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DIVISION 16 - ELECTRICAL

SECTION 16005

GENERAL ELECTRICAL
10/2010

PART 1 - GENERAL

1.1 The work covered by this division consists of providing all labor, equipment and materials and performing all operations necessary for the installation of the electrical work as herein called for and shown on the Drawings. The work shall include but shall not be limited to the following:

Provide all power, lighting, fire alarm, intercom, telephone, communications, and other electrical systems for the project. Fully coordinate all electrical requirements of equipment being furnished by other Divisions under this construction contract. Each system shall be complete and fully functional.

1.2 Related Documents:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to work of this Section.

B. Provisions of this Section apply to work of all Division 16 Sections.

C. All control wiring for Division 15 shall be governed by Division 16 requirements. All control wiring shall be in conduit in compliance with the Specifications.

D. Review all project Drawings to be aware of conditions affecting work herein.

1.3 Definitions:

A. Provide: Furnish, install, and test, complete and ready for intended use.

B. Furnish: Supply and deliver to project site, ready for subsequent requirements.

C. Install: Operations at project site, including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar requirements.

1.4 Permits and Fees: Contractor shall obtain all necessary permits, meters, and inspections required for his work and pay all fees and charges incidental thereto.

1.5 Verification of Owner's Survey Data: Prior to commencing any excavation or grading the Contractor shall satisfy himself as to the accuracy of all survey data indicated on the Drawings and/or provided by the Owner. Should the Contractor discover any inaccuracies, errors, or omissions in the survey data, he shall immediately notify the Engineer. Commencement by the Contractor of any excavation or upgrading shall be held as an acceptance of the survey data by him after which time the Contractor has no claim against the Owner resulting from alleged errors, omissions or inaccuracies of the said survey data.

1.6 Delivery and Storage of Materials: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. All material shall be stored to provide protection from the weather and accidental damage.

1.7 Extent of work is indicated in the Drawings, Schedules, and Specification. Singular references shall not be construed as requiring only one device if multiple devices are shown on the Drawings or are required for proper system operation.

1.8 Field Measurements and Coordination:

A. The intent of the Drawings and Specifications is to obtain a complete and satisfactory installation. Separate divisional Drawings and Specifications shall not relieve the Contractor or Subcontractors from full compliance of work of his trade indicated on any of the Drawings or in any Section of the Specifications. Report conflicts prior to start of work.

B. Verify all field dimensions and locations of equipment to insure close, neat fit with other trades' work. Make use of all Contract Documents and approved shop drawings to verify exact dimension and locations. Do not scale electrical drawings; rely on dimensions shown on architectural or structural drawings.

C. Coordinate work in this Division with all other trades in proper sequence to insure that the total work is completed within Contract time schedule and with minimum cutting and patching.

D. Locate all equipment, materials, and apparatus symmetrical with architectural elements. Install to exact height and locations when shown on architectural drawings. When locations are shown only on mechanical drawings, be guided by architectural details and conditions existing at job and correlate this work with that of others. Provide all required work clearances as defined in the NEC.

E. Install work as required to fit structure, avoid obstructions, and retain clearance, headroom, openings and passageways. Cut no structural members without written approval from Engineer or Architect.

F. Carefully examine any existing conditions, piping, and premises. Compare Drawings with existing conditions. Report any observed discrepancies. Written instructions will be issued by the Engineer to resolve discrepancies.

G. Because of the small scale of the Drawings, it is not possible to indicate all offsets and fittings or to locate every accessory. Drawings are essentially diagrammatic. Study carefully the sizes and locations of structural members, wall and partition locations, trusses, and rooms dimensions and take actual measurements on the job. Locate material, equipment and accessories with sufficient space for installing and servicing. Contractor is responsible for accuracy of his measurements and shall not order materials or perform work without verification. No extra compensation will be allowed because field measurements vary from the dimensions on the Drawings. If field measurements show that equipment or material cannot be fitted, the Engineer shall be consulted. Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.

H. Coordinate all equipment being supplied in other divisions to ensure proper electrical connections. Obtain full manufacturer’s electrical information and coordinate with electrical system specified. Make adjustments prior to submitting electrical shop drawings. Mark on shop drawings necessary modifications due to equipment being supplied. Contractor shall be responsible for replacement and upgrade of electrical equipment if at time of completion, it is apparent that electrical requirements do not meet the electrical system’s supply.

I. Verify all ceiling clearances prior to ordering panelboards and switchboards. Dimensioned drawings are required for all electrical rooms showing actual plan and elevation layouts. Any equipment ordered prior to verifying that it will fit, will be returned at the contractor’s expense. Coordinate panelboard and switchboard locations with structural members, beams and column foundations.

J. Coordinate location of electrical equipment with pipes and duct work being supplied by other Divisions. The equipment space included all referenced NEC clearances shall be maintained. If any pipes or duct work violate any electrical clearance requirements, it shall be removed and

relocated at the contractor's expense. Drip pans are not permitted unless specifically called for in the construction documents.

K. Guarantee and Service:

1. The Contractor shall guarantee labor, materials and equipment for a period of one (1) year from Substantial Completion, or from Owner's occupancy, whichever is earlier. Contractor shall make good any defects and shall include all necessary adjustments to and replacement of defective items without expense to the Owner.
2. In addition to the manufacturer's guarantee of each item, Contractor shall provide his standard guarantee after final acceptance and make good any defects of materials or workmanship occurring during this period without expense to the Owner.
3. Owner reserves the right to make emergency repairs as required to keep equipment in operation without voiding Contractor's Guarantee Bond nor relieving Contractor of his responsibilities during guarantee period.

1.9 Shop Drawings:

A. Shop drawings, product literature, and other approved submittals will only be reviewed if they are submitted in full accordance with the General and Supplementary Conditions and Division 1 Specification sections and the following:

1. Submittals shall not include items from more than one specification in the same submittal package.
2. Submittals shall be properly identified by a cover sheet showing the project name, Architect and Engineer names, submittal control numbers, specification section, a list of products or item names with model numbers in the order they appear in the package, and spaces for approved stamps. A sample cover sheet is included at the end of this section.
3. Submittals shall have been reviewed and approved by the General Contractor (or Prime Contractor). Evidence of this review and approval shall be an "Approved" stamp with a signature and date on the cover sheet.
4. Submittals that include a series of fixtures or devices (such as lighting fixtures) shall be organized by the fixture number and be marked accordingly. Each fixture must include all items associated with that fixture regardless of whether or not those items are used on other fixtures.
5. The electrical design shown on the drawings supports the mechanical equipment basis of design specifications at the time of design. If mechanical equipment is submitted with different electrical requirements, it is the responsibility of the mechanical contractor to resolve all required electrical design changes (wire and conduit size, type of disconnect or overload protection, point(s) of connection, etc.) and clearly show the new electrical design on the mechanical submittal with a written statement that this change will be provided at no additional cost. Mechanical submittals made with no written reference to the electrical design will be presumed to work with the electrical design. Any corrections required will be at no additional cost.

B. Before ordering any materials or equipment, and within 30 days after the award of Contract the Contractor shall submit to the Engineer one complete schedule showing the make, type, manufacturer's name and trade designation of all equipment.

1. This schedule shall be accompanied by six (6) copies of the manufacturer's printed specifications and shop drawings for each piece of equipment or specialty and shall give dimensions, diagrams, descriptive literature, capacity or rating, kind of material, finish,

guarantee, etc., and such other detailed information as the Engineer may require.

2. When approved, such schedule shall be an addition to these Specifications, and shall be of equal force in that no deviation will be permitted except with the approval of the Engineer.
3. Each shop drawing shall reference the Specification section.
4. The submittal should reference any delivery/scheduling problems with the equipment being supplied.
5. The submittal shall not contain any equipment and/or systems that have not been either listed in the construction documents or provided in an addendum as “approved for bidding”. This formality may be waved by the Engineer, if in his opinion, it is to the Owner’s benefit.

C. If shop drawings show variation from the requirements of the Contract Documents, the Contractor shall make specific mention of such variation in his letter of transmittal. If acceptable, Contractor will not be relieved of the responsibility for executing the work in accordance with the Contract.

D. Review of shop drawings, descriptive literature, catalog data, or schedules by the Engineer shall not relieve the Contractor from responsibility for deviations from Contract Drawings or Specifications, unless he has in writing called to the attention of the Engineer such deviation at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings, descriptive literature, catalog data, or schedules. Any feature or function specified but not mentioned in the submittal shall be assumed to be included per the specification.

E. Submit shop drawings and any other drawings specifically called for in other sections. Shop drawings shall consist of plans, sections, elevations and details to scale (not smaller than 1/4" per foot), with dimensions clearly showing the installation. Direct copies of small-scale project drawings issued to the Contractor are not acceptable. Drawings shall take into account equipment furnished under other Sections and shall show space allotted for it. Include construction details and materials.

F Submit product data after award of the Contract and before any equipment or materials are purchased. Product data are defined as manufacturer's printed literature specifically marked to indicate size and model and accompanied by rating sheets listing values showing that equipment meets scheduled or specified values. Properly coded stamp from the Engineer on returned submittal is required before ordering equipment.

G. Coordinate with other division’s supplying equipment prior to submitting shop drawings.

H. Shop drawings shall be submitted in one package unless approved otherwise by the Engineer. Provide an index of sections list manufacturers and “as-specified” or not. Each Specification Section shall be tabbed with equipment inserted.

I. Electrical Room Drawings: A detailed, 1/4"=1'-0" scaled plan view drawing shall be submitted for each electrical room to ensure that the equipment being supplied will fit properly. Include on the drawings and obstruction from building structural or mechanical. Review all duct work and piping shop drawings to ensure proper clearance. Specific grounding requirements shall be noted on the drawings. This includes additional driven grounds and bonding to building steel, water piping, and foundation rebar. This drawing shall make specific mention of any NEC violation. Conduit and/or equipment placement shall take into account any structural or foundation interference. All equipment within the electrical room shall be labeled and actual dimensions shown. The drawings shall be submitted with the shop drawings and manufacturer's product sheets. ***Failure to supply scaled drawings shall be the basis of rejecting the entire submittal package.***

1.10 Test Reports and Verification Submittals: Submit test reports, certifications and verification letters as called for in other sections. Contractor shall coordinate the required testing and

documentation of system performance such that sufficient time exists to prepare the reports, review the reports, and take corrective action within the scheduled contract time.

1.11 O & M Data Submittals: Submit Operations and Maintenance data as called for in other sections when a copy of approved submittals is included in the O & M Manual, only the final "Furnish and Submitted" or "Furnish as Corrected" copy shall be used. Contractor shall organize these later in the O & M Manuals tabbed by specification number. Prepare O & M Manuals as required by Division 1 and as described herein.[Submit O & M manuals on CD-Rom in addition to required hard bound copies.] Submit manuals at the substantial completion inspection

PART 2 - PRODUCTS

2.1 All materials shall be new and unused, Owner-supplied, or reused as shown on the Drawings, the best of their respective kinds, suitable for the conditions and duties imposed on them. The description, characteristics, and requirements of materials to be used shall be in accordance with qualifying conditions established in the following Sections.

2.2 Equipment and Materials

A. Equipment and materials furnished under this Division shall be the product of a manufacturer regularly engaged in the manufacture of such items for a period of three years. Where practical, all of the components shall be products of a single manufacturer in order to provide proper coordination and responsibility. Where required, Contractor shall furnish proof of installation of similar equipment or materials.

B. Each item of equipment shall bear a nameplate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. This plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.

C. The label of the approving agency, such as UL or NEMA, by which a standard has been established for the particular item shall be in full view. Materials shall be UL-listed for the application specified or indicated on the Drawings or Specifications.

D. The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be a product of the manufacturer's latest design.

E. A service organization with personnel and spare parts shall be available within two hours for each type of equipment furnished.

F. Install in accordance with manufacturer's recommendations. Place in service by a factory trained representative where required.

G. Materials and equipment are specified herein by a single or by multiple manufacturers to indicate quality, material and type of construction desired. Manufacturer's products shown on the Drawings have been used as basis for design; it shall be the Contractor's responsibility to ascertain that alternate manufacturer's products meet detailed specifications and that size and arrangement of equipment are suitable for installation.

H. Model Numbers: Catalog numbers and model numbers indicated in the Drawings and Specifications are used as a guide in the selection of the equipment and are only listed for the Contractor's convenience. The Contractor shall determine the actual model numbers for ordering equipment and materials in accordance with the written description of each item and with the intent of the Drawings and Specifications.

2.3 Requests for Substitution:

A. Where a particular system, product or material is specified by name, consider it as standard basis for bidding, and base proposal on the particular system, product or material specified. Other systems, products, equipment or materials may be accepted only if in the opinion of the Engineer, they are equivalent in quality and workmanship and will perform satisfactorily its intended purpose. The Engineer shall approve all such substitutions in materials or equipment in writing. This shall occur prior to bidding.

B. In making requests for substitutions, the Contractor shall list the particular system, product, equipment or material he wishes to substitute and at bid time the Contractor shall state the amount he will add or deduct from his base bid if the substitution is approved by the Engineer. If the Contractor allows no deduction or addition to the base bid for such substitution, it shall be so stated on the request.

C. Requests by Contractor for substitution will be considered only when reasonable, timely, fully documented, and qualifying under one or more of the following circumstances.

1. Required product cannot be supplied in time for compliance with Contract time requirements.
2. Required product is not acceptable to governing authority, or determined to be non-compatible, or cannot be properly coordinated, warranted or insured, or has other recognized disability as certified by Contractor.
3. Substantial cost advantage is offered Owner after deducting offsetting disadvantages including delays, additional compensation for redesign, investigation, evaluation and other necessary services and similar considerations.

D. All requests for substitution shall contain a "Comparison Schedule" and clearly and specifically indicate any and all differences or omissions between the product specified as the basis of design and the product proposed for substitution. Differences shall include but shall not be limited to data as follows for both the specified and substituted products:

1. Principle of operation.
2. Materials of construction or finishes.
3. Thickness of materials.
4. Weight of item.
5. Deleted features or items.
6. Added features or items.
7. Changes in other work caused by the substitution.
8. Performance and rating data.

If the approved substitution contains differences or omissions not specifically called to the attention of the Engineer, the Owner reserves the right to require equal or similar features to be added to the substituted products at the Contractor's expense.

2.4 Prior Approval: Prior Approval shall be required for any manufacturer other than those listed for all specified items in the Drawings and Specifications. Submit all requests for approval of the alternate manufacturer's products two weeks prior to bid opening. Approval will be in the form of an Addendum to the Specifications and Drawings. Clearly indicate all differences between the specified and proposed product following the guidelines for substitution herein. This requirement may be waived if, in the opinion of the Engineer, it is in the best interest of the Owner. Submittals received after the award of the bid for equipment that has not been Prior Approved is subject to immediate rejection. ***Any Engineering time required due to equipment that has not been Prior Approved is subject to billing charged directly to the contractor at the Engineer's current billing rate.***

PART 3 - EXECUTION

3.1 Workmanship: All materials, fixtures, and equipment shall be installed and completed in a first-class workmanlike manner and in accordance with the best modern methods and practice. Any materials installed which do not present an orderly and reasonably neat and/or workmanlike appearance, or do not allow adequate space for maintenance, shall be removed and replaced when so directed by the Engineer.

3.2 Coordination

A. The Contractor shall be responsible for full coordination of the electrical systems with shop drawings of the building construction so the proper openings and sleeves or supports etc., are provided for conduit, devices, or other equipment passing through slabs or walls.

B. Any additional steel supports required for the installation of any electrical equipment, etc., shall provided by the Contractor.

C. It shall be the Contractor's responsibility to see that all equipment that may require maintenance and operation are made easily accessible, regardless of the diagrammatic location shown on the Drawings.

D. All connections to fixtures and equipment shown on the Drawings shall be considered diagrammatic unless otherwise indicated by a specific detail on the Drawings. The actual connections shall be made to fully suit the requirements of each case and adequately provide for servicing.

E. The Contractor shall protect equipment and fixtures at all times during storage and construction. He shall replace all equipment and fixtures, which are damaged as a result of inadequate protection. Any electrical equipment with electronic components shall be stored off-site in a climate controlled facility until the building conditions are suitable for installation. Any equipment damaged or compromised by unprotected climate control, in the opinion of the Engineer, shall be replaced at contractor’s cost with factory new equipment.

F. Prior to starting and during progress of work, examine work and materials installed by others as they apply to work in this division. Report conditions, which will prevent satisfactory installation.

G. Start of work will be construed as acceptance of suitability of work of others.

H. The Contractor shall review all equipment being supplied by other divisions prior to ordering electrical equipment. Any conflicts between equipment being supplied and the electronic requirements on the drawings shall be corrected and incorporated into the electrical submittals prior to ordering equipment. Installation of the electrical system is the contractor’s acceptance of equipment requirements. Any conflict with equipment’s electrical requirements after electrical system has been installed shall be the responsibility of the contractor to make corrective action. Any corrective action shall be at the contractor’s expense.

3.3 Utilities Coordination: The Contractor shall meet with respective personnel of the telephone, cable TV and electric utilities and review all details of the service and distribution. All details shown on contract documents shall be verified for adequacy and accuracy. The Contractor shall incorporate any required revisions without additional cost to the Owner.

3.4 Construction Electrical Utilities: Provide all temporary wiring for power and light required for construction purposes and remove such temporary wiring when use is no longer required. The contractor shall be responsible to provide all cabinets, meter enclosures and conduit required by the local utility for the permanent electrical service.

3.5 Interruption of Service: Before any equipment is shut down for disconnecting or tie-ins, arrangements shall be made with the Engineer and this work shall be done at the time best

suited to the Owner. Outages must be scheduled through the Engineer. The Engineer shall review extent, length, and timing of outages. Services shall be restored the same day. Provide temporary power or other services as required during outages. All overtime or premium costs associated with this work shall be invoiced in the base bid.

3.6 Cutting and Patching: Contractor shall be responsible for cutting and patching of all holes, chases, sleeves, and other openings required for installation of equipment furnished and installed under these Specifications. Obtain permission from Engineer before cutting any structural items.

3.7 Equipment Setting: Bolt equipment directly to concrete pads or foundations, using hot-dipped galvanized anchor bolts, nuts and washers. Level equipment. All floor mounted equipment shall be provided with a housekeeping pad at least 4" in depth.

3.8 Painting: Touch-up factory finishes on equipment located inside and outside shall be done under Division 16. Obtain matched color coatings from the manufacturer and apply as directed by manufacturer. If corrosion is found during inspection on the surface of any equipment, clean, prime, and paint, as required. If corrosion is found to be extensive by the Engineer, the equipment shall be removed and replaced with factory new at the expense of the contractor.

3.9 Clean-up: Thoroughly clean all exposed parts of apparatus and equipment of cement, plaster, and other materials and remove all oil and grease spots. Repaint or touch up as required to look like new. During progress of work, Contractor is to carefully clean and leave premises free from debris and in a safe condition.

3.10 Start-up and Operational Test: Start each item of equipment in strict accordance with the manufacturer's instructions; or where noted under equipment specification, a qualified representative of the manufacturer shall do start-up. Alignment, lubrication, safety, and operating control shall be included in start-up check.

3.11 Record Drawings:

A. During the progress of the work the Contractor shall record on their field set of Drawings the corrections, variations, and deviations for systems which are not installed exactly as shown on the Contract Drawings.

B. Upon completion of the work, record drawings shall be prepared as described in the General Conditions, Supplementary Conditions, and Division 1 Sections.

3.12 Certificate of Occupancy:

Following items are required for issue of Certificate of Occupancy. These shall be provided at or before of Substantial Completion Inspection:

A. Provide certification that asbestos containing products were not used in the project.

B. Fire Alarm Certification. In addition, the documentation shall contain witnessed accounts of the shut-down of electrical and mechanical equipment and the operation of fire doors as required by Code and the Construction Documents.

C. Provide certification that the Intercommunications System is fully operational (If applicable).

D. Provide certification that all emergency lights and exit signs are operational.

E. Provide certification that all selective protective devices have been set according to the coordination study/recommendations including all ground fault selections.

3.13 Acceptance

A. Request inspections as required under the Supplementary or General Conditions. Conceal no work until inspected.

B. Punch List: Submit written confirmation that all punch lists have been checked and the required work completed. **The contractor at the Engineer's current billing rate shall pay for additional field time required by the Engineer to report or check on past punch list deficiencies.**

C. Instructions: At completion of the work, provide a competent and experienced person who is thoroughly familiar with the project, for a period deemed necessary by the Owner to instruct permanent operating personnel in the operation of equipment and control systems.

D. Operation and Maintenance Manuals: Furnish four complete manuals bound in ring binders and organized by system or section. Manuals shall contain:

1. Detailed operating instructions and instructions for making minor adjustments.
2. Complete wiring and control diagrams.
3. Routine maintenance operations.
4. Manufacturer's catalog data, service instructions, and parts list for each piece of operating equipment.
5. Copies of approved submittals.
6. Copies of all manufacturer's warranties.
7. Copies of test reports and verification submittals.

E. Control Diagrams: Frame under glass and mount on equipment room wall. Include copy in O and M Manuals.

F. Test together and separately to determine that:

1. System is free from short circuits and other faults.
2. Motor starter overload devices are sized correctly.
3. Motors rotate correctly.
4. All equipment operates correctly and as specified.

G. Warranties: Submit copies of all manufacturers' warranties.

H. Record Drawings: Submit "Record Drawings".

I. Install engraved metal or plastic nameplates or tags on controls, panels, switches, starters, timers, and similar operable equipment, keyed by number to operating instructions. Dymo type labels are not acceptable.

J. Acceptance will be on the basis of tests and inspections of the work. A representative of the firm, which performed the testing, shall be in attendance to assist during inspection. Contractor shall furnish necessary electricians to operate system, make any necessary adjustments and assist with final inspection.

This is a sample cover sheet. Use one for each shop drawing.

PROJECT NAME
PROJECT NUMBER

SAMPLE

ARCHITECT/ENGINEER: Dell Consulting LLC

CONTRACTOR: XYZ Construction

SUBCONTRACTOR: ABC Electrical Contractor

SUPPLIER: Jones Supply Co.

