 17017 “Electrical Work” for further explanation of Contractor responsibility.
   7. FA interface: See Section 16040.

F. Plumbing Equipment:
   1. The Electrical Contractor shall provide power supplies and final electrical connections to equipment provided by the Plumbing Contractor. Provide pigtails, flexible connections, disconnecting means, receptacles, etc., as required and coordinate exact locations with the Plumbing Contractor.
   2. See Plumbing Specifications Section 15017 “Electrical Work” for further explanation of Contractor responsibility.

G. Fire Protection (Sprinkler) System: The Electrical Contractor shall interface fire alarm system devices to sprinkler flow and tamper switches, and all other fire protection system components requiring supervision by the fire alarm system, provided and installed by the Sprinkler contractor. Connections shall be made under the direct supervision of the Fire Protection Contractor. See Fire Alarm System Drawings and Specifications Section 16040 for interface requirements and details. Coordinate with the Fire Protection System Contractor and refer to the Fire Protection System Drawings and Specifications for additional details and requirements.

H. Food Service Equipment: The Electrical Contractor shall provide a power source adjacent to and final electrical power connections for equipment provided by the Food Service Equipment Contractor. Provide pigtails, flexible connections, disconnecting means, receptacles, etc., as required and coordinate exact locations with the Food Service Equipment Vendor. See Food Service Equipment Electrical Notes and Food Service Equipment Schedule on the Drawings for electrical requirements, electrical connection details and additional details.

I. Laundry Equipment: The Electrical Contractor shall provide a power source and final electrical power connections for laundry equipment. Provide pigtails, flexible connections, disconnecting means, receptacles, etc., as required and coordinate exact locations with the Laundry Equipment Vendor. See Laundry Equipment Electrical Notes and Laundry Equipment Schedule on the Drawings for electrical requirements, electrical connection details and additional details.

J. General Contractor Provided Equipment: The Electrical Contractor shall provide a power source adjacent to equipment provided by the General Contractor. Final connections to this equipment shall be provided by the Electrical Contractor. Coordinate exact locations and requirements with the General Contractor.

1. Door Hold-Open Devices: The Electrical Contractor shall furnish and install electrical connections from the fire alarm system to each door hold-open device, furnished by the General Contractor, at locations as shown and as directed by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by the Electrical Contractor in cooperation with the General Contractor.
2. Electrically-Operated Doors: The Electrical Contractor shall furnish and install a power supply to each electrically-operated door at locations as shown and as directed by the General Contractor. The Electrical Contractor shall also install and wire door activation switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the door hardware vendor. Final connections to the equipment shall be by the Electrical Contractor in cooperation with the General Contractor.
3. Projection Screens: The Electrical Contractor shall furnish and install a junction box and disconnect switch adjacent to each projection screen and make power connections to the screen power terminals. The Electrical Contractor shall also install and wire screen position switches provided by the General Contractor. Provide connections as required and coordinate exact locations and configurations with the General Contractor and the projection screen vendor. Final connections to the equipment shall be by the Electrical Contractor in cooperation with the General Contractor.

K. Low Voltage (LV) Systems Equipment: The Electrical Contractor shall provide boxes, raceways and power for LV equipment. Coordinate exact locations and requirements with the Owner's LV System Contractor. Final connection to the equipment will be provided by the Electrical Contractor in coordination with the LV

Systems Contractor. Provide receptacle configurations as required and coordinate exact locations and configurations with the LV Systems Contractor. Do not apply power to equipment without the permission of the LV Systems Contractor.

L. Owner Provided Equipment: The Electrical Contractor shall provide a power source adjacent to equipment provided by the Owner. Coordinate exact locations and requirements with the General Contractor. Final connection to the equipment will be provided by the Electrical Contractor. Provide receptacle configurations and/or provide direct connection as required by equipment and coordinate exact locations and configurations with the Owner. Do not apply power to equipment without the permission of the Owner.

M. Make electrical connections in accordance with equipment manufacturer's instructions.

N. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.

O. Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.

P. Provide suitable strain relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.

Q. Provide interconnecting conduit and wiring between devices and equipment where indicated.

16050 SHORT CIRCUIT, ARC FLASH AND SELECTIVE COORDINATION STUDY

A. The Electrical Contractor shall provide a facility Short Circuit, Arc Flash and Selective Coordination Study for approval by the Architect/Engineer. The Study shall be performed by a North Carolina Registered Professional Engineer and shall include the utility company transformer and downstream devices including the switchboard and all branch circuit panelboards, engine-generator sets and automatic transfer switches.

B. The Study shall be complete with calculations to demonstrate that overcurrent devices, transfer switches, switchboards, panelboards, motor controls and feeders are adequately sized to safely withstand available phase-to-phase and phase-to-ground faults. The study shall also include an analysis of generator performance under fault conditions and a coordination study resulting in the tabulation of settings for all over-current device adjustable trips, time delays, relays and ground fault coordination.

C. The Division 16 Contractor shall be responsible to ensure proper AIC ratings for protection of electrical equipment. All switchboards, panelboards, enclosed circuit breakers, safety switches, engine-generator set, automatic transfer switches, etc.

and overcurrent device ratings, and upsizing of downstream conductors and raceways, if required, shall conform to the results of this Study. Adjustment of protective device equipment, conductors, raceways, etc. to meet the approved coordination study submittal shall be the responsibility of the Electrical Contractor at no additional cost to the Owner. The Study shall be coordinated to 0.1 seconds.

D. Provide and install equipment warning labels indicating arc flash energy, PPE requirements, etc. as required by Drawings detail, and fault current data required by NEC Article 408.6.

E. The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form.
   1. Coordination study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination Study Report.
   4. System One Line Diagram.

16052 SCHEDULE OF WORK

The Electrical Contractor shall schedule his work as described in the Architectural Specifications.

16053 GUARANTEE

The Contractor shall guarantee the materials and workmanship covered by these Drawings and specifications for a period of one year from the date of acceptance by the Owner. The Contractor shall repair and/or replace any parts of any system that may prove to be defective at no additional cost to the Owner within the guarantee period.

END OF SECTION 16000