MANUFACTURER: Various

DATE: 2/12/07

SECTION: 26 51 00 / Interior Lighting

1. Type A

2. Type B

3. Type C

4. Type D

5. Type E

Use whatever standard headings you want here

List each item separately

Typical - list mfr name & model number

General Contractor's APPROVAL stamp must be on this sheet.

END OF SECTION 16005

SECTION 16020

CODES AND STANDARDS
10/2010

PART 1 - GENERAL

1.1 All work under Division 16 shall be constructed in accordance with the codes and standards listed herein. The design has been based on the requirements of these codes and standards. While it is not the responsibility of the Contractor to verify that all work called for complies with these codes and standards, he shall be responsible for calling to the Engineer's attention any details on the Drawings and/or Specifications that are not in conformance with these or other codes and standards. Current issue of code applies unless specifically noted otherwise.

1.2 Comply with regulations and codes of suppliers of utilities.

1.3 Where no specific method or form of construction is called for in the Contract Documents, the Contractor shall comply with code requirements when carrying out such work.

1.4 Where code conflict exists, generally the most stringent requirement applies.

1.5 Codes or standards applying to a specific part of the work may be included in that section.

PART 2 - CODES AND STANDARDS

2.1 Codes:

a. Florida Building Code – Building – 2007 with 2009 Amendments
b. Florida Building Code – Test – Protocols for High Velocity Hurricane Zones – 2007 with 2009 Amendments
c. National Electric Code (NFPA-72) - 2008
d. Uniform Fire Code (NFPA 1) – 2006 Florida Edition
e. National Electric Safety Code (NESC)
f. Life Safety Code (NFPA 101) – 2006 Florida Edition

2.2 Standards: All electrical materials, installation and systems shall meet the requirements of the following standards, including the latest addenda and amendments:

a. American National Standard Institutes (ANSI)
b. Illuminating Engineering Society (IES).
c. Institute of Electrical and Electronics Engineers (IEEE).
d. National Electrical Manufacturer's Associations (NEMA).
e. National Fire Protection Association (NFPA).
f. Occupational Safety and Health Act (OSHA).
g. Underwriter's Laboratories, Inc. (UL).

PART 3 - EXECUTION

3.1 Not used.

END OF SECTION 16020

SECTION 16030

ELECTRICAL RELATED WORK
4/2011

PART 1 - GENERAL

1.1 All Division 1 Sections apply to all Division 16 Sections.

1.2 Coordinate for all cutting and patching. Contractor shall review all cutting and patching required prior to bidding and shall coordinate installation.

PART 2 - DIVISION 2 - SITEWORK

2.1 Specific requirements for excavation and backfill for underground conduit are contained in Section 16105.

2.2 The following is part of Division 16 work.

A. Underground electrical utilities.

PART 3 - DIVISION 3 - CONCRETE

3.1 Perform the following as part of Division 16 work, complying with the requirements of Division 3, Concrete.

A. Curbs, foundations and pads for electrical equipment.

B. Encasement of electrical work.

C. Underground structural concrete to accommodate electrical work.

D. Rough grouting in and around electrical work.

E. Patching concrete cut to accommodate electrical work.

PART 4 - DIVISION 4 - MASONRY

4.1 Refer to Division 4, Masonry for:

A. Patching openings to accommodate electrical work.

PART 5 - DIVISION 5 - METALS

5.1 Refer to Division 5, Metals for:

A. Supports for electrical work.

B. Framing openings for electrical equipment.

PART 6 - DIVISION 6 - WOOD

6.1 Refer to Division 6, Wood for:

A. Supports for electrical work.

B. Framing openings for electrical equipment.

PART 7 - DIVISION 7 - THERMAL & MOISTURE PROTECTION

7.1 Refer to Division 7, Thermal and Moisture Protection for:

A. Installation of all supports for electrical work.

B. Caulking and waterproofing of all wall and roof mounted electrical work.

7.2 Perform the following as part of Division 16 work, complying with Division 7 requirements.

A. Fire barrier penetration seals.

B. Caulking and related shielding around ducts and pipes for sound isolation and attenuation.

PART 8 - DIVISION 8 - DOORS AND WINDOWS

8.1 Refer to Division 8, Doors & Windows for:

A. Installation of all access doors for electrical work.

PART 9 - DIVISION 9 - FINISHES

9.1 Refer to Division 9, Finishes for:

A. Painting exposed conduit and equipment.

B. Painting structural metal and concrete for electrical work.

C. Painting access panels.

9.2 Colors shall be selected by the Architect for all painting of exposed electrical work unless specified herein.

9.3 Perform the following as part of Division 16 work.

A. Touch up painting of factory finishes.

PART 10 - DIVISION 15 - MECHANICAL

10.1 Mechanical Contractor shall furnish to Electrical Contractor all necessary nameplate data, equipment power requirements, wiring diagrams, etc., pertaining to the electrical phase of mechanical installation, as well as all required motors, on/off switches, warning lights, relays, and control devices.

10.2 Contractor shall furnish and install all power wiring, starters and contactors, and make final electrical connections to motors, on/off switches, warning lights, relays, and control devices.

10.3 Disconnect switches for mechanical equipment shall be furnished and installed by the Contractor, unless specifically noted on the Drawings as being furnished as part of mechanical equipment.

10.4 Wiring for controls as indicated on the electrical drawings shall be furnished and installed by the electrical contractor. Control wiring and signal wiring between field installed controls, indicating devices and unit control panels as part of mechanical energy management system shall be provided by Division 15, complying with the requirements of Division 16 specifications.

PART 11 - DIVISION 17 - TELECOMMUNICATIONS

11.1 See “Contractor Coordination and Responsibilities Note” on the Drawings.

END OF SECTION 16030

SECTION 16034

REINFORCED CONCRETE FOUNDATIONS
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes all concrete foundations for electrical equipment.

1.3 Quality Assurance

A. Concrete shall have a minimum 28-day compressive strength of 3,000 psi when cured and tested per ASTM C 31 and C 39. Comply with IEEE C 57.12.91.

PART 2 - PRODUCTS

2.1 Materials

A. Concrete:

1. Concrete shall have a minimum 28-day compressive strength of 3,000 psi when cured and tested per ASTM C 31 and C 39.
2. Concrete shall be placed within 1-1/2 hours after adding cement.
3. Slump range shall be 2 to 4 inches and air entrainment between 3 percent and 6 percent by volume.

B. Reinforcing Steel:

1. Shall be deformed bars conforming to ASTM A 615, Grade 60 sized as shown on the Drawings.
2. Reinforcing steel shall be supported with concrete blocks of the same strength as the concrete mix. Use of broken concrete brick or stone for supporting reinforcing steel shall not be permitted.

C. Expansion Joint FIller:

1. Shall conform to ASTM D 994, 1/2-inch thick.

D. Nonshrink Grout:

1. Nonshrink grout shall conform to the Corps of Engineers Specification for Nonshrink Grout, CRD-C586-78
2. Grout shall be fluid and shall be nonmetallic. Grout shall be nongas-liberating type, cement base, premixed product, requiring only the addition of water for the required consistency. All components shall be inorganic.

E. Forms:

1. Use new plywood for exposed areas, and shiplap or plywood for unexposed areas. Materials shall produce tight forms and an acceptable finish.

F. Form Ties:

1. Form ties shall be constructed so the tie remains embedded in the wall, except for the removable portion at each end.
2. Form ties shall have conical or spherical type inserts. Inserts shall be fixed to remain in contact with forming material, and shall be constructed so that no metal is within one inch of the concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties shall not be used.

G. Anchor Bolts:

1. Unless otherwise indicated on the Drawings, anchor bolts shall have minimum yield strength of 75,000 psi.
2. The thread area plus 6 inches of the bolts shall be hot-dip galvanized. In no case shall less than the top 18 inches of the bolt be galvanized. The remainder of the bolt shall not be galvanized, painted, or coated with oil.

PART 3 - EXECUTION

3.1 Installation

A. Forms:

1. Forms shall be constructed accurately with tight joints to prevent the escape of mortar and to avoid the formation of fins.
2. Brace forms to prevent distortion during concrete placement.

B. Placing Reinforcing Steel:

1. Reinforcing steel shall be placed in accordance with CRSI, Recommended Practice for Placing Reinforcing Bars.
2. Minimum length of splices shall be 18 inches. Splices shall be tied with 18-gauge annealed wire.

C. Placing Concrete:

1. Prior to placing concrete, remove water from excavation and all debris and foreign material from forms.
2. Before depositing new concrete on old concrete, clean surface and pour a 1-inch layer of cement sand grout over the surface of the old concrete.

3. Place concrete in 2 ft. layers without segregation or loss of ingredients and without splashing forms or steel above. Vertical drop to final placement shall not exceed 6 feet.

4. Do not place concrete when ambient temperature is below 40 degrees F or approaching 40 degrees F and dropping.

D. Compaction:

1. Concrete shall be vibrated in place until it becomes uniformly plastic. Vibrators shall penetrate the fresh placed concrete and into the previous layer of concrete below.

E. Concrete Finishing:

1. Screed surfaces to true level planes. After absorption of initial water, float with wood float and trowel with steel trowel to a smooth finish.

2. Do not absorb wet spots with neat cement.

3. Foundation shall not vary from level more than 1/4 inch in 10 feet.

F. Removal of Forms: Forms shall not be removed until the concrete has set sufficiently to carry the dead load and construction load it has to sustain. Forms shall be removed with care to minimize scarring or other surface damage.

G. Finishing Formed Concrete Surface:

1. Cut out honeycombed and defective areas. Cut edges perpendicular to surface at least 1 inch deep, no featheredge shall be allowed. Soak area to be patched for 24 hours. Allow surface to drain free of standing water and patch with nonshrink grout

2. When forms are removed, remove fins or projections from surface of exposed areas and rub surface with wood float to provide a uniform surface texture.

H. Concrete Protection and Curing: Protect fresh concrete from direct rays of the sun, drying winds, and wash by rain. When forms are removed and finishing completed, cure formed surfaces with curing compound applied in conformance with manufacturer's directions.

I. Concrete Quality Control: Contractor shall furnish certified test reports for the concrete used. Cost of taking, storing, and testing of sample cylinders shall be included in the bid price.

J. Concrete Testing:

1. Three representative cylinders of each batch of concrete shall be taken and tested as follows:

a. 1 at 7 days
b. 1 at 28 days
c. 1 Spare

2. Test cylinders shall be taken at the site of the pour and shall be prepared and cured in a manner similar to the concrete work being done.

3. Cylinders shall be tested by an approved testing laboratory to verify the strength of the concrete.

K. Anchor Bolts:Anchor bolts shall be set level, square, plumb, to the correct elevation, and properly spaced. Anchor bolts shall not be reinforcing bar. After concrete is set, no force shall be applied to anchor bolts in an attempt to move them and correct their separation. Boltholes on equipment base plates shall not be reamed or redrilled to fit an improper anchor bolt installation.

END OF SECTION 16034

SECTION 16040

ALTERATIONS AND ADDITIONS TO EXISTING WORK
03/2004

PART 1 - GENERAL

1.1 The provisions of this Section are in addition to the provisions of Division 1, Building Modifications.

1.2 Building will be occupied by owner during construction.

PART 2 - PERFORMANCE

2.1 General:

A. All necessary additions and alterations to existing work shall be included as required to provide and maintain a complete and proper electrical installation. As necessary, relocate existing electrical work so other trades can pursue their work and maintain building in service, when occupied.

B. The work shall include, but not be limited to, the following:

1. Relocation of fixtures, pull-boxes, electrical ducts, and other similar items, to permit the installation of new equipment.

2. Installation of new conduits, conductors, wiring, and wiring devices, in order to maintain temporary and permanent use of electrical facilities.
3. Disconnection and reconnection of circuits as required for continued operation of services.
4. Provision for the relocation of all mechanical work as required for proper installation of electrical work where not shown or specified in other sections or on other drawings.
5. Repair or replace, as required, any damage due to the installation of the new electrical system in existing areas.

C. Unused, existing, surface mounted work shall be removed and concealed. Outlets shall be blanked off.

D. Existing work to be maintained shall be reconnected and shall have all outlets, boxes and devices accessible after completion of work by other trades.

E. Within NEC limitations, existing conduits may be reused after cleaning.

F. All new work in existing areas shall be exposed on walls in unfinished areas and concealed in finishes in finished areas. Where cutting and patching are required, finishes shall match existing surface finishes. In existing finished areas, all work shall be concealed in new finishes.

G. Consolidate existing and new building ground systems.

H. In general, all new work is intended to be concealed in finishes to be added under this project.

2.2 Existing Building Power Outages:

A. All necessary power outages in existing and in renovated areas shall be at a time approved by Owner in writing and of shortest possible duration. Coordinate details with Engineer, who will assist in determining Owner's requirements, prior to work.

B. Where portions of buildings are altered, and remainder of building continues in operation, temporary wiring shall be provided to maintain all necessary building functions. Provide all equipment, material, labor for a continuous functional system.

2.3 Temporary Wiring for Remodeled Areas:

A. Progress of the work will require temporary wiring installations to utilize a portion of the remodeled area. Wiring may not be the final, permanent installation, and shall be included, as necessary to supply required electrical function.

2.4 Planning for Sequence of the Work:

A. Electrical feeders, branch wiring, signal wiring, and other similar work as shown and specified shall be scheduled to correspond with the sequence of work necessary to demolish, remove and construct new work.

B. Close coordination in scheduling is required between the Owner, Contractor, and other trades to assure a smooth work flow with minimum interference and interruption to building power and communication systems.

2.5 Openings in Existing Work:

A. Provide cutting and patching of existing work as required. Verify exact locations and materials before performing work. Cutting of structural members and bearing walls shall not be done without written approval of the Engineer. Provide access covers were required to meet code requirements.

2.6 Verification of Existing Work:

A. Where shown on the Drawings, work which is "existing" is assumed to be in place and suitable for the necessary alterations and additions required. Contractor shall carefully field check these items and include alterations as may be necessary for proper installation and guarantee.

2.7 Removal and Ownership of Existing Work:

A. Unless noted otherwise, existing electrical work shall be removed. Parts of existing electrical systems that are required to maintain service after the alteration shall remain in service. Unless otherwise specified, all equipment and materials shall remain the property of the Owner except as that judged obsolete or unusable. The Engineer shall provide all final decisions about obsolete or unusable equipment.

B. Property of Owner shall be delivered to a location where directed by the Owner and all other items shall be promptly removed from the job site. The equipment shall be protected during demolition.

2.8 Cutting of Concrete Materials:

A. Holes for materials and supports shall be made with uniform speed rotation drilling equipment which does not provide effects associated with impact type equipment.

B. The use of impact drills, air drills, and the like is not acceptable for this project.

2.9 Maintenance of Existing Lighting Systems and Electric Outlets:

A. Where new lighting layouts are not shown on the Drawings, the existing lighting fixtures and wiring controls shall be reused. If necessary, these items shall be temporarily removed (as light fixtures), if necessary, and shall be reinstalled where removed. New wiring from existing sources shall be provided where remodeling operations require. These items are not shown on the Drawings and shall be site determined by the Contractor.

B. Where existing electrical outlets are located in areas of remodeling, these shall be maintained in service. This work is not shown on the Drawings and shall be site determined by the Contractor.

2.10 Concealed Work: Where required, provide accessed doors to make electrical devices accessible as required by the NEC. If impractical to install access doors, relocate existing electrical work so that access is not required. This shall include, but not limited to, adding additional conduit, pulling new wire, and adding junction boxes.

PART 3 - EXECUTION

3.1 Not used.

END OF SECTION 16040

SECTION 16075

ELECTRICAL IDENTIFICATION

10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following:

1. Identification for raceway.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 Submittals

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate color, lettering style, and graphic features of identification products.

1.4 Quality Assurance

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 Raceway Identification:

A. Paint: Semigloss acrylic-enamel.

B. Marker for circuit identification on box covers: Permanent, waterproof, black ink marker (exception : brown and black painted covers which shall use permanent, waterproof, white paint based marker).

2.2 Conductor and Cable Identification Materials:

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

D. Write-On Tags: Polyester tag, 0.01 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 Floor Marking Paint:

A. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.

1. Primer: Interior concrete and masonry primer.

2. Finish Coats: Interior semigloss alkyd enamel.

2.4 Underground-line Warning Tape:

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 5.5 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core 3.5 mils thick.

4. Printed legend shall indicate type of underground line.

2.5 Warning Labels and Signs:

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.

C. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

F. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.6 Instruction Signs:

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.

B. Engraved legend with black letters on white face.

C. Punched or drilled for mechanical fasteners.

D. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 Equipment Identification Labels:

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. White letters on a red background for Emergency and Optional Standby systems.

2.8 Miscellaneous Identification Products:

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 Accessible Raceways More Than 600 V:

A. Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.

3.2 Accessible Raceways 600 V or Less, for Service, Feeder, and Branch Circuits:

A. Identify interior raceway systems with paint as follows:

1. Conduits: paint all couplings per the color coding below.

2. Junction Boxes:

a. Paint all junction and pull box covers per the color coding below.

b. For covers containing branch circuits: after painting the cover the appropriate color, hand write the panelboard/circuit number contained in the box (i.e. 2P1-15,17,19).

c. For covers containing feeder circuits: after painting the cover the appropriate color, hand write the feeding panel and load panel (i.e. 4D1 to 2P1A).

B. Coupling and box cover colors as follows:

1. 120/208 Volt Systems: Black.

2. 120/208 and 277/480 Volt System Junction Boxes containing Emergency Circuits: Paint box cover color of voltage and provide a red stripe.

3.3 Auxiliary Systems:

A. Identify interior raceway systems with paint as follows:

1. Conduits: paint all couplings per the color coding below.

2. Junction Boxes: Paint all junction and pull box covers per the color coding below.

B. Coupling and box cover colors as follows:

1. Fire Alarm System: Red.
2. Access Control & Security System: Yellow.
3. Telecommunication System: Blue.
4. Other Systems: Paint a unique color (do not use any of the above colors or green or white).

3.4 Conductors:

A. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

B. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.

C. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and circuit number.

E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

3.5 Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

3.6 Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.

3.7 Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:

A. Power transfer switches.

B. Controls with external control power connections.

3.8 Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

3.9 Instruction Signs:

A. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

B. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/3inch high letters for emergency instructions at equipment.

3.10 Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

3.11 Labeling Instructions:

A. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a with 1/4-inch high letters on 1-inch high label.

B. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

C. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

D. Equipment to Be Labeled:

1. Panelboards, electrical cabinets, and enclosures.
2. Access doors and panels for concealed electrical items.
3. Electrical switchgear and switchboards.
4. Emergency System Boxes and Enclosures
5. Disconnect switches.
6. Enclosed circuit breakers.
7. Motor starters.
8. Push-button stations.
9. Power transfer equipment.
10. Contactors.

11. Remote-controlled switches, dimmer modules, and control devices.
12. Battery inverter units.
13. Battery racks.
14. Power-generating units.
15. Voice and data cable terminal equipment.
16. Television/audio components, racks, and controls.
17. Fire-alarm control panel and annunciators.
18. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
19. Monitoring and control equipment.
20. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.12 Installation:

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.

G. Colors for 208/120-V Circuits:

1. Phase A: Black.
2. Phase B: Red.
3. Phase C: Blue.
4. Neutral: White.
5. Grounding Conductor: Green.

H. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

I. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 18" to 30" above the line and not less than 6" below grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

K. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

L. Identification Schedule: Prior to Substantial Completion Inspection provide one framed and under glass 11" x 17" color copy of the approved Identification Schedule in each electrical room.

END OF SECTION 16075

SECTION 16100

BASIC ELECTRICAL MATERIALS AND METHODS
10/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. This Section is a Division-16 Basic Materials and Methods Section, and is part of each Division-16 Section making reference to or requiring products specified herein.

C. The requirements of these specifications also apply to Divisions 15, 17, and 18 unless clearly indicated within those Divisions.

1.2 Summary

A. This Section includes the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Concrete equipment bases.
5. Cutting and patching for electrical construction.
6. Touchup painting.

1.3 Definitions

A. EMT: Electrical metallic tubing.

B. FMC: Flexible metal conduit.

C. IMC: Intermediate metal conduit.

D. RGS: Rigid galvanized steel conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. RNC: Rigid nonmetallic conduit.

1.4 Submittals

A. Product Data: Submit the producer's standard descriptive data sheets for each type of product being provided. Mark the data sheet for the product being provided with an identifying mark or arrow. The following shall be submitted:

1. All Conduit.
2. All conduit fittings.

3. Floor Boxes.
4. Cabinets.
5. Conduit coating material for underground use.
6. Fire stopping compound (if required by project requirements).
7. Any other special items being supplied on the project.
8. Cable tray, fittings and shop drawings.

1.5 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. All materials and equipment specified herein shall be UL listed or approved according to the requirements of applicable NEC articles.

1.6 Coordination

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."

E. Coordinate equipment clearance and working space with other equipment, pipes, duct work and obstructions prior to rough in. If clearances are compromised during construction, the contractor shall be required to relocate/modify as required to meet clearance requirements.

1.7 Other Divisions

A. The requirements of these specifications also apply to Divisions 15, 17 and 18 unless clearly indicated on the Drawings.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Allied Tube and Conduit;
2. Appleton Electric;
3. Belden Corporation;
4. W.H. Brady Co.;
5. Carlon;
6. Challenger,
7. Crouse-Hinds Co.;
8. ETP;
9. Elcen Metal Products Co.;
10. General Cable Co.;
11. General Electric Co.;
12. Hoffman Engineering Co.;
13. E-Box, Inc;
14. Harvey Hubbell, Inc.;
15. Midland-Ross Corporation;
16. Okonite Co.;
17. 0-Z/Gedney;
18. Raco, Inc.;
19. Republic Steel Corporation;
20. 3M; Southwire;
21. Seton Nameplate;
22. Square D Co.;
23. Thomas and Betts;
24. Triangle PWC, Inc.;
25. Walker Parkersburg Textron;
26. Wiremold Co.
27. Westinghouse.Engine Div.

2.2 Raceways

A. Electrical Metallic Tubing (EMT) Federal Specification WWC-563 and ANSI C80.3: ANSI C80.3, galvanized steel, protected inside and out. Maximum size of EMT shall be 4". Minimum size shall be 1/2" unless noted otherwise on the Drawings. EMT shall only be used with cables rated 600 volts or less and in indoor locations not subject to physical abuse.

B. Flexible Metal Conduit (FMC) NEC Article 350: galvanized steel protected inside and out.

C. Intermediate Metal Conduit (IMC) Federal Specification WWC-581: ANSI C80.6, galvanized steel, protected inside and out.

D. Rigid Galvanized Steel Conduit (RGS) NEC Article 346: galvanized steel, protected inside and out.

E. Liquid-tight Flexible Metal Conduit (LFMC) NEC Article 351: galvanized steel protected inside and out with sunlight and water resistant and mineral-oil-resistant extruded plastic jacket.

F. Rigid Non-metallic Conduit (RNC): NEMA TC 2, Schedule 40 or 80 PVC, with NEMA TC3 fittings as indicated on the Drawings.

G. Raceway Fittings: Specifically designed for the raceway type with which used.

1. Electrical Metallic Tubing (EMT): Federal Specification W-F-408, except only material of steel is acceptable. Couplings and connectors shall be concrete and rain tight, with connectors having insulated throats. Use gland and ring compression type couplings and connectors for conduit sizes 2" (50mm) and smaller. Use set screw type couplings with four set screws each for conduit sizes over 2" (50mm). Use set screws of case-hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding. Set screw fittings shall be provided with double set screws for each conduit termination (4 set screws total). Indent type connectors or couplings are prohibited. Die-cast or pressure-cast zinc-alloy fittings or fittings made of "pot metal" are prohibited.
2. Flexible Metal Conduit fittings shall be zinc plated steel or cadmium plated malleable iron screw type with insulated throat and angular wedge fitting between convolutions of conduit. Federal Specification W-F-406 and UL 5.
3. Intermediate Metal Conduit shall have threaded galvanized steel fittings; threadless, compression, galvanized steel fittings or threadless, compression, cadmium plated malleable iron fittings. Fittings shall be rain tight/concrete tight.
4. Rigid Galvanized Steel Conduit shall have threaded fittings, galvanized steel or threadless compression galvanized steel or threadless compression cadmium plated malleable iron. Fittings shall be rain tight/concrete tight.
5. Rigid Non-Metallic Conduit shall have polyvinyl chloride (PVC) fittings suited for the purpose and joined together by a method approved for the purpose. Schedule 80 conduit sections may be joined together with threaded fitting connectors.
6. Liquidtight Flexible Metal Conduit fittings shall be cadmium plated, malleable iron or steel with compression type steel ferrule and neoprene gasket sealing rings, with insulated throat.
7. Wireway fittings shall be steel with rust resistant undercoat and finish coat to match the wireway. The fittings shall be so designed that the sections can be electrically and mechanically fitted together to form a complete system. Dead ends shall be closed.
8. Couplings and Unions shall be galvanized steel, tapered thread standard conduit couplings for intermediate metal conduit and rigid metal conduit. PVC couplings for rigid non-metallic conduit shall use approved adhesive, and threaded couplings shall be used for schedule 80 conduit. Split couplings shall be galvanized steel. Unions shall be ground joint type galvanized steel.
9. Conduit seals shall be galvanized steel, tapered threads for IMC and RMC with sealing compound and fiber.

H. Bushings: Shall be provided at the end of all conduits prior to pulling cables to protect the insulation of the conductor. Provide grounding bushings for metal raceways, boxes, and

cabinets to insure that all metallic surfaces are effectively grounded. Metallic raceway may be bonded to cabinets, boxes and panelboards by double locknut and bushing to ensure the metallic parts are all effectively grounded. Bushings shall be one of the following types:

1. Zinc plated steel, threaded or threadless
2. Zinc plated steel of threaded or threadless, phenolic insulated with temperature rating of 150 degree C
3. Cadmium plated malleable iron, threaded or threadless
4. Cadmium plated malleable iron, threaded or threadless, phenolic insulated, with temperature rating of 150 degree C
5. Phenolic with temperature rating of 150 degree C
6. Zinc plated steel, or cadmium plated malleable iron; threaded or threadless; non-insulated or insulated with grounding connector or grounding lug.
7. Insulated bushings shall have phenolic insulation molded to the bushing (NEC Article 362).

2.3 Cable Trays

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cablofil, Inc.
2. Cooper B-Line, Inc.
3. Flex Tray

B. Except as otherwise indicated, provide metal cable trays, of types, classes and sizes indicated with splice hangers and all other necessary accessories. Provide cable trays with rounded edges and smooth surfaces in compliance with applicable standards, and with the following construction features:

1. Basket Type Cable Tray:
   a. Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, comply with ASTM B 633, Type 1.
   b. Dimensions: 12 inches wide by 4 inches deep minimum. Wire mesh spacing shall not exceed 2 inches by 4 inches.
   c. Supports: Cable tray shall be supported by trapeze style hanging clips on threaded rods on both sides of the tray. Center supports are prohibited. Exception: Cable tray in TRs which shall be supported by wall brackets.

2. Provide all necessary transitions at 90-degree angles, tees and change of cable tray size so that the cable tray is continuous. The drawings do not reflect these requirements due to the small scale. Transitions shall also be provided at all change of elevations.

C. Loading Capacities and Testing:

1. Cable tray shall meet the loading requirements of NEMA 12C.
2. Upon request, manufacturer shall provide test reports in accordance with the latest revision of NEMA VE-1 or CSA C22.2 No. 126-M91.

D. Coordinate installation with other trades to avoid conflicts prior to installation. Install as required to transition around, above, or below other trades work.

E. Shop Drawings: Provide complete shop drawings indicating all cable trays, devices, support points, offsets and transitions. Drawings shall be 1/8" scale. The Engineer will provide base sheets.

2.4 Boxes, Enclosures, And Cabinets

A. Sheet Metal Outlet and Device Boxes: Galvanized, NEMA OS 1. Boxes shall be 4"x 4" x 1-1/2" deep or larger(4” x 4” x 2 1/8” deep or larger for telecommunications and CATV). Use only in flush interior applications or non-finished surface mounted interior applications.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Use in exterior applications and interior finished surface mounted applications.

C. Floor Boxes: Per details on drawings.

D. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasket cover. Use in exterior applications and interior finished surface mounted applications.

E. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.

1. Metal Enclosures: Galvanized steel, finished inside and out with manufacturer's standard enamel.

F. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

G. Fabricated Boxes shall be steel with inside and outside surfaces coated with corrosion-resistant paint or weather resistant coating. Covers shall be hinged or screwed with or without gaskets depending on location. All exterior boxes shall be rated NEMA 3R. Boxes shall be sized to meet the NEC Article 370-6 fill requirements.

H. Exterior In-Ground Junction Boxes: UL listed, polymer concrete construction, flared-wall, heavy duty cover (15,000 lbs. over a 10” square), open bottom construction. Equivalent to Quazite “PG” syle. Size as required or as indicated on the drawings, whichever is bigger.

2.5 Conductors

A. Conductors, No. 10 AWG and Smaller: 98% conductivity solid or stranded copper.

B. Conductors, No 8 AWG and Larger: 98% conductivity stranded copper.

C. Insulation: THW, THWN or XHHW unless noted otherwise on the Drawings.

D. Low Voltage Cables: Provide plenum rated where required.

E. Wire Connectors and Splices: Connectors for 600-volt conductors Size No. 18 to No. 6 AWG shall be pressure type, spring connectors. Use 600 volt splicer-reducer pressure connectors for copper conductors to 500 KCMIL. Use rectangular, solderless pressure connectors or split bolt-copper alloy connectors for copper conductors to 1000 KCMIL.

F. Wire Pulling Lubricant shall be a product produced specifically for wire pulling lubrication.

2.6 Supporting Devices

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-steel channel supports for multiple conduit (trapeze) hangers: Not less than 1-1/2”x1-1/2” (38 mm x 38mm), 12 gage steel, cold formed, lipped channels; with not less than 3/8” (9 mm) diameter steel hanger rods.

1. Channel Thickness: Adjust to suit structural loading of conduit and cables.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

E. Conduit Straps: All conduit shall be secured with two hole galvanized straps where the following conditions exist:

1. All exterior locations.
2. All interior locations other than mechanical and electrical rooms where the conduit is below 10’. Conduit concealed in wall finishes and ceilings may use single hole strap if allowed by NEC.
3. All other locations not listed above and approved by the NEC may use single hole galvanized straps.
4. Single hole or double hole straps may not be used on direct grade. All conduits on grade shall be mounted to galvanized strut and properly attached and anchored.

F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

2.7 Concrete Bases

A. Concrete Forms and Reinforcement Materials: Shall be provided for all floor mounted electrical equipment including, but not limited to: switchboards, transformers, etc. Concrete bases and structural steel to support this Division's equipment and raceways, and not specifically shown on Structural or Architectural Drawings shall be furnished by the Contractor whose equipment or raceways is to be supported. Provide a raised reinforced 4" concrete base for all floor supported equipment. Equipment installed outdoors on concrete slabs shall be provided with a 4" raised concrete base. Pad shall exceed the equipment’s footprint by 4” on all sides. Provide a 1” chamfer on all exposed edges.

B. Concrete: 3000-psi (20.7-MPa), 28-day compressive strength.

2.8 Touchup Paint

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.9 Equipment Backboards

A. Equipment Backboards shall be exterior grade 3/4" plywood finished on one side. Finish backboard with two coats of fire retardant gray paint before mounting. Exposed side of plywood shall be smooth interior grade. A copper ground bus shall be supplied with each backboard. The ground bus shall be Harger #TGBI14412TMGB or approved equal. The ground bus shall terminate the #6 AWG ground wire provided from the electrical system. Locate equipment backboards where indicated on the Drawings. Install straight and plumb. Secure to structure using screws, toggle bolts or masonry anchors. DO NOT use plastic or wood plugs in masonry or concrete. Do not install combustible backboards in air handling space, plenums or where prohibited by the local governing authority.

2.10 Sleeves: Sleeves shall be galvanized metal flanged type or schedule 40 galvanized steel pipe.

2.11 Concrete Inserts: Concrete inserts shall be galvanized steel, minimum 14 gauge cut to necessary length for the purpose. Use galvanized hardware.

2.12 Pull Wire and Pull Rope:

A. Pullwire shall be galvanized steel wire, No. 14 AWG minimum size.

B. Pullrope shall be ply cord with 2000 lbs. tensile strength, minimum.

2.13 Terminal Strips: Terminal strips shall be sectional barrier type made of molded phenolic for use in wiring control panels. Number of terminals and ampacity shall be as indicated on the Drawings. The binding head shall be screw in type.

PART 3 - EXECUTION

3.1 Electrical Equipment Installation

A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom. Comply with NEC Requirements.

B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated. Materials and equipment shall be installed in a neat and workmanlike manner according to the standards of the industry. Materials and equipment installed and not meeting the standards of the industry may be rejected and required to be removed and reinstalled by the Contractor at no additional cost to the Owner. Minor location changes from those indicated may be necessary so that work can conform with the building as constructed, to fit work of other trades or to comply with the rules of

authorities having jurisdiction. Refer to structural drawings for framed openings for raceways, etc., in floors and roofs. Contractor shall be responsible for locating and providing proper dimensions for all required electrical openings.

C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 Raceway Application

A. Use the following raceways for **outdoor installations**:

1. Exposed: RGS.
2. Concealed: IMC or RGS.
3. Underground: RGS. Feeders and branch circuit raceways installed below grade equal to and greater than 3/4" may be Schedule 40 PVC, at the contractor's option. If PVC is used underground or below slab, elbows and risers through grade or slab shall be RGS, except as listed below in paragraph 3.4. All exposed raceways penetrating concrete slab shall be rigid metal conduit (no exceptions). Raceways shall not be routed in concrete slabs on grade. Raceways routed in concrete slabs above grade (second floor or above) shall be either RGS, IMC or Schedule 40 PVC. Communication raceways shall be run overhead within the building except for connection to floor boxes. Communication and/or low voltage system raceways that exit from under the building slab shall be metallic (in all cases). Any raceway not meeting this requirement shall be replaced at the contractor's expense. Additional construction time and compensation for the correction of the deficiency will not be allowed. Rigid metal conduit installed underground shall be painted with two coats of alkali and acid resistant paint such as bitumastic or equal. Coating shall not be diluted and shall completely cover conduit. Coating system shall be approved by the Engineer prior to use/application.
4. Connection to Vibrating Equipment: LFMC.
5. Provide sealing fittings to prevent passage of water vapor where conduits pass from warm to cold locations, i.e., refrigerated spaces, constant temperature rooms, air conditioned spaces, building exterior walls, roofs or similar spaces.
6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4.

B. Use the following raceways for **indoor installations**:

1. Exposed: IMC or RGS except EMT is acceptable in mechanical and electrical rooms above 6’ AFF. Conduit may be exposed in equipment rooms, vertical chases, mechanical and electrical rooms, other similar spaces not normally habitable or exposed to public view, and where electrical drawings specifically note "exposed conduit."
2. Concealed: EMT.
3. Connection to Mechanical, Plumbing and Fire Protection Equipment: LFMC; exceptions: controls not mounted on equipment, which shall comply with Section B above; and smaller air handling units such as variable air volume units and air terminal units mounted above ceilings outside mechanical rooms which shall be FMC.
4. Connection to Vibrating Equipment: FMC; except in wet or damp locations and as listed in B.4, use LFMC.
5. Damp or Wet Locations: IMC or RGS.
6. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

7. Rigid non-metallic conduit where used for risers in concealed areas, shall transition to metallic conduit at the first junction box, but in no case shall it extend higher than 7' within the space.

3.3 Raceway And Cable Installation

A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.

B. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

C. Refer to structural drawings for framed openings for raceways, etc., in floors and roofs. Contractor shall be responsible for locating and providing proper dimensions for all required electrical openings. Review structural steel shop drawings and coordinate location of equipment with structural elements to ensure proper clearance and headroom.

D. Layout and install raceways with sufficient clearance to permit proper installation.

E. Install raceways straight and plumb. Squarely cut conduit and properly ream to remove all constriction and burrs before making up joints. Paint exposed threads to retard rusting. Bending of conduit with a pipe tee or vise is prohibited.

F. Conductors shall not be installed until conduit system is complete. Bending radius of insulated wire or cable shall not be less than the minimum recommended by wire or cable manufacturer. Maximum pulling tension of any wire or cable shall not exceed manufacturer's recommended values. Do not injure insulation while installing wire in conduits.

G. Use temporary raceway caps to prevent foreign matter from entering. During construction, after the building has been dried in and prior to any wire being pulled, all conduit shall be cleaned so that it is free of foreign material and water.

H. Provide an equipment grounding conductor which shall be separate from the electrical system neutral conductor. See corresponding specification section.

I. Make conduit bends and offsets so inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

J. Make bends in exposed parallel or banked runs from the same centerline.

K. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

L. For slabs located above grade in multistory buildings (second floor and above), embed raceways in slabs in middle third of slab thickness where practical, and leave at least 1-inch (25-mm) concrete cover.

1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in concrete.
3. Install conduit larger than 1-inch trade size (DN27) parallel to or at right angles to main reinforcement. Where conduit is at right angles to reinforcement, place conduit close to slab support.

4. Transition from nonmetallic tubing to Schedule 80 nonmetallic conduit or rigid steel conduit before rising above floor.
5. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

M. For slabs on grade level, conduit shall be buried below grade by a minimum of 12”. Conduits may not be installed in grade level slabs.

N. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

O. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

P. Set floor boxes level and trim after installation to fit flush to finished floor surface. Seal box to prevent entrance of moisture or dirt.

Q. Boxes: Attach boxes to concrete formwork, or to other surrounding building material. Provide additional junction and pull boxes where injury to insulation or deformation of wire would occur due to excessive pulling resistance. When several feeders pass through a common pull box, tag each feeder separately, indicating electrical characteristics and destination.

1. Boxes shall be accurately located. Consult Architectural plans for dimensions.
2. Mount boxes in the course nearest to the height specified when installed in finished block, brick or tile walls.
3. Boxes for use with raceway systems shall be minimum 1 1/2 inches deep, except where shallower boxes required by structural conditions are approved. Boxes for other than lighting fixture outlets shall be minimum 4 inches square, except 4-by-2 inch boxes may be used where only one raceway enters outlet.
4. Pull boxes shall be at least the minimum size required by NFPA 70 and of code-gauge galvanized sheet steel, or compatible with nonmetallic raceway systems, except where cast-metal boxes are required in locations specified herein. Furnish boxes with screw-fastened covers. Where several feeders pass through a common pull box, tag feeders to indicate clearly electrical characteristics, circuit number, and panel designation.
5. Extension rings shall not be used in new construction. Size all boxes according to fill. Any extension rings found shall be removed at the contractor's expense, unless specifically approved by the Engineer.
6. Recessed Installation: Boxes and covers shall be installed so that the covers are flush with the finished surfaces. Boxes in masonry or tile construction shall have masonry boxes or boxes with square cut tile covers. Do not cut concrete block through its entirety in order to accommodate any type box. "Handy" boxes shall not be used.
7. Boxes in Partitions: Through type boxes are not permitted except where shown on electrical drawings. Recessed outlet boxes, cabinets, consoles, etc., when shown located back-to-back shall be provided with 1/2" fiberglass insulation between the boxes.
8. Verify box/enclosure placement in rated assemblies and comply with UL spacing/opening requirements. Fire stop as required.

R. Surface raceway and fittings:

1. Prior to and during installation, refer to manufacturer’s layout drawings indicating all elements of the system. Contractor shall comply with detailed manufacturer’s instruction

sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.

2. Mechanical Security. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, cabinets, in accordance with manufacturer's installation sheets.
3. Electrical Security. All metal raceway shall be electrically continuous and bonded in accordance with the National Electrical Code for proper grounding.
4. Raceway Support. Raceway shall be securely supported at intervals not exceeding 10 feet or in accordance with manufacturer's installation sheets.
5. Completeness. All systems shall be installed complete, including bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
6. Install in dry locations only. It shall be used in all renovated areas where raceway is exposed. Exception: mechanical, electrical, janitor, and storage areas. EMT shall not be used in exposed finished areas.

S. Wet or Damp Locations:

1. Use rigid steel or IMC unless noted otherwise.
2. Provide sealing fittings, to prevent passage of water vapor, where conduits pass from warm to cold locations, i.e., (refrigerated spaces, constant temperature rooms, air conditioned spaces building exterior walls, roofs) or similar spaces.
3. Use rigid steel or IMC conduit within five feet of the exterior and below concrete building slabs in contact with soil, gravel, or vapor barriers. Cover conduit on the outside with factory coating of 20 mil bonded PVC or field coat with asphaltum before installation. After installation, completely coat damaged areas of coating.
4. Wireways and fittings shall be used for exposed work and when installed outdoors or in wet locations shall be approved weatherproof construction.

T. Bushings shall be provided at the end of all conduits to protect the insulation of the conductor. Provide grounding bushings for metal raceways, boxes, and cabinets to insure that all metallic surfaces are effectively grounded. Metallic raceway may be bonded to cabinets, boxes and panelboards by double locknut and bushing to ensure the metallic parts are all effectively grounded.

U. Install pull boxes in conduit at intervals of 200 feet or less except when these intervals will place the pull box cover in a finished floor area or non-accessible place, the interval may be extended to a maximum distance of 300 feet. Request for each deviation or extension of interval shall be made and approval granted by the Engineer before proceeding with the installation. If any conduit run is found to be greater than 300 feet and the contractor has not secured prior approval from the engineer, a new raceway shall be installed to replace the deficient one at the contractor's expense.

V. Conduit Installed in Concrete:

1. Conform to applicable portion of Section 703 of ACI Standard Code for reinforced concrete.
2. Conduit: Rigid Steel, IMC or EMT; except do not install EMT in concrete slabs that are in contact with soil, gravel or vapor barriers.
3. Align and run conduit in direct lines.
4. Locate conduits in center third of concrete slab thickness. Outside conduit diameter not to exceed 1/3 concrete slab thickness. Install no conduit in concrete slabs of less than 3" thick.
5. Conduits in concrete slabs shall not cross at an angle of less than 45 degrees.

6. Conduits shall not pass through beams except when shown on the Drawings.
7. Space vertical installation of conduit through concrete slabs not closer than three diameters on center.
8. Space between conduit in slabs not closer than six diameters apart, except one conduit diameter at conduit crossings.
9. Where conduits rise through floor slabs, curved portion of bends shall not be visible above finish floor.

3.4 Special PVC Requirements

A. Floor Penetrations:

1. Rigid metallic conduit for all exposed conduits, regardless of size and concealed conduits greater than 1 ½". Schedule 40 PVC for conduits less than 1 ½" concealed in walls. All conduit concealed by floor mounted equipment may be schedule 40 PVC (if less than 1 ½" and less than 50 feet and length) or rigid metallic conduit (if 1 ½" or greater and greater than 50 feet in length). Concealed PVC conduit (less than 1 ½") shall transition to metal conduit as soon as practical above slab.

B. Bends:

1. Conduits less than 1 ½": Conduit elbows may be either rigid non-metallic or non-corrosive rigid metallic conduit. In circuit runs exceeding 50', all bends shall be non-corrosive rigid metallic conduit. Bends may be factory or field fabricated using manufacturer approved heat boxes. Field fabricated bends using blowtorch are not acceptable.
2. Conduits 1 ½" and larger: Conduit elbows shall be rigid non-corrosive metallic conduit only, unless specifically allowed otherwise by the Engineer. Schedule 40 PVC elbows shall not be used.
3. A cable pulling plan may be requested by the Engineer on long pulls.
4. The Engineer may allow special provisions for the installation of PVC elbows.

C. Minimum Size:

1. Minimum size of PVC conduit to be installed below slab shall be 3/4".

D. Jointing:

1. Pipe and fittings shall be cement welded or threaded (only for Schedule 80 conduit) and made watertight. All joints shall be cleaned with solvent or sanded smooth prior to application of cement.

3.5 Raceway Methods For Voice, Data And Catv

A. A conduit shall be a home run overhead from each data outlet and each CATV outlet to the serving communications room. Each conduit shall serve one CO outlet only. Conduit shall be 1" trade size for data outlets and ¾" trade size for CATV outlets. Total conduit length to each data outlet shall not exceed 280'.

B. J-hook: A conduit shall be stubbed up above ceiling from each data outlet and each CATV outlet to an accessible ceiling space. Each conduit shall serve one CO outlet only. Conduit shall be 1" trade size for data outlets and 1" trade size for CATV outlets. Cables will then be J-hooked to serving telecommunications room.

C. Cable tray: A conduit shall be stubbed up above ceiling from each data outlet and each CATV outlet to the nearest cable tray. Each conduit shall serve one CO outlet only. Conduit shall be 1" trade size for data outlets and 1" trade size for CATV outlets. Conduit shall terminate at cable tray.

D. Conduit bodies such as 'LB' fittings are not allowable.

E. Pull boxes for 1" data conduits and ¾" CATV conduits shall be 4" wide x 4" long x 2-1/8" deep NEMA 1 galvanized steel with screw cover. Where 1" data or ¾" CATV conduits are tightly racked with uniform spacing, wider pull boxes may be provided to serve multiple conduits. Terminate conduits at opposite ends of pullboxes. Do not terminate conduits at right angles to each other except as specifically indicated.

F. Provide pullboxes for each run of conduit at every 100 feet on center and at each end of conduit runs containing a total of two 90 deg bends or a combination of lesser bends totaling 180 deg (minimum requirements - provide whether specifically indicated or not). Conduit runs containing more than two 90 deg bend without a pullbox are not acceptable. Factory conduit elbows and all other bends shall have a minimum radius of six times the internal conduit diameter. Conduit offsets and pullboxes required to suit field conditions and to conform to these requirements shall be provided at no additional cost to the owner.

G. Conduits that extend outside the building shall be metallic, no exceptions.

H. For existing facilities: NEMA 3R metallic enclosures shall be provided where the conduit exits the building. The box shall be sided to terminate all circuits and provide proper TVSS and grounding. A separate driven ¾" by 20' ground rod shall be driven at each junction box location. Grounding shall also be bonded to the building electrical ground. Metallic conduit shall be properly bonded to the metallic junction box.

3.6 Wiring Methods For Power, Lighting, And Control Circuits

A. Feeders: Type THHN/THWN insulated conductors in raceway.

B. Underground Feeders and Branch Circuits: Type THWN insulated conductors in raceway.

C. Branch Circuits: Type THHN/THWN insulated conductors in raceway.

D. Remote-Control Signaling and Power-Limited Circuits: Type THHN/THWN insulated conductors in raceway for Classes 1, 2, and 3, unless otherwise indicated.

E. Except for control wiring, the minimum size of wire shall be No. 12 AWG.

F. For all lighting and power receptacle circuits (20 ampere), the minimum wire size is #12 AWG. The total distance for the travelers on three-way circuits shall calculated and distance limitations applied. Wire sizes that are installed and do not meet the size/distance criteria, shall be removed and replaced at the contractor's expense. The larger wire size applies to the home run. Minimum wire size for 120V and 277V, 20 ampere circuits to limit voltage drop to 3% or less is as follows:

1. Less than 50' - #12 AWG (120V).
2. Circuits greater than 50' but less than 100' - #10 AWG (120V).
3. Circuits greater than 100' but less than 150' - #8 AWG (120V).
4. Circuits greater than 150' but less than 270' - #6 AWG (120V).
5. Circuits greater than 270' but less than 420' - #4 AWG (120V).

6. Less than 150’ - #12 AWG (277V).
7. Circuits greater than 150’ but less than 240’ - #10 AWG (277V).
8. Circuits greater than 240’ but less than 400’ - #8 AWG (277V).
9. Circuits greater than 400’ but less than 620’ - #6 AWG (277V).
10. Circuits greater than 620’ but less than 950’ - #4 AWG (277V).

3.7 Wiring Installation

A. General: Conductors shall not be installed until conduit system is complete. Bending radius of insulated wire or cable shall not be less than the minimum recommended by wire or cable manufacturer. Maximum pulling tension of any wire or cable shall not exceed manufacturer's recommended values. Do not injure insulation while installing wire in conduits.

B. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Splices: Splices shall be permitted in junction boxes, outlet boxes of other permanently accessible locations. Conductors No. 6 or smaller shall be spliced with devices approved by Underwriters Laboratories, Inc., as splicing connectors. Splices in conductors larger than No. 6 shall be accomplished with devices approved by Underwriters Laboratories as pressure cable connectors.
2. Splices made in underground boxes or wet locations shall be made with commercial, UL approved cast resin splicing kit (120 volt circuits or greater). Splices for low voltage circuits may not be made below grade or in wet/damp locations.

C. Wire Pulling Lubrication: Shall be used when any wire is pulled by mechanical means. Wire and cable shall be carefully handled during installation. Soap flakes or vegetable soaps shall not be used for lubrication.

D. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.

E. Connect outlet and component connections to wiring systems and to ground. 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.

F. Provide dedicated neutrals for all 120V and 277V circuits.

G. Conductors in Parallel: Conductors connected in parallel (electrically joined at both ends to form a single conductor) shall be of the same length, of the same conductor material, the same circular-mil area, the same insulation types and terminate in the same manner. Where installed in separate raceways or cables, the raceways or cables shall have the same physical characteristics.

H. Wiring in switchboards, panelboards, junction cabinets, etc., shall be neatly formed to present a neat and orderly appearance.

I. Interconnections of control wiring shall be on identified numbered terminal strips.

3.8 Expansion Joints

A. Conduits three inches and larger that are secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install couplings in accordance with the manufacturers' recommendations.

B. Provide conduits smaller than three inches with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible conduit to produce 5" vertical drop midway between end. Flexible conduit shall have a green copper ground-bonding jumper installed. In lieu of this flexible conduit, expansion and deflection couplings as specified above for three inches and larger conduits are acceptable.

C. Expansion fittings shall be provided for raceways to compensate for thermal expansion and contraction in conduit runs 200 feet or greater and at building expansion joints. Bonding jumpers shall be provided for electrical continuity of the raceway system at the expansion fittings.

3.9 Caulking And Seals:

A. Where conduits, wireways, and other electrical raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases. Fire stop shall be rock wool fiber, silicone foam sealant or approved equal. Completely fill and seal clearances between raceways and openings with the fire stop material. Adhere to manufacturer's installation instructions.

B. At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight.

3.10 Electrical Supporting Device Application

A. Damp Locations and Outdoors: Hot-dip galvanized materials.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.11 Support Installation

A. Install support devices to securely and permanently fasten and support electrical components.

B. Support no electrical work from piping, ductwork, etc. Where metal decking is used, provide supports independent of decking so that loads will not be transferred to decking. Drill through decking and secure supports to concrete slab.

C. Conduit through Slab Supports: Conduit supports for conduits routed from below grade up through concrete slabs shall be solid, metallic type. Metallic conduit shall not be used to

support conduits through slab. After concrete slab has been poured and set, supports shall be cut flush with slab.

D. Support conduit within one foot of changes of direction, and within one foot of each enclosure to which it is connected.

E. Electrical devices in lay-in and gypsum board ceilings: Coordinate location of electrical outlets with architectural features of the building and with the equipment of other trades. Boxes or devices mounted between bar joists or "T" bars shall be supported from two bars or joists. Devices and associated boxes shall not be supported by the lay-in tiles.

F. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

G. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

H. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

I. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

J. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.

K. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.

L. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals. Vertical conduit inside building shall be supported at each floor level and at 10'0" intervals. Simultaneously install vertical conductor supports with conductors.

M. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.

N. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

O. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

P. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.

3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
7. Light Steel: Sheet-metal screws.
8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

Q. Equipment Supports: Concrete bases and structural steel to support this Division's equipment and raceways, and not specifically shown on Structural or Architectural Drawings shall be furnished by Contractor whose equipment or raceways is to be supported. Provide a raised reinforced 4" concrete base for all floor supported equipment. Equipment installed outdoors on concrete slabs shall be provided with a 4" raised concrete base. If equipment is being installed on grade, concrete base shall be provided that will allow a minimum of 3” above finished grade and sod.

3.12 Firestopping

A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Comply with UL assembly rating requirements.

B. Space junction boxes, receptacles and panels installed in rated assemblies to comply with UL listings. Verify prior to installation.

C. Cracks, voids, or holes up to 4" diameter shall be filled with putty, caulking, or one-piece intumescent elastomer which is non-corrosive to metal, compatible with synthetic cable jackets, and capable of expanding 10 times when exposed to flame or heat.

D. For openings 4" or greater use a sealing system capable of passing 3-hour fire test in accordance with ASTM E-814. Sealing system shall consist of wall wrap or liner, partitions, and end caps capable of expanding when exposed to temperatures of 250 to 350□F.

3.13 Concrete Bases

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement.

3.14 Cutting And Patching

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

C. Sleeves Through Roof: Coordinate setting with Division 7. Contractor setting sleeves for his electrical conduit is responsible for filling sleeve pockets with roof bitumen and insuring there is no moisture leakage during roof guarantee period.

3.15 Field Quality Control

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Concrete bases.
6. Cutting and patching for electrical construction.
7. Touchup painting.

3.16 Refinishing And Touchup Painting

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
5. Finishes in areas not listed or otherwise noted shall be black enamel.
6. Hangers, supports, structural steel and equipment that are not factory finished shall be prime coated and finished coated with color to match the area in which it will be located.
7. Electric cabinets, switchboards, panelboards and equipment that is factory finished and has damaged finish shall be touched up to match the factory finish.
8. All surfaces that are to be painted shall be free of rust, scale, oil and grease before prime coat is applied.
9. Paint all junction boxes and conduit as described herein.

3.17 Grounding

A. Ground and bond in accordance with NEC Article 250 and other applicable articles.

B. Provide an equipment grounding conductor which shall be separate from the electrical system neutral conductor. The equipment grounding conductor shall be colored green. It shall be continuous from a connection at the Service Entrance Equipment Ground to all switchboards, distribution and branch panelboards. Equipment grounding conductors shall be provided in all branch circuits serving convenience outlets, receptacles, portable and permanently installed electrical appliances, equipment apparatus and other miscellaneous metal enclosing bodies including light switch boxes normally within contact of personnel. Branch circuit grounding conductors shall be sized in accordance with the National Electrical Code. Connections at

panelboards, outlets, equipment and apparatus shall be made in an approved and permanent manner. Resistance to ground shall not exceed 15 ohms.

C. Bond bushings of the raceway system to ground lugs in boxes, cabinets, motors and equipment to assure electrical continuity of all metallic components of the electrical systems. Comply with the requirements of NEC Articles 250D, 250E, 250F, 250G, 250J and 250K. Where equipment is not provided with a grounding lug, provide ground lugs suitable for wire being installed.

3.18 Cleaning And Protection

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.19 General Tests And Inspections

A. Prepare systems, equipment, and components for tests and inspections, and perform preliminary tests to ensure that systems, equipment, and components are ready for testing. Include the following minimum preparations as appropriate:

1. Perform insulation-resistance tests.
2. Perform continuity tests.
3. Perform rotation test (for motors to be tested).

B. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

C. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

D. Test and Inspection Reports: In addition to requirements specified elsewhere, report the following:

1. Manufacturer's written testing and inspecting instructions.
2. Calibration and adjustment settings of adjustable and interchangeable devices involved in tests.
3. Tabulation of expected measurement results made before measurements.
4. Tabulation of "as-found" and "as-left" measurement and observation results.

END OF SECTION 16100

SECTION 16103

GROUNDING AND BONDING
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 Submittals

A. Product Data: For each type of product indicated.

B. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Test Reports and Verification Submittals:
1. Provide ground system drawings per section 3 of this specification.
2. Perform the following field tests and inspections and prepare test reports.

a. Ground Resistance Test: See Part 3 of this specification.

1.4 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1. Comply with UL 467.

B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a. Harger Lightning Protection, Inc.
b. Erico Inc.; Electrical Products Group.
c. Thermoweld, Inc.

2.2 Grounding Conductors

A. For insulated conductors, comply with Division 16 Section "Conductors and Cables."

B. Material: copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

2.3 Connector Products

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Copper or Bronze bolted-pressure-type connectors, or compression type. Do not use below grade.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions. For use in below grade applications.

2.4 Grounding Electrodes

A. Ground Rods: Sectional type; copper clad steel.

1. Size: 3/4 by 120 inches (19 by 3000 mm) in diameter.

PART 3 - EXECUTION

3.1 Application

A. In raceways, use insulated equipment grounding conductors.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the specified height above the floor.
3. Provide UL Listed compression lugs for all ground conductors to be connected to the ground bus.

3.2 Equipment Grounding Conductors

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated. As a minimum, provide a driven ground rod system (as described below), bond to building foundation rebar, building steel, and building water service.

B. Install equipment grounding conductors in all feeders and circuits. Bond all metal conduit to metal enclosures.

C. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

D. Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 Installation

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes. Configuration shall be an equilateral triangle. Any deviation from this shape shall be approved by the Engineer in writing.

1. Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
3. The total depth/length of each ground rod shall be 30’ minimum unless noted otherwise.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

E. Building Foundation: The electrical service, remote buildings and transformers shall be tied to the building foundation. The rebar in the foundation shall be bonded electrically by metal wire. The rebar shall be turned up and extended through the slab by the equipment so the connection can be within sight and be inspected. The rebar shall be coated with protective paint where it penetrates the concrete slab.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

G. Bond each above ground portion of gas piping system upstream from equipment shutoff valve.

H. Building Steel: The electrical service, transformers and remote buildings shall be tied to building steel.

3.4 Connections

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable. Inspect molds prior to use and discard if deformed.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding 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.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 Field Quality Control

A. Testing: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

2. Ground Resistance Test

a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

b. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

1) Equipment Rated 500 kVA and Less: 10 ohms.
2) Equipment Rated 500 to 1000 kVA: 5 ohms.
3) Equipment Rated More Than 1000 kVA: 3 ohms.
4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
5) Manhole Grounds: 10 ohms.
6) Building grounding system: 10 ohms.

c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 16103

SECTION 16105

EXCAVATION AND BACKFILL
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Review all project Drawings to be aware of conditions affecting work herein.

PART 2 - PRODUCTS

2.1 Sand: Clean, hard, uncoated grains free from organic matter or other deleterious substances. Sand for backfill shall be of a grade equal to mortar sand, with 95% passing a No. 8 sieve, and not more than 8% passing a No. 100 sieve.

2.2 Gravel: Clean, well-graded hard stone or lime rock gravel, free from organic material. Size range to be from No. 4 screen retentions to 1".

2.3 Earth: Must be free of stones, wood, roots or rubbish.

2.4 Underground-Line Warning Tape: See Specifications Section 16075/Electrical Identification

PART 3 - EXECUTION

3.1 Ditching and Excavation: Shall be performed by hand wherever the possibility of encountering obstacles or any existing utility lines. The Contractor will be totally responsible to insure that no utility or service interruptions shall be caused and that no existing utilities or obstructions will prohibit installations of service under this Contract at proper grade and location. Where clear and unobstructed areas are to be excavated, appropriate machine excavation methods may be employed. Avoid use of machine excavations within the limits of the building lines except when machine weights and operation will not damage sub-surface structural components or piping.

3.2 Bedding: Excavate to bottom grade of raceway to be installed, and shape bed of undisturbed earth to contour of conduit for a width of at least 5% of the conduit diameter. If earth conditions necessitate excavation below raceway grade, bring the bed up to the proper elevation with clean, dry sand deposited in 6" layers and firmly tamped by mechanical means. If sub-cut exceeds 12" or if bed is of an unstable nature, a 6" minimum layer of rock will be required before sand bedding begins.

3.3 Placing: Conduit shall be carefully handled into place in the excavation. Avoid knocking loose soil from the banks of the trench into the conduit bed. Coated conduit shall have special handling slings to prevent damage to the coating. All holidays in the conduit coating shall be touched in before beginning back filling.

3.4 Backfilling: Deposit earth or sand carefully in 6" layers, maintaining adequate side support. Compact fill in 6" layers, using mechanical means up to the top elevation of the conduit and 12" layers to finish grade.

3.5 Identification: Provide identifying metalized plastic warning tape above non-metallic conduit and standard plastic warning tape above metal conduit. Warning tape shall be placed approximately 12" above the conduit. Replace surface to the original condition, i.e., sodding, sprigging, and fine grading.

3.6 Excavation shall be maintained in satisfactory condition during the progress of the work. Sub-surface structures shall be constructed in adequately sized excavations and dewatering equipment shall be installed and properly maintained. Shoring shall be employed in the event of unstable soil conditions, and in all cases to protect materials and personnel from injury.

3.7 Conduits to be installed below the footings or foundations shall be installed prior to the installation of the footings. All soil shall be compacted to meet the structural requirements for the footings. If it is not possible to install the conduit prior to pouring of the footings, it shall be necessary for the contractor to provide a bridge footing to span the excavation plus 2 feet on either side of the excavation. The footing modifications shall be approved prior to installation by the Structural Engineer.

END OF SECTION 16105

SECTION 16107

SERVICE ENTRANCE METHODS AND MATERIALS – UNDERGROUND
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division-16 Basic Electrical Materials and Methods Sections apply to work of this Section.

C. Review all project drawings to be aware of conditions affecting work herein.

PART 2 - PRODUCTS

2.1 Materials for this section are specified in the Section "Basic Materials and Methods."

PART 3 - EXECUTION

3.1 Installation shall comply with the requirements of the Utilities Company and the applicable paragraphs in Article "3.0 EXECUTION" of the Section "Basic Materials and Methods."

3.2 Comply with NEC 70 - Underground Services.

3.3 Comply with the Section "Excavation and Backfill."

3.4 Provide concrete pads as shown on the Drawings. Coordinate requirements with Utility company. The Utility Company will provide transformer. Confirm adequacy of dimensions and size and number of openings in concrete pad with Utility Company.

3.5 The Utility Company will furnish and install the current transformers, potential transformer. The contractor shall coordinate the installation of service feeders with the Utility Company so that the current transformers can be installed. The Utility Company will furnish and install the meter. The contractor shall furnish and install CT cabinets, meter cabinets and all associated conduit. Coordinate exact requirements with local utility.

3.6 The electrical contractor shall provide the raceways and service conductors from the reinforced concrete transformer pad to the service equipment as indicated on the Drawings.

3.7 The Electrical Contractor shall provide the raceways from the transformer pad to the meter cabinet. Minimum conduit size is 1” and shall be RGS. Unless otherwise noted, the meter shall be mounted on a 6”x6”x8’ concrete post, provided by the contractor. The location of the post shall be approved by the Utility Company.

3.8 Raceways for service conductors shall be schedule 80 PVC or bitumastic coated rigid metal conduit for straight lengths and bitumastic coated rigid metal conduit for any bends of 45 or 90 degrees. Service entrance raceways shall be concrete encased where specifically noted on the Drawings.

3.9 The 45 or 90-degree bends shall have a minimum radius of 36 inches.

3.10 Rigid metal conduit shall receive two undiluted coats of bitumastic free from holidays and pinholes.

3.11 The Electrical Contractor shall provide 200# test poly cord in each spare raceway.

END OF SECTION 16107

SECTION 16120

ENCLOSED SWITCHES AND CIRCUIT BREAKERS
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following individually mounted, enclosed switches and circuit breakers:

1. Nonfusible switches.
2. Molded-case circuit breakers.
3. Enclosures.

1.3 Definitions

A. GFCI: Ground-fault circuit interrupter.

B. HD: Heavy duty.

C. RMS: Root mean square.

D. SPDT: Single pole, double throw.

1.4 Submittals

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Time-current curves, including selectable ranges for each type of circuit breaker.
3. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
4. Current and voltage ratings.
5. Short-circuit current rating.
6. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 O & M Submittals:

A. Submit manufacturer's maintenance date including parts lists. Include in these data, a copy of approved submittals (product data and shop drawings) in O & M manual.

1.6 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. All products shall be UL listed.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 Project Conditions

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

1.8 Coordination

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Square D Co.
2. Eaton Corp.; Cutler-Hammer Products.
3. General Electric Co.; Electrical Distribution & Control Division.

2.2 Nonfusible Switches

A. Nonfusible Switch: NEMA KS 1, Type Heavy Duty, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Copper material internally mounted and labeled for copper ground conductors. Provide with each switch. Attach to enclosure with stainless steel, self tapping screws.

2.3 Molded-Case Circuit Breakers And Switches

A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Unless indicated otherwise, breakers smaller than 250A frame shall be thermal-magnetic.

2. Adjustable Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. Unless indicated otherwise, breakers smaller than 800A frame and at least 250A frame shall be adjustable thermal-magnetic.

3. Electronic Trip-Unit Circuit Breakers: Unless indicated otherwise, breakers 800A frame and larger shall be electronic trip type. RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

6. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical style suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

4. Shall have overcenter, trip free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle indication. All breakers shall be bolt-on type.

5. Circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.

6. Provide with shunt trip features where indicated on the Drawings.

2.4 Enclosures

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location and shall be dead front type.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

PART 3 - EXECUTION

3.1 Examination

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Installation

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 Identification

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 16 Section "Basic Electrical Materials and Methods."

3.4 Adjusting

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.5 Cleaning

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 16120

SECTION 16140

ENCLOSED CONTROLLERS
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.

1.3 Submittals

A. Product Data: Submit manufacturer’s technical product data, specifications and installation instructions for each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    a. Enclosure types and details.
    b. Nameplate legends.
    c. Short-circuit current rating of integrated unit.
    d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Written reports specified in Part 3.

D. Manufacturer's field service report.

E. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 O & M Data Submittals: For enclosed controllers and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Approval submittals, product data and shop drawings.

1.5 Quality Assurance

A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

E. All products shall be UL listed.

F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, including clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 Delivery, Storage, And Handling

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 Coordination

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Enclosed Controllers:
    a. Square D Co.
    b. Eaton Corp.; Cutler-Hammer Products.
    c. General Electrical Distribution & Control.
    d. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.

2.2 Relays

A. Relays shall be electrically held DPDT unless specifically noted on drawings, with contacts rated for the load connected and with NEMA 1 enclosures. Minimum contact rating for lighting controllers shall be 30 amps.

2.3 Manual Enclosed Controllers

A. Description: NEMA ICS 2, general purpose, Class A, with toggle action and overload element.

2.4 Magnetic Enclosed Controllers

A. Description: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, Starters through NEMA size seven shall be equipped with double break silver-alloy contacts. Contacts shall be replaceable without removing power wiring or removing the starter from the enclosure. The starters shall have straight-through wiring, Starter coils shall be molded construction through NEMA size seven, coils shall be replaceable from the front without removing the starter from the enclosure. Operating voltage shall be as indicated on the Drawings, unless otherwise indicated. Magnetic motor controllers shall have "Hand-Off-Auto" selector switch on cover unless noted otherwise. Magnetic motor controllers shall have red "run" and green "stop" LED pilot lights on the cover.

B. Control Circuit: Voltage per drawings; obtained from integral fused control power transformer with sufficient capacity to operate coil plus 50VA.

C. Combination Controller (where specified on the drawings): Factory-assembled combination controller and disconnect switch.

1. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.

E. Phase-Failure and Undervoltage Relays: Magnetic motor controllers shall have solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

F. Multispeed Enclosed Controller (where specified on the drawings): Match controller to motor type, application, and number of speeds; include the following accessories:

1. Compelling relay to ensure motor will start only at low speed.
2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
3. Decelerating relay to ensure automatically timed deceleration through each speed.

2.5 Multipole Contactors

A. Manufacturers:

1. Allen-Bradley/Rockwell Automation.
2. Cutler-Hammer; Eaton Corporation.
3. GE Industrial Systems; Total Lighting Control.
4. Square D Co.

B. Description: Electrically operated and electrically held, complying with NEMA ICS 2 and UL 508.

1. Current Rating: As indicated on drawings.
2. Control-Coil Voltage: Match control power source.

2.6 Enclosures

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.
2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.7 Accessories

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type. Magnetic motor controllers shall have "Hand-Off-Auto" selector switch on cover unless noted otherwise. Magnetic motor controllers shall have red "run" and green "stop" pilot lights on the cover. Pilot lights shall be LED type.

C. Stop and Lockout Push-Button Station: Magnetic motor controllers shall have momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Phase-Failure and Undervoltage Relays: Magnetic motor controllers shall have solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable undervoltage setting.

2.8 Factory Finishes

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 Examination

A. Examine area and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 Applications

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 Installation

A. See Division 16 Section "Basic Electrical Materials and Methods" for general installation requirements.

B. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 16 Section "Basic Electrical Materials and Methods."

C. Install freestanding equipment on concrete bases.

3.4 Identification

A. Identify enclosed controller components and control wiring according to Division 16 Section "Basic Electrical Materials and Methods."

3.5 Control Wiring Installation

A. Install wiring between enclosed controllers according to Division 16 Section "Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.

2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.6 Connections

A. Conduit installation requirements are specified in other Division 16 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment.

C. 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 and UL 486B.

3.7 Field Quality Control

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including pretesting and adjusting solid-state controllers.

3.8 Adjusting

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.9 cleaning

A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.10 Startup Service

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

B. Verify that enclosed controllers are installed and connected according to the Contract Documents.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 16 Sections.

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

END OF SECTION 16140

SECTION 16170

GENERAL WIRING DEVICES
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following:

1. Single and duplex receptacles, ground-fault circuit interrupters, integral surge suppression units, and isolated-ground receptacles.
2. Single- and double-pole snap switches and dimmer switches.
3. Device wall plates.
4. Pin and sleeve connectors and receptacles.
5. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 Definitions

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. PVC: Polyvinyl chloride.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 Submittals

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions. For each type of product indicated.

B. Samples: One for each type of device and wall plate specified, in each color specified.

1.5 Quality Assurance

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. UL Listed.

1.6 Coordination

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:
   a. Eagle Electric Manufacturing Co., Inc.
   b. Hubbell Incorporated; Wiring Device-Kellems.
   c. Leviton Mfg. Company Inc.
   d. Pass & Seymour/Legrand; Wiring Devices Div.

2. Poke-Through, Floor Service Outlets and Telephone/Power Poles:
   a. Hubbell Incorporated; Wiring Device-Kellems.
   b. Pass & Seymour/Legrand; Wiring Devices Div.
   c. Square D/Groupe Schneider NA.
   d. Thomas & Betts Corporation.
   e. Wiremold Company (The).

2.2 Receptacles

A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Devices shall be heavy duty, specification grade. Use black finished devices throughout except as hereinafter noted otherwise.

B. Single Receptacle Devices:

20 amp, 2 pole, 3 wire, 125V, NEMA 5-20R Hubbell HBL5361
30 amp, 2 pole, 3 wire, 125V, NEMA 5-30R Hubbell HBL9308
50 amp, 2 pole, 3 wire, 125V, NEMA 5-50R Hubbell HBL9360
20 amp, 2 pole, 3 wire, 250V, NEMA 6-20R Hubbell HBL5461
30 amp, 2 pole, 3 wire, 250V, NEMA 6-30R Hubbell HBL9330
50 amp, 2 pole, 3 wire, 250V, NEMA 6-50R Hubbell HBL9367

C. Duplex Receptacle Devices: The receptacle shall be heavy duty specification grade and have the following features: back and side wiring, 0.032 inches thick brass triple wipe power contacts, brass center inset, all brass grounding system, impact resistant nylon face, thick wall thermoset base. 20 amp, 2 pole, 3 wire, 125V, NEMA 5-20R Hubbell HBL2162 BK or approved equal.

D. GFCI Receptacles: Straight blade, Devices shall be heavy duty specification grade. Use white finished devices throughout except as hereinafter noted otherwise, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter. Hubbell GFR 5362 SG BK or approved equal.

E. TVSS Receptacles: Straight blade, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground. Hubbell HBL 8362SA or approved equal.

1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.

2. Active TVSS Indication: Visual and audible with light visible in face of device to indicate device is "active" or "no longer in service."

3. Identification: Distinctive marking on face of device to denote TVSS-type unit.

F. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 Pendant Cord/Connector Devices

A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, Heavy-Duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.

2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 Switches

A. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.

1. Single Pole, 20 amp, 120/277 shall be Hubbell DS120BK or approved equal.

2. Double Pole, 20 amp, 120/277V shall be Hubbell DS220BK or approved equal.

3. Three-Way, 20 amp, 120/277V shall be Hubbell DS320BK or approved equal.

4. Four-Way, 20 amp, 120/277V shall be Hubbell DS420BK or approved equal.

B. Snap Switches: Specification grade, quiet type, abuse resistant nylon toggle, color coded base, one piece rivetless copper alloy spring contact arm & terminal plate, one piece integral grounding terminal with #8 brass screw, stainless steel automatic grounding clip, back wiring, one piece rivetless copper alloy spring contact arm and terminal plate. Provide 15 amp switch for circuits controlling up to but not exceeding 15 amperes. Provide 20 amp switch for circuit exceeding 15 amperes but less than or equal to 20 amperes. Provide 30 ampere switches for circuits exceeding 20 amperes but less than 30 amperes.

C. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters. Colors shall be white.

1. Low voltage dimming switch: 600 watt slider type preset dimming switches gang mounted as indicated on the drawings. The dimmer shall be Lutron NLV-600. Color shall be white with white cover.

2.5 Wall Plates

A. Single and combination types to match corresponding wiring devices.

1. Material for Finished Spaces: Provide UL listed one-piece device plates for outlets to suit the devices installed. Except as listed below, all wiring device plates shall be .302 stainless steel 0.302 in. thick. Jumbo plates shall be used on all walls. HUBBELL “SJ” Series, 302 stainless or approved equal. Sectional type device plates will not be permitted. Screws shall be machine-type with countersunk heads in color to match finish of plate.

2. Material for Unfinished Spaces: Provide UL listed one-piece device plates for outlets to suit the devices installed. Except as listed below, all wiring device plates shall be .302 stainless steel 0.302 in. thick. Jumbo plates shall be used on all walls. HUBBELL “SJ” Series, 302 stainless or approved equal. Sectional type device plates will not be permitted. Screws shall be machine-type with countersunk heads in color to match finish of plate.

3. Material for Wet Locations: Plates installed in wet locations shall be cast, gasketed and UL listed for "wet locations."

2.6 Floor Service Fittings

A. Type: Modular, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Power Receptacle: NEMA WD 6, Configuration 5-20R, unless otherwise indicated.

2.7 Finishes

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70.

2. Wiring Devices Connected to Emergency Power System: Red.

3. TVSS Devices: Blue.

PART 3 - EXECUTION

3.1 Installation

A. Install devices and assemblies level, plumb, and square with building lines.

B. Mounting Heights: Mounting heights for receptacle outlets shall be 18" above finished floor or as indicated on the Drawings. Mounting heights for receptacles over casework shall be 7" above counter top. Verify all receptacle heights prior to rough-in. Provide a written description to the Engineer, prior to rough-in, any conflicts. The Contractor shall at his expense, be responsible for the relocation of any receptacle not installed according to these specifications.

C. Prior to roughing-in wall outlet boxes, the Contractor shall verify from general construction drawings; door swings, type of wall finishes and locations for counters and work benches. Do not scale the plans; location of devices is shown on plans in desired vicinity. The Contractor shall carefully locate devices symmetrically and in coordination with architectural features.

D. Switches that control remote outlets, fans, etc., shall have engraved plastic name tags indicating the outlets, fans, etc. that are controlled.

E. Install wall dimmers to achieve indicated rating after derating for ganging according to manufacturer's written instructions.

F. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Remove wall plates and protect devices and assemblies during painting.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 Connections

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. 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 and UL 486B.

3.3 Field Quality Control

A. Perform the following field tests and inspections:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.

2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 16170

SECTION 16202

NATURAL GAS GENERATOR
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. Related Sections include the following:

1. Division 16 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 Definitions

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

B. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 Submittals

A. Product Data: Include the following:

1. Data on features, components, accessories ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For manufacturer.

D. Certified summary of prototype-unit test report.

E. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

F. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

G. Test Reports:

1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

2. Report of sound generation.

3. Field quality-control test reports.

H. Certification of Torsional Vibration Compatibility: Comply with NFPA 110.

I. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals. In addition include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

J. Warranty: Special warranty specified in this Section.

1.5 Quality Assurance

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than 4 hours' normal travel time from Installer's place of business to Project site.

2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer’s Distributor Qualifications: A qualified supplier. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs. Service cannot be sublet to another service organization.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

D. Comply with NFPA 30 37A.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110 requirements for emergency power supply system.

H. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.6 Coordination

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.7 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.8 Maintenance Service

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Generac Power Systems, Inc.

2.2 Control And Monitoring

A. Functional Description: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of the generator set. When mode-selector switch is switched to the on position, the generator set starts. The off position of the same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set. Control system shall be microprocessor based.

B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

C. Indicating and protective devices and controls shall include those required by NFPA 110, and the following:

D. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals. Data system connections to terminals are covered in Division 16 Section "Electrical Power Monitoring and Control."

E. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.

1. Engine high-temperature shutdown.
2. Lube-oil low-pressure shutdown.
3. Overspeed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature prealarm.
6. Lube-oil low-pressure prealarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

9. Overcrank shutdown.
10. Coolant low-temperature alarm.
11. Control switch not in auto position.
12. Battery-charger malfunction alarm.
13. Battery low-voltage alarm.

F. Remote Alarm Annunciator: Comply with NFPA 99. Labeled LED shall identify each alarm event. Common audible signal shall sound for alarm conditions. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

G. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation. Install as indicated on the Drawings or Engineer approved location.

H. Provide TVSS on all circuits exiting genset.

2.3 Generator Overcurrent And Fault Protection

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection. Provide circuit breaker settings to coordinate with generator damage characteristics.
2. Trip Rating: Matched to generator rating.
3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication (where indicated on drawings): Comply with NFPA 70, Article 700-7(d). Integrate ground-fault alarm indication with other generator-set alarm indications.

2.4 Source Quality Control

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2.
2. Generator Tests: Comply with IEEE 115.
3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype shall have been factory tested to demonstrate compatibility and reliability.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Full load run.
2. Maximum power.
3. Voltage regulation.

4. Transient and steady-state governing.
5. Single-step load pickup.
6. Safety shutdown.

C. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 Examination

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

3.2 Installation

A. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 Connections

A. Ground equipment according to Division 16 Section "Grounding and Bonding." Generator shall be configured as a “separately derived electrical system” by bonding the neutral and ground at the generator.

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. 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.

3.4 Identification

A. Identify system components according to Division 16 Section "Basic Electrical Materials and Methods."

3.5 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.15.2.1 and 7.22.1 (except for vibration baseline test). Certify compliance with test parameters.
2. Perform tests recommended by manufacturer.
3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
   a. Single-step full-load pickup test.
4. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer's specifications.

5. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

6. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

G. Perform reactive load bank test for a minimum of 4 hours at 0.8 pf.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Remove and replace malfunctioning units and retest as specified above.

J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 Startup Service

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

B. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

C. Complete installation and startup checks according to manufacturer's written instructions. Provide test documentation to Engineer.

3.7 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

1. Coordinate this training with that for transfer switches.

END OF SECTION 16202

SECTION 16207

TRANSFER SWITCHES
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

1.3 Submittals

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Wiring Diagrams: Single-line diagram. Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 Quality Assurance

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches, remote annunciators, and remote annunciator and control panels through one source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Emerson; ASCO Power Technologies, LP.

b. Kohler Co.; Generator Division.

c. Onan Corp./Cummins Power Generation; Industrial Business Group.

d. Russelectric, Inc.

2.2 General Transfer-Switch Product Requirements

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including 100% tungsten filament lamp loads.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

C. Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communication capability matched with remote device.

D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Neutral Terminal: Switched, solid and fully rated.

G. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

J. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Fully rated silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

2.3 Automatic Transfer Switches

A. Comply with Level 1 equipment according to NFPA 110.

B. Microprocessor based.

C. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

D. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

2.4 Automatic Transfer-Switch Features

A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.

C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

E. Test Switch: Simulates normal-source failure.

F. Switch-Position Pilot Lights: Indicate source to which load is connected.

G. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

H. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

J. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

K. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.

L. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

2. Push-button programming control with digital display of settings.

3. Integral battery operation of time switch when normal control power is not available.

2.5 Remote Annunciator System

A. Functional Description: Remote annunciator panel annunciates conditions for indicated transfer switches. Annunciation includes the following:

1. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Switch position.

3. Switch in test mode.

4. Failure of communication link.

B. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

1. Indicating Lights: Grouped for each transfer switch monitored.

2. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.

3. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

4. Lamp Test: Push-to-test or lamp-test switch on front panel.

2.6 Remote Annunciator And Control System

A. Functional Description: Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.

2. Indication of switch position.

3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key-switch or user-code access to control functions of panel.
6. Control of switch-test initiation.
7. Control of switch operation in either direction.
8. Control of time-delay bypass for transfer to normal source.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand-alone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

C. Remote Annunciation and Control Panel: Solid-state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate the transfer switch it controls, location of switch, and load it serves.
3. Digital Communication Capability: Matched to that of transfer switches supervised.
4. Mounting: Flush, modular, steel cabinet, unless otherwise indicated.

2.7 Finishes

A. Enclosures: Manufacturer's polyester powder coat over corrosion-resistant pretreatment and primer.

2.8 Source Quality Control

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 Application

A. Four-Pole Switches: install neutral switching.

3.2 Installation

A. Floor-Mounted Switch: Anchor to floor by bolting.

1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 2 inches (50 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated. Cast anchor-bolt inserts into bases. Comply with Division 3 Section "Cast-in-Place Concrete."

B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

C. Identify components according to Division 16 Section "Basic Electrical Materials and Methods."

3.3 Wiring To Remote Components

A. Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.4 Connections

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

C. 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.

3.5 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.22.3. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.

   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

   c. Verify that manual transfer warnings are properly placed.

   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

   b. Simulate loss of phase-to-ground voltage for each phase of normal source.

   c. Verify time-delay settings.

   d. Verify pickup and dropout voltages by data readout or inspection of control settings.

   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.

f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

3.6 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below.

1. Coordinate this training with that for generator equipment.

END OF SECTION 16207

SECTION 16420

PANELBOARDS
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 Definitions

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 Submittals

A. Approval Submittals:

B. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of:

1. Panelboard
2. Overcurrent protective device
3. Transient voltage surge suppression device
4. Metering device

C. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of panelboards and overcurrent protective devices.

d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

e. Time-current curves, including selectable ranges for each type of overcurrent protective device.

2. Wiring Diagrams: Power, signal, and control wiring.

D. Panelboard Schedules: For installation in panelboards.

E. Electrical Room Layouts: For each electrical room, provide ¼" scale drawing showing equipment layouts for clearance verification. Show all equipment including equipment in other specification sections.

F. Operation and Maintenance Data: include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 Quality Assurance

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Panelboards shall be listed and labeled by Underwriters' Laboratories, Inc. in accordance with UL Standard 67.

G. Panelboards for use as service disconnecting means shall additionally conform to UL 869.

1.6 Project Conditions

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F (40 deg C).

2. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet (2000 m).

1.7 Coordination

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Provide recommended settings for all circuit breakers with selectable settings to coordinate with down stream devices.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.

b. General Electric Co.; Electrical Distribution & Protection Div.

c. Square D.

2.2 Panelboards

A. Enclosures: Galvanized surface-mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.

a. Outdoor Locations: NEMA 250, Type 3R.

2. Hinged Front Cover (Indoor units only): Entire front trim hinged to box and with standard door within hinged trim cover.

3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

5. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

6. Directory Card: Type written with transparent protective cover, mounted in metal frame, inside panelboard door.

7. Provide an engraved laminated phenolic or micarta nameplate 1" high by 3" wide with minimum 1/4" letters indicating the panelboard identification, voltage and upstream protective device. The panelboard shall also have a nameplate affixed to the panelboard with the following information stamped therein: Nameplate: Manufacturer, Voltage, Ampacity, Type of Panelboard, Manufacturer's Order No. and Date, Interrupting Rating - RMS Sym.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box. Ground bus shall have the same rating as the panelboard.

3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads as indicated on drawings.

C. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Compression type.

2. Ground Lugs and Bus Configured Terminators: Compression type.

D. Service Equipment Label (where indicated): UL labeled for use as service equipment for panelboards with main service disconnect switches.

E. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 Panelboard Short-Circuit Rating

A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 Distribution Panelboards

A. Doors: Concealed hinges, secured with vault-type latch with tumbler lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breakers: Bolt-on circuit breakers.

2.5 Lighting And Appliance Branch-Circuit Panelboards

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 TVSS - Service Entrance Suppressors

A. Surge Protective Device Description: Modular design, UL 1449 2nd Edition Listed, mounted integral to panel enclosure with field-replaceable modules and the following features and accessories:

1. Fuses, rated at 200-kA interrupting capacity.
2. Fabrication using bolted compression lugs for internal wiring.
3. Integral disconnect switch.
4. Arrangement with copper busbars and for direct bolted connections to phase buses, neutral bus, and ground bus.
5. Red and green LED indicator lights for power and protection status.
6. Audible alarm, with silencing switch, to indicate when protection has failed.
7. One set of dry contacts rated at 2A and 24-V dc, for remote monitoring of protection status. Coordinate with building power monitoring and control system.
8. Surge-event operations counter.

9. The TVSS system shall be duty life cycle tested to survive a minimum of 1,000 surges per phase of 10kV, 10 kA, IEEE C62.45 Category C3 surge current with less than 10% degradation of clamping voltage.

10. The TVSS system shall have EMI/RFI filtering, UL1283 listed and per MIL-STD-220A.
11. Per NEC Article 285.6, TVSS shall be marked by a Short Circuit Current Rating (SCCR), equal to or greater than the available fault current where connected (as noted on drawings).

B. Peak Single-Impulse Surge Current Rating: 200kA per phase (L-N + L-G), 100kA per mode.

C. Protection modes and UL1449 clamping voltage for grounded wye circuits with voltages of 480Y/277 or 208Y/120; 3-phase, 4-wire circuits, shall be as follows:

1. Line to Neutral: 800V for 480Y/277, 400V for 208Y/120.
2. Line to Ground: 800V for 480Y/277, 400V for 208Y/120.
3. Neutral to Ground: 800V for 480Y/277, 400V for 208Y/120.

2.7 Overcurrent Protective Devices

A. Circuit breakers shall be molded case with trip units of size, type and quantity shown on the drawings. The circuit breakers shall be bolt-on type, equipped with individually insulated, braced and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Paper stickers are not acceptable for individual circuit numbers. Individual circuit numbers shall be phenolic. Trip indication shall be clearly shown by the breaker handle. Provisions for additional breakers shall be such that no additional connectors will be required to add circuit breakers. Breaker terminals shall be UL listed as suitable for type and size of conductor provided for.

B. The following are general/minimum requirements. Provide features trip units, etc. per the selective coordination study as required to achieve coordination.

1. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

2. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; let-through ratings less than NEMA FU 1, RK.

3. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Unless indicated otherwise, breakers smaller than 250A frame shall be thermal-magnetic.

4. Adjustable Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting. Unless indicated otherwise, breakers smaller than 800A frame and at least 250A frame shall be adjustable thermal-magnetic.

5. Electronic Trip-Unit Circuit Breakers: Unless indicated otherwise, breakers 800A frame and larger shall be electronic trip type. RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

   a. Instantaneous trip.

   b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I^2t response.

C. Multipole Breakers: Provide common trip-type with single operating handle. Breaker design shall be such that overload in one pole automatically causes all poles to open. Maintain phase sequence throughout each panel so that any three adjacent breaker poles are connected to Phases A, B, and C, respectively.

2.8 Digital Metering Device

A. Provide where indicated on the drawings a digital power monitoring device (equivalent to Square D PM-820) on the front of the panel fully connected with CT's with the following capabilities:

1. LCD alpha-numeric display.
2. Certified ANSI C12 revenue accuracy.
3. Current per phase and neutral.
4. Volts L-L and L-N.
5. Real Power (kW) A, B, C, total.
6. Reactive Power (kVAR) A, B, C, total.
7. Apparent Power (kVA) A, B, C, total.
8. Power Factor (true) A, B, C, total.
9. Frequency (Hz).
10. Real Energy (kWh) 3 phase total.
11. Reactive Energy (kVARh) 3 phase total.
12. Apparent Energy (kVAh) 3 phase total.
13. RS-485 communications.
14. THD voltage and current A, B, C.
15. Real power demand (kWd) 3 phase total present & peak.
16. Reactive power demand (kVARd) 3 phase total present & peak.
17. Apparent power demand (kVAd) 3 phase total present & peak.
18. Date and time stamping on peak demands.

2.9 Accessory Components And Features

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 Installation

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mount top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

G. Provide four ¾" conduits from all recessed panelboards to above accessible ceiling for future use.

3.2 Identification

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Basic Electrical Materials and Methods."

B. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Verify room numbers with Owner prior to creating directory. All room and building numbers/names shall reflect the final labels assigned for occupancy.

C. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic nameplate mounted with corrosion-resistant screws. Nameplate shall comply with the requirements listed in Section 2.2.A.7 above.

3.3 Connections

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.4 Field Quality Control

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Equipment Meters. Adjust and calibrate as recommended by manufacturer.

3.5 Cleaning

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 16420

SECTION 16470

LIGHT POLES AND STANDARDS
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following poles for support of luminaires:

1. Aluminum poles.

B. Related Sections include the following:

1. Division 16 Section "Site Lighting" for lighting fixtures, lamps, ballasts, and accessories.

1.3 Definitions

A. Luminaire: Complete lighting fixture, including ballast housing if provided.

B. Pole: Luminaire support structure, including foundation, standard, pole top and high pole, and tower used to illuminate large area.

C. Standard: Same definition as "Pole" above.

1.4 Performance Requirements

A. Wind Load: Pressure of wind on standard and luminaire, calculated and applied as stated in AASHTO LTS-3.

1. The actual wind speed for the required loading shall not be less than that referenced in ASCE 7-98, Minimum Design Loads for Buildings and Other Structures, 1998. Linear interpolation between contours is permitted.

1.5 Submittals

A. Product Data: For each type of pole indicated, arranged in order of lighting unit designation. Include data on accessories, finishes, and the following:

1. Materials and dimensions of poles
2. Means of attaching luminaires and indication that attachment is suitable for it
3. Concrete bases (for anchor base poles)
4. Overall pole dimensions
5. Working moment capacity
6. Total moment resulting from applied loads

7. Total axial load
8. Anticipated pole top deflection due to applied loads
9. Total weight of each pole
10. Bolt hole locations (for anchor base poles)
11. Description and location of steel reinforcement (for direct burial concrete poles)
12. Twenty-eight day strength of concrete and detention strength (for direct burial concrete poles)
13. Ultimate moment
14. Cracking moment
15. Minimum clear concrete cover over spiral steel (for direct burial concrete poles)
16. Wind loading calculations.
17. Structural foundation requirements, signed by a registered structural engineer.

B. Shop Drawings: Include anchor-bolt templates keyed to specific poles and certified by manufacturer.
   1. Design calculations, certified by a qualified professional engineer, indicating strength of the foundation.

C. Product Certificates: Signed by manufacturer of poles, certifying that products are designed for load requirements in AASHTO LTS-3 and that load imposed by luminaire has been included in design.
   1. Design calculations, certified and signed by a qualified professional engineer, indicating strength of the foundation.

1.6 Delivery, Storage, And Handling

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Retain factory-applied pole wrappings on metal poles until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Lyte Poles.
   2. Union Metal
   3. Kim

2.2 Poles, General

A. Description: Comply with AASHTO LTS-3 in structural design of poles.

B. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Performance Requirements" Article, with a gust factor of 1.3.

1. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

C. Luminaire Attachment: Structural supports to comply with luminaire mounting requirements.

D. Finish: Match finish of pole and support structure on arm, bracket, and tenon mount materials.

E. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Mountings: Correctly position luminaire attachment to provide indicated light distribution.

3. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless stainless-steel items are indicated.

4. Anchor-Bolt Template: Plywood or steel.

5. Concrete Bases: Cast-in-place concrete.

F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and having strength, mounting bolt, and top-plate dimensions required to support pole, luminaire, and accessories.

2.3 Aluminum Poles

A. Poles: Seamless, extruded structural tube complying with ASTM B 429, 6063-T6 alloy with access handhole in pole wall.

B. Pole-Top Tenons: Fabricated to support luminaire or luminaires and brackets indicated, and securely fastened to pole top.

C. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 16 Section "Grounding and Bonding," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

D. Brackets for Luminaires: Detachable, with pole and adapter fittings of cast aluminum. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

E. Aluminum Finish: Comply with NAAMM's "Metal Finishes Manual for Engineerural and Metal Products" for recommendations for applying and designating finishes.

1. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Engineerural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: per drawings.

b. Shape: per drawings.

PART 3 - EXECUTION

3.1 Erection, General

A. Set reinforcement for anchor bolts, nuts, and washers according to anchor-bolt templates furnished by pole manufacturer.

1. Concrete Finish: Trowel and rub smooth.

B. Embedded Poles: Install poles as required by structural foundation shop drawings.

C. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.
4. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
5. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

3.2 Corrosion Prevention

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

3.3 Grounding

A. Ground poles/support structures according to Division 16 Section "Grounding and Bonding."

1. Install grounding electrode (minimum size is ¾" by 10' long) for each pole.
2. Nonmetallic Poles: Ground metallic components of pole accessories and foundations.
3. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B. 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.

END OF SECTION 16470

SECTION 16510 –

OCCUPANCY SENSORS
10/2010

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes occupancy sensors for lighting control.

1.3 Definitions

A. DT: Dual Technology

B. LED: Light-emitting diode.

C. PIR: Passive infrared.

1.4 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. All products shall be UL listed.

1.5 Coordination

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

1.6 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of product indicated.

B. Shop Drawings:

1. Show installation details for occupancy and light-level sensors.

2. _" or ¼" scaled lighting plan showing location, orientation, and coverage area of each sensor.

3. Interconnection diagrams showing field-installed wiring.

1.7 Test Reports and Verification Submittals:

A. Training: Submit letter verifying that Owner training has been received by factory representative.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements. Verify actuation of each sensor and adjust time delays. Set sensitivities, time delays, etc as required for each specific device based on the actual conditions of the environment in which it exists.

1.8 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

PART 2 - PRODUCTS

2.1 Manufacturers

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hubbell Lighting Inc.

b. Watt Stopper (The).

c. Greengate.

d. Crestron.

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted though a ½-inch knockout in a standard electrical enclosure.
   c. Time Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; keeps lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.
1. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in.
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on an 8-foot high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot high ceiling in a corridor not wider than 14 feet.

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch minimum movement of any portion of a human body that presents a target of at least 36 sq. in., and detect a person of average size and weight moving at least 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch high ceiling.

F. Wall Switches: Mount at 48" AFF.

1. PIR Type: Single or Dual relay as indicated on plans with override off.

2. Digital Time Type: Automatically turns light off after preset time. LCD on front. Audible and visual alert prior to turning lights off.

2.2 Conductors and Cables

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG, complying with Division 16 Section “Basic Electrical Materials and Methods."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 18 AWG, complying with Division 16 Section “Basic Electrical Materials and Methods."

C. Class 1 Control Cable: Multiconductor cable with stranded copper conductors not smaller than No. 14 AWG, complying with Division 16 Section “Basic Electrical Materials and Methods."

D. Provide plenum rated cable where required.

PART 3 - EXECUTION

3.1 Sensor Installation

A. Install and aim sensors in locations to achieve at least 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 Wiring Installation

A. Wiring Method: Comply with Division 16 Section "Basic Electrical Materials and Methods."

1. Minimum conduit size shall be ½ inch.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. 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 and UL 486B.

3.3 Identification

A. Identify components and power and control wiring according to Division 16 Section “Basic Electrical Materials and Methods."

3.4 Adjusting

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

END OF SECTION 16510

SECTION 16520

INTERIOR LIGHTING
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following:

1. Interior lighting fixtures with lamps and ballasts.
2. Lighting fixtures mounted on exterior building surfaces.
3. Emergency lighting units.
4. Exit signs.

1.3 Quality Assurance

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.4 Coordination

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

1.5 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of lighting fixture scheduled.

1. Arrange data in the order as they appear in the Lighting Fixture Schedule.

2. Include with each light fixture product data the ballast and lamp product data for that particular fixture. This information must accompany the light fixture product data.

1.6 Test Reports and Verification Submittals:

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal. Test every fixture and provide written documentation of results.

1.7 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

PART 2 - PRODUCTS

2.1 Manufacturers

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include the products specified.

2.2 Fixtures and Components, General

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1570.

C. HID Fixtures: Comply with UL 1572.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

H. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.156 inch (3.175 mm) minimum unless different thickness is scheduled.

b. UV stabilized.

2. Glass: Tempered glass, unless otherwise indicated.

I. Electromagnetic-Interference Filters: A component of fixture assembly. Suppress conducted electromagnetic-interference as required by MIL-STD-461D. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 Lighting Fixtures

A. Fixtures shall be as indicated in the Lighting Fixture Schedule.

2.4 Fluorescent Lamp Ballasts

A. Ballasts for Low-Temperature Environments: Fluorescent ballast having a minimum starting temperature of zero degrees F in fixtures mounted in outdoors, in unheated buildings, and as indicated.

B. Programmed Start Solid State Electronic Ballasts: Electronic ballasts shall include the following features, unless otherwise indicated:

1. The electronic ballast shall be physically interchangeable with standard electromagnetic ballasts and standard electronic ballasts.

2. The electronic ballast shall have a maximum height of 1.18 in. and maximum weight of 1.8 lbs.

3. The electronic ballast shall be furnished with integral leads, color-coded to ANSI C82.11.

4. The electronic ballast shall operate from a nominal line voltage of 120 or 277 volts, +/- 10%, 60Hz.

5. The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when used with primary lamp.

6. The electronic ballast shall have a Power Factor greater than 98% when used with primary lamp.

7. The electronic ballast shall withstand a sustained short to ground or open circuit of any output leads.

8. The electronic ballast shall be Sound Rated A.

9. The electronic ballast shall be specifically designed for use with the specified lamps.

10. The electronic ballast output frequency to the lamps shall be above 40kHz to minimize interference with infrared control systems and eliminate visible flicker.

11. The electronic ballast shall meet ANSI C82.11, where applicable.

12. The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

13. The electronic ballast shall be CBM certified, where applicable.

14. The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

15. The electronic ballast shall comply with all applicable state and federal efficiency standards.

16. The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

17. The electronic ballast shall not contain Polychlorinated Biphenyl (PCB's).

18. The electronic ballast shall carry a five-year warranty from the date of manufacture. Warranty shall be valid for a maximum case temperature of 70°C.

19. The manufacturer shall have a ten-year history of producing electronic ballast for the North American market.

20. The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

21. Ballast shall be produced in the United States of America.

22. Ballast shall have a minimum starting temperature of 0°F.

23. Approved Manufacturer: Universal Accustart, Phillips Advance Optanium series, G.E. Ultra Start.

C. Solid State 3-Wire Electronic 5% Dimming Ballasts: Electronic ballasts shall include the following features, unless otherwise indicated:

1. Dimming Range: 100% to 5% measured relative light output (RLO).
2. 3-wire operation.
3. Lamp Starting: programmed rapid start.
4. Minimum Lamp Starting Temperature: 10°C (50°F).
5. Ambient Temperature Operating Range: 10°C (50°F) to 60°C (140°F).
6. Relative Humidity: maximum 90% noncondensing.
7. Operating Voltage: 120V, 60Hz nominal line.
8. Lamp Current Crest Factor: less than 1.7.
9. Lamp Flicker: none visible.
10. Light Output: constant ±5% light output for line voltage variations of ±10%.
11. Lamp Life: average lamp life meets or exceeds rating of lamp manufacturer.
12. Ballast Factor: greater than .85.
13. Power Factor: greater then .95.
14. Total Harmonic Distortion (THD): less than 20% at full light output.
15. Frequency of Operation: greater than 42kHz.
16. Maximum Inrush Current: 7 amps per ballast at 120V.
17. Sound Rating: Inaudible in a 27dBa ambient.
18. Maximum Ballast Case Temperature: 75°C (167°F).
19. UL Listed (evaluated to the requirements of UL935).
20. CSA certified (evaluated to the requirements of C22.2 No. 74).
21. Class P thermally protected.
22. Meets ANSI C82.11 High Frequency Ballast Standard.
23. Meets FCC Part 18 non-consumer requirements for EMI/RFI emissions.
24. Meets ANSI C62.41 Category A surge protection standards up to and including 6kV.
25. Manufacturing facilities employ ESD reduction practices that comply with the requirements of ANSI/ESD S20.20.
26. Manufacturer registered to ISO 9001.2000.

27. Approved Manufacturer: Lutron Tu-wire, Advance Mark 10 Powerline.

2.5 High-intensity-discharge Lamp Ballasts

A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F Minus 30 deg C for single-lamp ballasts.

3. Normal Ambient Operating Temperature: 104 deg F 40 deg C.

4. Open-circuit operation that will not reduce average life.

B. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.

2.6 Exit Signs

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.

2. Charger: Fully automatic, solid-state type with sealed transfer relay.

3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Shall have Self Verification and Test capability installed.

2.7 Fluorescent Emergency Lighting Fixtures

A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

1. Emergency Connection: Operate one or more fluorescent lamps continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.

2. Night Light Connection: Operate one or more fluorescent lamps continuously.

3. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

4. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum seven-year nominal life.

5. Charger: Fully automatic, solid-state, constant-current type.

6. 1400 lumen output for a minimum of 90 minutes depending upon lamp type and quantity.

7. Approved manufacturers are Bodine, Beghell and Emergi-lite.

8. In exterior locations, provide equipment capable of operating at temperatures from 0° F to 130°F.

2.8 Fluorescent Lamps

A. T5 Fluorescent: Provide the number, type, and wattage indicated. T5 lamps shall be programmed start, low mercury, rated 28 watts, 2950 approximate initial lumens, 24,000 hours average rated life, 82 CRI, 4100k color temp. Average rated life is based on 3 hours operating per start. Lamps shall be General Electric, Sylvania, Philips.

B. Compact Fluorescent: Provide the number, type, and wattage indicated. Lamps shall be rated, 10,000 hours average rated life, 82 CRI, 4100k color temp. Average rated life is based on 3 hours operating per start. Lamps shall be General Electric, Sylvania, Philips.

2.9 High-intensity-discharge Lamps

A. Metal-Halide Lamps: ANSI C78.1372, wattage and burning position as scheduled, CRI 65 (minimum), and color temperature 4000.

2.10 Fixture Support Components

A. Comply with Division 16 Section "Basic Electrical Materials and Methods" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: ½-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, ½-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated, 12 gage (2.68 mm).

E. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

H. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.11 Finishes

A. Fixtures: Manufacturers' standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 Installation

A. Fixtures: Set lighting fixtures plumb, square, and level with ceiling and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings. The installation shall meet with the requirements of NFPA 70. Mounting heights specified or indicated shall be to bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before installation is commenced and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. 1' x 4', 2' x 4' and 2' x 2' recessed and semi-recessed fixtures may be supported from suspended ceiling support system ceiling tees if the ceiling system support wires are provided at a minimum of four wires per fixture and located not more than 6 inches from each corner of the fixture. Additionally, for recessed fixtures, provide support clips securely fastened to ceiling grid members, a minimum of one at or near each corner of each fixture. For round fixtures or fixtures smaller in size than the ceiling grid, provide a minimum of two wires per fixture and locate at opposite corners of the ceiling grid in which the fixture is located. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicted to be centered in the acoustical panel, support such fixtures independently or with at least two 3/4-inch metal channels spanning, and secured to the ceiling tees. Provide wires for lighting fixture support in this section. There are

many type of ceiling systems available on the market and any number of these ceiling systems may be used as part of this work. Verify the types of ceiling construction before ordering fixture fabrication. Determine that suspension methods and flange arrangements for fixtures coordinate with ceiling types and their suspension systems.

B. Adjust aimable fixtures to provide required light intensities.

3.2 Connections

A. 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 and UL 486B.

3.3 Field Quality Control

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

D. Clean all fixtures. Wipe down and remove finger prints, dust, dirt, grime, etc.

E. Lamp “Burn-in”: All lamps, at initial energization, shall be “burned-in” at 100% output for a minimum of 100 hours.

END OF SECTION 16520

SECTION 16525

SITE LIGHTING
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following:

1. Site lighting fixtures with lamps and ballasts.

1.3 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of lighting fixture scheduled.

1. Arrange data in the order as they appear in the Lighting Fixture Schedule.

2. Include with each light fixture product data the ballast and lamp product data for that particular fixture. This information must accompany the light fixture product data.

1.4 Test Reports and Verification Submittals:

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal. Test every fixture and provide written documentation of results.

1.5 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

1.6 Quality Assurance

A. Comply with NFPA 70.

B. Site lighting shall be per plans and specifications in base bid. It is the contractor's responsibility to insure that all items supplied for use on this project comply with the specifications. Any alternate to the base bid specifications must be reviewed and approved by the Engineer in writing at least 10 days prior to the bid. Information sufficient to determine conformance to the specifications must be submitted to the engineer at least two weeks prior to bid date to be considered for approval. No substitutions will be considered without compliance with the requirements listed herein. Contractor shall be responsible for all cost (engineering time, manufacturer's cost, distributor cost, etc.) incurred to replace equipment not approved if substitutions are made by the distributor, manufacturer representative, or contractor. For an alternate to the base bid specifications to be reviewed, the following samples and technical information must be supplied:

1. A working sample of the alternate luminaire complete with lamps, ballast, and optical system that will be supplied for the bid installation. For convenience, the Engineer may require a sample, which operates at 120 volts.

2. A complete photometric report of the submitted sample with the specified lamp type must list the actual candela values for the luminaire's distribution in at least three planes. Candela curves, footcandle and lumen tables in iso-footcandle contours are not acceptable. Prorated data is not acceptable. Data will be supplied both in written form and in the form of a data file on 3 ½" floppy disk in IES format for use in recognized computer lighting applications.

3. A current original catalog data sheet with luminaire catalog numbers. Modified data sheets are unacceptable.

4. A factory generated point-by-point computer printout of the entire site on one plan verifying the illumination criteria for the entire site plan based on using the alternate luminaires. The spacing increment of points on the verification printouts shall not exceed one half the scale of the original site plan or the luminaire mounting height, whichever is less. The printouts shall be based on the footcandle levels based on the criteria set by the Engineer for this specific project with a summary table showing the maximum, minimum, and average horizontal footcandle levels on the entire site. Footcandle values shall be in decimal value. Values shall not be rounded up or down. Values shall be shown with no less than two decimal points. At a minimum, two printouts must be supplied, one showing initial footcandles, and one showing maintained footcandle values based on a .72 light loss for metal halide luminaires and a .80 light loss factor for high pressure sodium luminaires. The report must show that the alternate fixtures provides performance equal to or better than the lighting levels of the specified product.

5. The engineer reserves the right to verify the lighting performance of the fixtures following installation on the site. Should the luminaire performance fail to meet the criteria set forth for this specific job, or fail to meet the performance specification set forth for the specific fixture, the contractor shall be responsible for acquiring and installing any additional equipment necessary to bring the lighting levels up to the required values. All cost related to purchase and installation of such additional equipment shall be the responsibility of the contractor. Verification of the site by the engineer may take place anytime following the completion of the site and the initial 100-hour burning of the lamps in the fixtures, up to 180 days following the initial 100-hour burning period.

PART 2 - PRODUCTS

2.1 Manufacturers

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified on the drawings.

2.2 Fixtures And Components, General

A. HID Fixtures: Comply with UL 1572. Where LER is specified, test according to NEMA LE 5B.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

2.3 Lighting Fixtures

A. Construction:

1. Housing shall be a square or rectilinear design with die formed (or die cast) aluminum housing sides with integral reinforcing spline and no welded corners.

2. All housings and arms shall feature an Aluminum Association Architectural Class I anodized finish. The fixture will be anodized after fabrication with an electrolytic process that does not use dyes or organic chemicals.

3. All fixtures shall provide for segmented, electro-chemically brightened, anodized aluminum sheet reflectors set in facets to produce the specified light distribution patterns. The assembly shall be easily to rotate in the field in 90 degree increments without rotating the luminaire.

4. Complete installation and wiring of the fixture must be accomplished without opening the fixture housing except to install the lamp.

5. The fixture shall permit access without tools into the reflector assembly and ballast compartments for ease of maintenance and safety.

6. Ballast assemblies shall be provided on a unitized tray permitting removal of the ballast tray form the fixture without the necessity to cut any wires. Additional ballast trays pre-assembled and including all ballast components must be available from the manufacturer of the fixture.

2.4 High-intensity-discharge Lamp Ballasts

A. General: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.

2. Minimum Starting Temperature: Minus 22 deg F Minus 30 deg C for single-lamp ballasts.

3. Normal Ambient Operating Temperature: 104 deg F 40 deg C.

4. Open-circuit operation that will not reduce average life.

2.5 High-intensity-discharge Lamps

A. Metal-Halide Lamps: ANSI C78.1372, wattage and burning position as scheduled, CRI 65 (minimum), and color temperature 4000.

2.6 Finishes

A. Fixtures: Manufacturers' standard, unless otherwise indicated.

1. Paint Finish: Polyester powder coat applied over corrosion-resistant treatment or primer, free of defects.

2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 Installation

A. Fixtures: Set lighting fixtures plumb, square, and level and secure in accordance with manufacturers' directions and approved drawings. The installation shall meet with the requirements of NFPA 70.

B. Adjust aimable fixtures to provide required light intensities.

C. Provide ground rod at base of pole.

D. Provide fusing for each pole mounted fixture inside handhole in pole.

3.2 Connections

A. 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 and UL 486B.

3.3 Field Quality Control

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Verify normal operation of each fixture after installation.

C. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

END OF SECTION 16525

SECTION 16570

LOW VOLTAGE LIGHTING CONTROL SYSTEM
10/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes the following lighting controls: low voltage relay-based lighting control system.

1.3 Definitions

A. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

B. PC: Personal computer; sometimes plural as "PCs."

C. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.

D. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.4 Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each device provided.

B. Shop Drawings:

1. System wiring diagram indicating required connections and cables for all components.

1.5 Test Reports and Verification Submittals:

A. Training: Submit letter verifying that Owner training has been received by factory representative.

1.6 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

1.7 Quality Assurance

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

1.8 Coordination

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of lighting control functions.

1.9 Warranty

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Software: Failure of input/output to execute switching or dimming commands.

b. Failure of modular relays to operate under manual or software commands.

c. Damage of electronic components due to transient voltage surges.

2. Warranty Period: Cost to repair or replace malfunctioning parts for one year after the date of Substantial Completion.

1.10 Extra Materials

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Electrically Held Relays: Equal to 5 percent of amount installed for each size indicated, but no fewer than one relay.

1.11 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each device provided.

B. Shop Drawings:

1. System wiring diagram indicating required connections and cables for all components.

1.12 Test Reports and Verification Submittals:

A. Training: Submit letter verifying that Owner training has been received by factory representative.

1.13 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Watt Stopper (The).
2. Lutron.
3. LC&D.
4. Hubbell Building Automation.
5. ILC.
6. Crestron.

7. Greengate

2.2 System Requirements

A. Expansion Capability: Adequate to increase the number of control functions in the future by 25 percent more than those indicated. This expansion capability applies to equipment ratings, housing volumes, spare relays, terminals, number of conductors in control cables, and control software.

B. Line-Voltage Surge Suppression: Factory installed as an integral part of 120- and 277-V ac, solid-state control panels.

C. FCC Compliance: The programmable controllers shall comply with FCC emission standards specified in Part 15, sub-part J for commercial applications. In addition the controllers must meet the higher FCC standards for residential applications. Equipment that cannot meet both commercial & residential FCC certification shall not be acceptable.

2.3 Functional System Description

A. Manual switch, an internal timing and control unit, or an external sensor or other control signal source sends a signal to programmable-system control module that processes the signal according to its programming and routes an open or close command to one or more relays in the power-supply circuits for groups of lighting fixtures or other loads. Equivalent to ILC QuantaElite Series.

2.4 Control Module

A. Control Module Description: Complying with UL 916; microprocessor-based control unit receives programming from hand-held programmer. Control units shall include a solid-state, programmable, 365-day timing unit and can receive inputs from indicated sensors and other sources. Output circuits shall be pilot-duty relay type capable of operating latching-type, single-pole lighting circuit relays; multipole lighting contactors; and other devices. Output circuits shall include digital circuits arranged to transmit control commands to remote preset dimmers.

2.5 Relays and Modules

A. Transformer Relays (TR): The transformer relay shall be combined Class 2 transformer and magnetic latching relay. Relay systems requiring external control transformer or systems without capability to operate all relays simultaneously shall not be acceptable. Load contacts will be rated 20 amps - ballast, tungsten and general use at 277 VAC. Auxiliary contacts shall close concurrently with the line voltage contacts and serve to signal relay status through pilot devices or other monitors of load status. Control of the rated line voltage circuit requires that a half-wave rectifier (diode), be momentarily connected to establish a magnetic field and lines of flux required to latch the relay. The direction of the DC current pulses, i.e. electrical direction of the diode, determines the polarity of the magnetic field and whether the transformer relay

contacts are left open (unlatched) or closed (latched). Relays with closing coils or solenoids shall not be acceptable. Transformer relay control circuits shall be 15 VAC circuit and 200 ma. short circuit maximum.

B. Interface Module (IFM): The interface module shall be a group of half-wave rectifiers (diodes) designed to maintain the isolation of interconnected transformer relays and provide the means for simultaneous control (mastering) of transformer relay groups. System shall be designed to provide multiple master control groups for common relays and multiple master control switched parallel connected to IFM to achieve system switching strategy as specified. Interface modules shall allow unlimited local (PCS) control of individual transformer relays for maximum system function.

C. Contact Interface Module (CIF): The contact interface module shall be a solid state electronic assembly designed to convert a maintained dry contact closure to the momentary pulse required to operate from 1 to 30 transformer relays. CIF's may be connected in parallel groups up to ten controlled from a single switch point. Control shall be dry contacts.

D. Serial Add-On Modules: Each programmable lighting controller requiring Serial or LAN communications shall be provided with a Serial / LAN Add-On Module. Serial / LAN Add-On Modules shall support both RS232 and RS485 high-speed serial communications standards. RS485 addressing shall be accomplished with an 8-position DIP switch that shall allow any Serial /LAN Add-On Module to be set to any NODE address from 1 to 256. Serial / LAN Add-On Module shall allow both RS232 and RS485 communications to be present at the same time and shall detect the presence of either or both automatically, without the need for any user intervention. It shall be possible for the system user to connect the Serial / LAN Add-On Module RS232 with a Windows-based PC and make local programming changes while the control system remains completely functional and continues to process all networked (RS485) and programmed commands, including time schedules, local switching, network commands and status updates. Systems that must be halted or taken “OFF LINE” for programming are not acceptable.

E. Pilot Light Transformer: Pilot light transformers for control switches shall be an energy-limiting Class 2 transformer specifically designed to energize RCSS pilot lights through the auxiliary contacts of a Transformer Relay. It shall have 10 VAC/10VA at the secondary derived from and input voltage of 277VAC. Primary and secondary leads shall be minimum 8" length, #18 AWG and color coded as follows: primary - black, secondary - orange and violet. Transformer shall have a nipple for mounting in ½" standard knockout and be UL listed.

F. Relay Panel Enclosures: All transformer relays, interface modules, contact interface modules and pilot light transformers shall be completely factory assembled and wired into 'RP' type relay panels. Relay panels shall be a UL listed enclosure with screw cover and internal mounting bracket for transformer relays and accessories. Mounting bracket shall also provide barrier between high and Class 2 low voltage in compliance with NEC standard. All field wiring connections shall be labeled terminal blocks in both high and low voltage panel sections. Complete assembly shall be factory assembled, tested, and guaranteed to perform according to the approved system drawings and projected specifications.

2.6 Manual Switches and Plates

A. Switches: Addressable switches. Provide and install custom switchplates and switches where shown on the drawings and/or schedules. Switch and plate assembly shall be single gang, double gang or custom configuration with switches installed as scheduled. Switches shall be capable of connection via Cat 5e cable.

B. Switchplates shall be .302 stainless steel. Plates shall be punched for switches as specified herein and switches shall be factory installed in the plates. Plate mounting holes shall be standard electrical industry "Box Mount" spacing and provided with black screws.

C. Master switchplate shall be custom engraved to indicate each switch zone. Verify exact zone names with engineer prior to engraving.

D. Configurations that are not standard catalog items shall be custom made at the factory and not a contractor item made up in the field.

2.7 Conductors and Cables

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 16 Section "Basic Electrical Materials and Methods."

B. Switch Cable: Category 5e, color other than that used for Telecom (voice/data).

C. Digital and Multiplexed Signal Wire: Shielded, twisted-pair cable.

PART 3 - EXECUTION

3.1 Wiring Installation

A. Wiring Method: Install wiring in raceways. Comply with Division 16 Section " Basic Electrical Materials and Methods." Minimum conduit size shall be ½ inch (13 mm).

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.

C. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.

D. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.

F. 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 and UL 486B.

3.2 Identification

A. Identify components and power and control wiring according to Division 16 Section “Basic Electrical Materials and Methods.”

3.3 Field Quality Control

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing.

B. Custom Programming Engage a factory-authorized service representative to program the system with custom presets, zones, scenes, etc., as directed by engineer and owner. This session shall take place on site after the system is fully operational and at a time convenient for the engineer and owner.

3.4 Adjusting

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

3.5 Demonstration

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls.

END OF SECTION 16570

SECTION 16731

FIRE DETECTION AND ALARM SYSTEM-ADDRESSABLE
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 Summary

A. This Section includes fire alarm systems.

1.3 Definitions

A. FACP: Fire alarm control panel.

B. LED: Light-emitting diode.

C. NAC: Notification Appliance Circuit.

D. NICET: National Institute for Certification in Engineering Technologies.

E. SLC: Signaling Line Circuit.

F. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 System Description

A. Noncoded, analog-addressable system; automatic sensitivity control of certain smoke detectors; and multiplexed signal transmission dedicated to fire alarm service only.

1.5 Performance Requirements

A. Fire alarm signal initiation: Shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Area smoke detectors.
4. Automatic sprinkler system water flow.
5. Fire extinguishing system operation.
6. Fire standpipe system.

B. Fire alarm signal: Shall initiate the following actions:

1. Alarm notification appliances shall operate continuously.
2. Identify alarm at the FACP and remote annunciators.
3. De-energize electromagnetic door holders.
4. Transmit an alarm signal to the remote alarm receiving station.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
7. Close smoke dampers in air ducts of system serving zone where alarm was initiated.
8. Record events in the system memory.
9. Record events by the system printer where provided.

C. Supervisory signal initiation: Shall be by one or more of the following devices or actions:

1. Operation of a fire-protection system valve tamper switch.

D. System trouble signal initiation: Shall be by one or more of the following devices or actions:

1. Duct-mounted smoke detectors.
2. Open circuits, shorts and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
3. Opening, tampering, or removal of alarm-initiating and supervisory signal-initiating devices.
4. Loss of primary power at the FACP.
5. Ground or a single break in FACP internal circuits.
6. Abnormal ac voltage at the FACP.
7. A break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at the FACP or annunciator.
10. Fire-pump power failure, including a dead-phase or phase-reversal condition.
11. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

E. System Trouble and Supervisory Signal Actions: Ring trouble bell and annunciate at the FACP and remote annunciators. Record the event on system printer.

F. Air Handling Units: Air handling units shall shut down only in the area where the fire is detected or the area actually alarmed (floor above and below). Other air handling equipment shall remain on line. This shall not supersede any code requirement.

1.6 Quality Assurance

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project. The fire alarm system shall be installed by a state certified fire

alarm system installation contractor. The fire alarm system installation contractor shall have an unlimited electrical license (Type EC) or a fire alarm specialty license (Type EF).

1. The fire alarm contractor shall be an experienced firm regularly engaged in the layout and installation of automatic fire alarm systems. The contractor shall have successfully completed the installation, testing, and warranty of systems of the scope of the largest system on this project at least one year prior to bid, and have regularly engaged in the business of fire alarm systems contracting continuously since.

2. The fire alarm contractor shall have been NICET Level III certified, and certified by an approved equipment manufacturer to perform installation, testing, adjustment, maintenance, and repair on the approved manufacturer's equipment prior to the date of bid. The proposed fire alarm contractor shall commence no work on the project until he furnishes evidence, satisfactory to the aforementioned certifications and receives notice to proceed with the installation from the Engineer.

3. Firms shall have a factory authorized service organization and stock spare parts.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All equipment shall be UL listed.

1.7 Extra Materials

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Smoke and Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than 1 unit of each type.
2. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than 1 unit of each type.
3. Keys and Tools: One extra set for access to locked and tamper proofed components.
4. Audible and Visual Notification Appliances: One of each type installed.
5. Fuses: Two of each type installed in the system.

1.8 Approval Submittals:

A. Product Data: Submit manufacturer's technical product data, specifications and installation instructions for each type of device provided.

B. Calculations:

1. Battery size calculations
2. NAC circuit cable voltage drop calculations.

C. Qualification Data: For Installer.

D. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Engineer for review.

E. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire alarm system design.
b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

3. Floor Plans: Submit a "point-to-point" wiring diagram showing the connections to the equipment and terminal cabinets. Indicate the equipment numbers, terminal numbers, wire numbers, address numbers and wire colors. Include the connections for the Mechanical Systems. The submittal shall be made for approval prior to the installation of the wiring in the raceways. Indicate final outlet locations showing address of each addressable device. Show size and routing of cable and conduits.

4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

1.9 Test Reports and Verification Submittals:

A. Training: Submit letter verifying that Owner training has been received by factory representative

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

C. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.

3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
5. Detectors that are outside their marked sensitivity range shall be replaced.
6. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

1.10 O&M Data Submittals:

A. Submit manufacturer's maintenance data including parts lists. Include these data, a copy of approval submittals (product data & shop drawings) in O&M manual.

B. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.

PART 2 - PRODUCTS

2.1 Manufacturers

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. FACP and Equipment:
   a. Edwards Systems Technology Inc.
   b. NOTIFIER; a GE-Honeywell Company.
   c. SimplexGrinnell LP; a Tyco International Company.
   d. Siemens XLS.
2. Wire and Cable:
   a. Comtran Corporation.
   b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
   c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
   d. West Penn Wire/CDT; a division of Cable Design Technologies.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864 listed.

2. Addressable initiation devices that communicate device identity and status.
3. Smoke sensors shall additionally communicate sensitivity setting.
4. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
5. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two lines of 40 characters each, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

C. Electronic Loop Controller: Electronic Loop Controller shall be provided in each Fire Alarm Control Panel, to interface between the main panel, expansion modules, and the Analytical Microprocessor-based Detectors and modules. No electronic loop controller shall be loaded to more than 50% of the maximum allowable number of devices which can be connected to the electronic loop.

D. Circuits:

1. Signaling Line Circuits: NFPA 72, Class A, Style 6.
2. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
3. Actuation of alarm notification appliances, emergency voice communications where provided, annunciation, elevator recall shall occur within 10 seconds after the activation of an initiating device.
4. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

E. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Sound general alarm if the alarm is verified.
4. Cancel FACP indication and system reset if the alarm is not verified.

F. Notification-Appliance Circuit: Operation shall sound in a temporal pattern, complying with ANSI S3.41 60 beats per minute, march-time pattern. All visual appliances shall be synchronized. Do not load any NAC more than 75% of its rated amperage.

G. Elevator Controls(when elevator and fire protection system is present): Heat detector operation shuts down elevator power by operating a shunt trip in a circuit breaker feeding the elevator.

H. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

I. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP and remote annunciators, after initiating devices are restored to normal.

1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.

2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.

3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

J. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

K. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and control of changes in those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and make a print-out of the final adjusted values on the system printer.

L. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, trouble, and supervisory signals to a remote alarm station through a digital alarm communicator transmitter

M. Voice/Alarm Signaling Service: A central emergency communication system with redundant preamplifiers, amplifiers, and tone generators provided as a special module that is part of the FACP.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.

a. Allow the application of and evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
b. Programmable tone and message sequence selection.
c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.

2. Notification-Appliance Circuits: NFPA 72, Class B.

3. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.

4. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

N. Service Modem: Port for connection to a dial-in terminal unit.

1. The dial-in port shall allow remote access to the FACP for programming changes and system diagnostic routines. Access by a remote terminal shall be by encrypted password algorithm.

O. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines and trouble signal shall be powered by the 24-V dc source.

1. The alarm current draw of the entire fire alarm system shall not exceed 80 percent of the power-supply module rating.

2. Power supply shall have a dedicated circuit breaker for this connection at the service entrance equipment. Paint the circuit breaker red and identify it with "FIRE ALARM SYSTEM POWER."

P. Secondary Power: 24-V dc supply system with batteries and automatic battery charger and an automatic transfer switch.

1. Batteries: Shall be capable of providing power to the system for a minimum of 24 hours.

2. Battery and Charger Capacity: Comply with NFPA 72.

Q. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories.

2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

R. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.3 Manual Fire Alarm Boxes

A. Description: UL 38 listed; finished in red with molded, raised-letter operating instructions in contrasting color. Station shall show visible indication of operation. Mounted on recessed outlet box; if indicated as surface mounted, provide manufacturer's surface back box. Mount 48" AFF to center of device.

1. Single-action mechanism requiring one actions to initiate an alarm, pull lever type. With integral addressable module, arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2. Station Reset: Key- or wrench-operated switch.

2.4 System Smoke Detectors

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring. Removal of the respective detector shall not affect electronic loop communications with other detectors on that loop.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type.

6. In the event of a loss of communications of the smoke detector with the Electronic Loop Controller, the smoke detector will automatically revert to the "Standalone Conventional" operation, and Fire Alarm / Life Safety system functions shall not be compromised.

7. Shall be capable of transmitting pre-alarm and alarm signals to the Fire Alarm Control Panel via the Electronic Loop Controller. It shall be possible to program Fire Alarm Control Panel activity and response to each of the following signal levels: Normal, Pre-Alarm, Alarm, Trouble, Detector need cleaning.

8. Shall contain an environmental compensation algorithm, which identifies and sets ambient "Environmental Thresholds" continually and periodically. In this manner, the environmental impact of temperature, humidity, environmental contaminates as well as detector aging shall be automatically monitored. This process shall employ digital compensation techniques to adapt the detector to both long term and short-term changes in the environment in which they are installed. The microprocessor shall monitor this environmental compensation value and alert the system operator when the detector 80% of the allowable environmental compensation value. Differential sensing algorithms shall maintain a constant differential between selected detector sensitivity and the derived base line sensitivity that the detector has sensed in its environment. The base line

sensitivity information shall be automatically and periodically updated and permanently stored in the detector.

9. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

    a. Rate-of-rise temperature characteristic shall be selectable at the FACP for 15 or 20 deg F (8 or 11 deg C) per minute.
    b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at the FACP to operate at 135 or 155 deg F (57 or 68 deg C).
    c. Provide a minimum of 5 levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.

2. Detector Sensitivity: Between 1.0 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Shall utilize addressable photoelectric smoke detectors arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2. Sensor: LED or infrared light source with matching silicon-cell receiver.

3. Detector Sensitivity: Between 1.0 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.

5. Duct Housing Enclosure: UL listed for use with the supplied detector.

6. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

7. Integral Visual-Indicating Light: LED type. Provide remote status and alarm indicator where detector is not visible from normal standing position.

8. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

9. Each sensor shall have multiple levels of detection sensitivity.

10. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.

11. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit. Shall be addressable.

2.5 Notification Appliances

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

B. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

C. Visible Alarm Devices

1. Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-(25-mm-) high letters on the lens.

2. Rated Light Output: 75 candela synchronized flash outputs. In rooms exceeding 30'X30', a 110 candela strobe shall be used to comply with visual coverage.

D. Voice/Tone Speakers

1. UL 1480 listed.
2. High-Range Units: ½ W to 15 W taps.
3. Low-Range Units: ¼ W to 4 W taps.
4. Mounting: Flush mounted; bidirectional as indicated.
5. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.6 Sprinkler System Remote Indicators

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.7 Addressable Interface Device

A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall and to a circuit-breaker shunt trip for power shutdown.

2.8 Digital Alarm Communicator Transmitter

A. Listed and labeled according to UL 632.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising 2 lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.9 Guards for Physical Protection

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

B. Factory fabricated and furnished by manufacturer of the device.

C. Finish: Paint of color to match the protected device.

2.10 Wire and Cable

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, unshielded or shielded (as recommended by manufacturer) pair, not less than No. 18 AWG. Color shall be red.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 14 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 Equipment Installation

A. Detector Mounting

1. Smooth ceiling spacing shall not exceed 30 feet.
2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
3. Spacing of heat detectors shall be determined based on guidelines and recommendations in NFPA 72.
4. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of the duct. Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
5. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

6. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

B. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

C. NAC Devices: Install 80” AFF to bottom of strobe lens if wall mounted. Ceiling mounted devices shall be coordinated with all other trades work.

1. FACP: Surface mount with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

3.2 Wiring Installation

A. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable. Minimum raceway size for all fire alarm circuits is ¾”.

B. Wiring Method

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess.

Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved pressure-type terminal blocks

D. Cable Taps: Not allowed.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

3.3 Identification

A. Identify system components, wiring, cabling, and terminals according to Division 16 Section “Basic Electrical Materials and Methods” & “Cable Identification.”

B. Install instructions frame in a location visible from the FACP.

C. Label power-supply circuit breaker "FIRE ALARM."

3.4 Grounding

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.

3.5 Adjusting

A. 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 outside normal occupancy hours for this purpose.

END OF SECTION 16731

SECTION 16900

WORK REQUIRED FOR EQUIPMENT FURNISHED BY OTHER DIVISIONS
03/2004

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Division-16 Basic Electrical Materials and Methods Sections apply to work of this Section.

C. Review all project drawings to be aware of conditions affecting work herein.

PART 2 - PRODUCTS

2.1 Materials for this section are specified in the Section "Basic Materials and Methods."

PART 3 - EXECUTION

3.1 Make connections for the electrical power to equipment furnished and installed in other Divisions.

3.2 Provide raceway boxes, fittings, devices and conductors for the electrical power to equipment furnished and installed in the other Divisions.

3.3 Coordinate wiring and conduit requirements with equipment being furnished prior to rough-in.

3.4 Verify voltage, phase, and current requirements for all equipment being supplied by other divisions. Any modifications shall be incorporated into the electrical submittals with references to any modification and reason. The electrical system is designed around the specified equipment. Any change in the equipment shall be coordinated so that proper electrical protection is obtained. In addition, if the supplied equipment has higher minimum circuit ampacity that the equipment specified, the contractor shall call the modification to the Engineer's attention and make necessary conduit, wire, circuit breaker and equipment changes to accommodate the higher ampacity requirements.

3.5 Any change from the specified equipment requirements shall be the responsibility of the contractor.

3.6 The electrical contractor shall meet with the Division 15 contractor and fully coordinate locations of mechanical equipment, duct work and piping to ensure that proper working clearance as required in the NEC is obtained. Any conflict shall be reported to the Engineer in writing prior to the installation of any of the equipment. Refer to additional requirements for planning drawings.

3.7 Coordinate exact locations and electrical rough-in requirements with other Divisions prior to installation to ensure proper clearances and code requirements are met.

END OF SECTION 16900

SECTION 17000 COMMUNICATIONS STRUCTURED CABLING SYSTEM

PART 1 – GENERAL

1.1 CONTRACTOR QUALIFICATIONS

The Structured Cabling System Contractor shall be an experienced firm regularly engaged in the layout and installation of structured cabling systems of similar size and complexity as required for this installation. The Structured Cabling System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than five Structured Cabling Systems of the scope of the largest system on this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Structured Cabling Systems contracting continuously since. The Structured Cabling System Contractor shall have an existing permanent office located within 100 miles of the job site from which installation and warranty service operations will be performed.

The Structured Cabling System Contractor shall be in good standing with the Structured Cabling System Manufacturer as a Molex Certified Installer. The Structured Cabling System Contractor shall complete the Structured Cabling System Manufacturer's Certified Installer training program. The Structured Cabling System Manufacturer shall require that not less than two permanent employees of the Structured Cabling System Contractor each complete the full certification program. Each Certified Installer shall attend re-certification classes every two years. The Structured Cabling System certified employees shall include not less than one designer and one installation supervisor. The Structured Cabling System Contractor shall present, with his bid, the names and credentials of the Molex certified installers who will be responsible for this project.

In addition, the Structured Cabling System Contractor shall present, with his bid, the name and certification number of a BICSI certified Registered Communications Distribution Designer (RCDD) who is a permanent employee of the Structured Cabling System Contractor. The Structured Cabling System Contractor shall maintain this RCDD, or another RCDD approved by the Architect/Engineer, in his permanent employment throughout this project. The RCDD shall have overall responsibility for certifying that the installed structured cabling system conforms to these contract documents and to the referenced EIA/TIA, IEEE, BICSI, and UL standards. Specific requirements for the RCDD are as follows:

1.1.1 The RCDD shall be, in the judgment of the Architect/Engineer, thoroughly experienced in the design, layout, and installation of structured cabling systems of similar size and complexity as required for this installation. The RCDD shall submit evidence of these qualifications to the Architect/Engineer upon request.

1.1.2 The RCDD shall affix his stamp to the Contractor's pre-installation submittal drawings, indicating that he has reviewed and approved the drawings for conformance to the contract documents and to the referenced codes and standards.

1.1.3 The RCDD shall periodically visit the site and inspect the work in progress. RCDD site visits shall be made not less than once per month when the job is in active progress. The RCDD shall prepare a field report for each site visit for submission to the Architect/Engineer.

1.1.4 The RCDD shall sign off on all copper and fiber optic cable test results, indicating that he was in responsible charge of all cable testing procedures and that all cables were tested in compliance

with the contract documents and met or exceeded the requirements stated therein.

1.1.5 The RCDD shall affix his stamp to the Contractor's as-built drawings, indicating that he has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.

1.1.6 The RCDD shall be present for and participate in not less than four hours of user training.

1.1.7 Contractor Qualifications – Television System Installation:

The Structured Cabling System Contractor shall assign a lead technician to oversee the installation of the Television (TV) System for this project. The TV System lead technician shall be thoroughly skilled and experienced in the installation and configuration of the TV components required for the project. The TV System lead technician shall attend the pre-construction conference, construction progress meetings as required, and all close-out and training meetings.

The TV System lead technician shall periodically visit the site and inspect the work in progress. Lead technician site visits shall be made not less than once per month when the job is in active progress. The TV System lead technician shall prepare a field report for each site visit for submission to the Engineer.

The TV System lead technician shall sign off on all cable and system test results.

The TV System lead technician shall be present for and participate in not less than four hours of user training.

1.1.8 Contractor Qualifications – Conduit Installation:

All conduit and related work shall be provided by a licensed electrical contractor using tradesmen who are skilled and experienced in the types of conduit installations indicated in the bid documents.

1.1.9 Definitions

CM - Construction Manager
DB - Design Build Contractor
GC - General Contractor

Where the three terms CM, DB, and GC are used in the specifications and TEL drawings they are used interchangeably. The Contractor shall understand the terms to mean the construction entity in overall charge of the project, whether a CM, DB or GC.

1.2 PROOF OF CONTRACTOR QUALIFICATIONS

The Structured Cabling System Contractor shall provide the following documentation, to be presented with his bid, as evidence that the requirements for Structured Cabling System Contractor qualifications listed above are satisfied. All work under this section shall be performed by permanent employees of the Structured Cabling System Contractor listed on the bid form, and shall not be performed by another subcontractor, employees of another company, or by temporary employees. The only exception to this requirement shall be for conduit work, which may be

performed by an electrical contractor meeting the minimum requirements of paragraph 1.1.8.

1.2.1 Provide a list of not less than five (5) references for jobs of similar size and complexity including project name, location, contact person and phone number.

1.2.2 Provide RCDD name, BICSI certification number, and qualifications.

1.2.3 Provide location of existing permanent office from which installation and warranty work will be performed.

1.2.4 Provide copies of certificates issued by Structured Cabling System Manufacturer proving that the Structured Cabling System Contractor is in good standing with the manufacturer as a Certified Installer, and that the Structured Cabling System Contractor can offer the Owner a 20 year system warranty in partnership with the Structured Cabling System Manufacturer.

1.3 RELATED REQUIREMENTS

Drawings and general provisions of Contract apply to this section.

Electrical Specification Sections regarding conduit and raceway apply to work under this section, with the additions and modifications specified herein and on the communications drawings. The special requirements indicated on the communications drawings and in this specification section for structured cabling system conduit and all cable pathways shall take precedence over any requirements specified in Electrical Specification Sections.

Refer to Section 17300 – Intercom/PA System
Refer to Section 17400 – Audio-Visual Systems

1.4 DESCRIPTION OF WORK

The work consists of all labor, materials, equipment and services necessary to provide, install, test and certify all systems as described in the contract documents. The Structured Cabling System Contractor shall provide systems complete and ready for operation. The installation shall include all accessories and appurtenances required to provide a complete and operational system. Any materials not specifically mentioned in these specifications or not shown on the drawings, but required for a complete and finished installation shall be furnished and installed at no additional cost to the Owner.

1.4.1 Scheduling:

The Structured Cabling System Contractor shall become thoroughly familiar with the overall project schedule, and shall complete his work and make all systems fully operational prior to the date of occupancy of the facilities by the Owner.

The Structured Cabling System Contractor shall coordinate all work with the General Contractor and the Electrical Contractor, as well as all other trades.

The Structured Cabling System Contractor shall be responsible for coordinating all work related to cable pathways indicated on the communications drawings, even if that work is being performed by the project electrical contractor. The Structured Cabling System Contractor shall inform the

General Contractor if:

1) The conduit work is not being completed in accordance with the requirements indicated on the communications drawings and this specification.

2) The conduit work is not being completed in such a manner that will allow the Structured Cabling System Contractor to complete his work in a timely manner in accordance with the project schedule and this section

The Structured Cabling System Contractor shall provide adequate training of the Owner's forces prior to the date of occupancy, and shall provide follow-up training after occupancy. Total training time shall be as prescribed by this specification is considered a minimum requirement.

1.5 EXAMINATION OF SITES AND TOTAL SYSTEM RESPONSIBILITY

Prior to providing a proposal for this work, the Contractor shall visit the proposed site of work to become familiar with any condition that may affect the work to be performed in any way. No allowances shall be made because of lack of knowledge of these conditions.

The Contractor shall have total system responsibility to assure a fully operational system. Any additional labor and components required for the installation of complete operating systems but not specifically required by the bid documents shall be provided and the cost borne by the Contractor.

The Contractor shall remain the sole owner of the system and all of its components provided under this contract and is responsible for all risk of loss or damage of the system for the entire contract period up to and including the date and time of Final Acceptance by the Architect/Engineer and the Owner's Project Manager. After the date of Final Acceptance, the Owner shall assume full ownership of the system with all components, and the warranty period shall commence.

1.6 QUALITY ASSURANCE

Materials shall be new and shall be the best of their respective kinds. All work shall be accomplished in a workmanlike manner in keeping with the best practices and highest standards of the telecommunications industry.

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Architect/Engineer and the Owner.

1.7 CODES AND STANDARDS

All work done under this contract shall be performed in accordance with the most recent issue of the following codes, standards and guidelines. Where there is a perceived conflict between a standard or guideline and the contract documents, the Contractor shall perform the work as directed by the Architect/Engineer.

NFPA 70	National Electrical Code - 2008 Edition
NFPA 90A	Standard for the installation of Air-Conditioning and Ventilating Systems – 2009 edition
NFPA 101	Life Safety Code - 2009 Edition
FBC	Florida Building Code – 2007 Edition with the 2009 Supplement Florida Fire Prevention Code 2007 Edition
TIA/EIA	Telecommunications Industry Association/Electronic Industries Association
TIA/EIA 568-C.O	Generic Telecommunications Cabling for Customer Premises – 2009
TIA/EIA 568-C.1	Commercial Building Telecommunications Cabling Standard - 2009
TIA/EIA 568-C.2	Balanced Twisted-Pair Telecommunications Cabling and Components Standard – 2009
TIA/EIA 568-C.3	Optical Fiber Cabling Components Standard - 2008
TIA/EIA 569-B	Commercial Building Standard for Telecommunications Pathways and Spaces - 2004
TIA/EIA 598-B	Optical Fiber Cable Color Coding - 2001
TIA/EIA 606-A	Administration Standard for Commercial Telecommunications Infrastructure - 2002
ANSI-J-STD 607-A	Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications - 2002
TIA/EIA 758-A	Customer-Owned Outside Plant Telecommunications Cabling Standard – 2004

IEEE Institute of Electrical and Electronics Engineers

IEEE 802-2001, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture

IEEE LAN/MAN Bridging & Management (802.1)

IEEE 802.1f-1993, IEEE Standard for Local and Metropolitan Area Networks: Common Definitions and Procedures for IEEE 802 Management Information

IEEE 802.1h, 1997 Edition (R2001) (ISO/IEC TR11802-5: 1997), IEEE Technical Report and Guidelines--Part 5: Media Access Control (MAC) Bridging of Ethernet V2.0 in Local Area Networks

IEEE 802.1b, 1995 Edition (ISO/IEC 15802-2-1995), IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 2: LAN/MAN Management

IEEE 802.1d, 1998 Edition (ISO/IEC 15802-3:1998, IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Media access control (MAC) Bridges

IEEE 802.1t-2001, Amendment to IEEE Std 802.1D, 1998 Edition IEEE Standard for Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Common specifications--Part 3: Media Access Control (MAC) Bridges: Technical and Editorial Corrections

IEEE 802.1w-2001, IEEE Standard for Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Common specifications Part 3: Media Access Control (MAC) Bridges--Amendment 2--Rapid Reconfiguration [Amendment to IEEE Std 802.1D, 1998 Edition (ISO/IEC 15802-3:1998) and IEEE Std 802.1t-2001]

IEEE 802.1e, 1994 Edition, IEEE Standard for Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 4: System Load Protocol

IEEE 802.1g, 1998 Edition, Information technology--Telecommunications and information exchange between systems--IEEE standard for local and metropolitan area networks--Common specifications--Part 5: Remote Media Access Control (MAC) bridging

IEEE 802.1q-1998, IEEE standard for local and metropolitan area networks: Virtual Bridged Local Area Networks

P802.1s/D13, Draft IEEE Standard for Local and Metropolitan Area Networks--Amendment 3 to IEEE 802.1q Virtual Bridged Local Area Networks: Multiple Spanning Trees

IEEE 802.1u-2001, (Amendment to IEEE Std 802.1q, 1998 Edition) IEEE Standard for Local and metropolitan area networks--Virtual Bridged Local Area Networks--Amendment 1: Technical and editorial corrections

IEEE 802.1v-2001, (Amendment to IEEE Std 802.1q, 1998 Edition) IEEE Standards Amendment to IEEE 802.1q: IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks--Amendment 2: VLAN Classification by Protocol and Port

IEEE 802.1x2001 IEEE Standards for Local and Metropolitan Area Networks: Port-Based Network Access Control

IEEE CSMA/CD Access Method (802.3)

IEEE 802.3-2002® IEEE Standard for Information technology--Telecommunications and information exchange between systems-Local and metropolitan area networks--Specific requirements -Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications. Incorporates the IEEE 802.3z Standard for 1000BASE-X Gigabit Ethernet over fiber optic cabling and the IEEE 802.3ab Standard for 1000BASE-T Gigabit Ethernet over copper UTP cabling.

IEEE 802.3ae-2002 (standard ratified June 2002)
Supplement to IEEE 802.3 CSMA/CD Access Method & Physical Layer Specifications - Media Access Control (MAC) Parameters, Physical Layer, and Management Parameters for 10Gb/s Operation

IEEE 802.3at Amendment: Data Terminal Equipment (DTE) Power Via the Media Dependent Interface (MDI) Enhancements (PoE Plus)

IEEE Wireless LANs (802.11)

IEEE Std 802.11, 1999 Edition, IEEE Standard for Information Technology - Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Network - Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

IEEE 802.11a-1999, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications—Amendment 1: High-speed Physical Layer in the 5 GHz band (An errata is available)

IEEE 802.11b-1999 Supplement to 802.11-1999,Wireless LAN MAC and PHY specifications: Higher speed Physical Layer (PHY) extension in the 2.4 GHz band

IEEE 802.11d-2001, Amendment to IEEE 802.11-1999, (ISO/IEC 8802-11) Information technology--Telecommunications and information exchange between systems--Local and metropolitan area networks--Specific requirements--Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Specification for Operation in Additional Regulatory Domains

IEEE 802.n-2009, Amendment 5 to IEEE 802.11-1999, Enhancements for Higher Throughput

BICSI	Building Industry Consulting Service International
	Telecommunications Distribution Methods Manual (TDMM) Latest Edition
	Network Design Reference Manual (NDRM) Latest Edition
	Outside Plant Design Reference Manual (OSPDRM) – Latest Edition
	Telecommunications Cabling Installation Manual (TCIM) Latest Edition
AT&T	"Outside Plant Engineering Handbook"
SCTE	Society of Cable Television Engineers

All materials and equipment shall be UL listed for the intended application.

1.8 PRE-INSTALLATION SUBMITTALS

1.8.1 Manufacturer's Catalog Data:

Submit five (5) copies of manufacturer's standard descriptive data sheets to the Architect/Engineer for review and approval prior to commencing work. Furnish complete data sheets bearing the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The following items shall be submitted:

1. Conduit and Pull Boxes, Fittings, Related Hardware & Accessories, each type
2. Surface Raceway, each type with all fittings
3. Floor Boxes, each type
4. Cable Runway, Fittings, Related Hardware & Accessories, each type
5. Racks, Related Hardware & Accessories, each type
6. Enclosures and Cabinets, each type
7. Copper Patch Panels, each type
8. Copper Wiring/Patch Blocks, each type
9. Fiber Optic Patch Panels, each type
10. Multi-pair Voice Cable, each type
11. Voice Protector Blocks, each type
12. Voice Surge Protectors, 66 block mounted, each type
13. Fiber Optic Cable, each type
14. Category 6 UTP Cable, each type
15. Cable End Connectors, each type
16. Patch Cables - Copper and Fiber Optic, each type
17. Patch Cord Organizers and Cable Rings, each type
18. Wire Management Devices, each type
19. Communications Outlets (CO), each type
20. Special Purpose Outlets, each type
21. RG11 Coaxial Cable, each type
22. RG6 Coaxial Cable, each type

23. TV Splitters, Taps, Attenuators and Equalizers, each type
24. TV Outlets and Device Plates
25. Coaxial Cable Connectors, each type
26. TV Jumpers
27. TV Amplifiers, each type
28. TV Surge Suppressors, each type
29. Power Surge Protectors
30. Uninterruptible Power Supplies (UPS), each type
31. Grounding Busbars and Lugs, each type
32. Firestopping Systems, each type
33. Labeling Products, each type
34. All other materials and equipment indicated to be furnished under this section, whether specifically listed here or not.

1.8.2 Pre-Installation Drawings:

As part of the Structured Cabling System installation, the Contractor shall provide detailed documentation to facilitate system administration, maintenance, and future moves, adds and changes. Drawings shall be provided which incorporate all information in the Contract Drawings, and which fully document any and all Architect/Engineer approved changes in materials and methods made by the Contractor. Drawings are not required if no changes to the design are made by the Contractor. Changes to the design shall not be made without the prior written approval of the Architect/Engineer. Drawings shall provide the same level of detail as the bid documents. *Electronic files of the Architect/Engineer's AutoCAD drawings will not be provided to the Contractor*.

Drawings shall be prepared using AutoCAD Release 14 and shall be furnished in hard-copy format and on industry standard CD or ZIP drive media.

Submit five (5) copies of pre-installation drawings to the Architect/Engineer for review and approval prior to commencing work.

1.9 CONTRACTOR'S RECORD DOCUMENTS

The Structured Cabling System Contractor shall maintain a full set of contract documents at the job site at all times, consisting of specifications, drawings, addenda, pre-installation submittals, change orders, and change directives. The record documents shall be updated by the Contractor, in red pen and on a daily basis, to show the following:

1. Final location of all Communications Outlets and TV Outlets.
2. Final conduit routing.
3. Location of all buried utilities encountered during the course of work on this project.
4. Final location of all handholes, pull boxes, and access doors.
5. Any changes to the work authorized by the Architect/Engineer.
6. Any other pertinent information that may be of value to the Owner in operating and maintaining the system.

The Contractor's record documents shall be available for viewing by the Architect/Engineer or the Owner at the site at any time, and shall be presented and reviewed by the Contractor at each construction progress meeting. The record documents shall be clearly marked "Record Set", shall

be kept in a protected location, and shall not be used for general construction purposes. The record documents shall be provided to the Architect/Engineer at the close of the project.

The Architect/Engineer will provide a full set of Adobe Acrobat *.PDF format drawings to the Contractor. The Contractor shall be required to annotate (redline) the Adobe Acrobat *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the Adobe Acrobat *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Architect/Engineer. The Contractor shall also provide 11”x17” laser prints of Adobe Acrobat *.PDF drawings in each O&M Manual.

PART 2 - PRODUCTS

2.1 GENERAL

All materials, equipment, and devices shall be new and unused, of current manufacture and of the highest grade, free from defects.

All products shall be the manufacturer and model or part number specified. Where a model or part number is indicated in error for any reason, the Contractor shall verify the intent of the Architect/Engineer prior to providing a proposal, and shall provide the product intended by the Architect/Engineer. Where a manufacturer has updated or improved a product subsequent to issuance of the bid documents by the Architect/Engineer, the Contractor shall provide the updated or improved product at no additional cost to the Owner

Provide new equipment and materials only. Each component shall be the most recent model number, revision, or update offered by the manufacturer at the time of purchase by the Contractor. Newly manufactured containing used or rebuilt parts, remanufactured, rebuilt, reconditioned, used, shopworn, demonstrator or prototype equipment is not acceptable and will be rejected. Each major component of telephone and data systems equipment provided under this contract shall include a certification from the manufacturer stating that the equipment is new and referencing the serial number of the delivered equipment. The Contractor shall track the placement of each major component in the field, and shall provide the Owner a list identifying each component by manufacturer, model number, serial number, and installed location (example rack number and rack position).

All materials, equipment and devices shall meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70.

All like items of material or equipment shall be the same product of the same manufacturer, model number and production series.

All materials and equipment shall be a standard catalogued product of a manufacturer regularly engaged in the manufacture of similar products.

2.2 PRODUCT SPECIFICATIONS

See drawings for all product requirements not indicated in these specifications. The Structured Cabling Contractor shall be responsible for providing and installing all components indicated in these specifications and on the drawings, unless specifically indicated to be provided by others.

2.2.1 Structured Cabling System:

Provide all system components as indicated the drawings. To insure a uniform basis for bidding, and to standardize the Owner's facilities, base all bids on the particular systems, equipment and materials specified.

2.2.2 Data Equipment:

See drawings for data cabling system specifications and equipment mounting requirements.

See drawings for data cabling system specifications and equipment mounting requirements. Data equipment will be Owner Furnished Contractor Installed (OFCI) as indicated on the drawings, unless specifically indicated otherwise.

2.2.3 Telephone System:

See drawings for telephone cabling system specifications.

The existing Telephone System headend equipment will be expanded and all telephone handsets provided by others (the Telephone System Provider) under separate contract with the Owner.

2.2.4 Television System:

See drawings for TV system cabling specifications.

2.2.5 intercom/PA System – see Section 17300.

2.2.6 Audio-Visual Systems:

Coordinate all work with the A/V System Provider.

PART 3 - EXECUTION

3.1 GENERAL

The installation shall be in strict accordance with all applicable codes and standards, the respective manufacturer's written recommendations, and the contract drawings and these specifications.

Workmanship shall be of the highest grade in accordance with the best modern practice and the highest standards of the telecommunications industry.

The installed system shall be neat, clean, and well organized in appearance. Provide working clearances for normal system operation, reconfiguration and repair.

The completed installation shall meet with the approval of the Owner's Project Manager and the Architect/Engineer.

The General Contractor and the Structured Cabling System Contractor shall share full responsibility for protecting all communications outlets, all television outlets, the CER and all

structured cabling system components from dust and debris during construction and until final completion of the project. The SCS shall not install racks, wire managers, patch panels, protector blocks, 66 blocks, or dress out and terminate cables until paint, backboards and tile floors in the CER are completely finished and those rooms are completely isolated from dust infiltration with plastic sheeting and duct tape. All COs and television jacks and plates shall be protected by bagging and sealing dust tight at all times after connectivity devices are installed. All system components that, in the sole judgment of the Engineer, are exposed to excessive accumulation of construction dust/debris at any stage of the project shall be removed and replaced with new components at no additional cost to the Owner. It is recommended that lay-in ceiling grids in the CER be installed after conduits and cable trays and cable runways have been installed to allow the ceiling installer to trim around conduits. Lay-in ceiling tiles in these areas should follow completion of cable dressing into racks.

3.1.1 Delivery:

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition in original factory sealed cartons, and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for receiving and storing of all equipment and materials, and shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Architect/Engineer and the Owner.

3.1.2 Data Equipment:

Provide a system of data cabling as indicated on the drawings.

Data equipment will be Owner Furnished Contractor Installed (OFCI) as indicated on the drawings. The Structured Cabling System Contractor shall be responsible for mounting the equipment in the racks, connecting power to a rack power strip and providing all patching and documentation of patching in an Excel spreadsheet as specified under paragraph 3.3. All equipment configuration shall be provided by the Owner.

Power Cords: The Structured Cabling System Contractor shall provide factory made electrical power extension cords as required to extend power connections from all Owner Furnished data equipment to rack power strips. Cords shall route from equipment, up racks attached to standoff brackets as indicated on drawings, and over in cable runway to rack power strips. The Structured Cabling System Contractor shall also all provide factory made electrical power extension cords as required to extend cords from all rack power strips to a rack mounted UPS or to a wall mount 120VAC power outlet as directed by the Owner in the field. Power extension cords shall be black, 20 amp capacity (or heavier if required by the equipment served), heavy duty insulation, length as required to make each connection, properly routed and secured at 12 inches on center, with only one cord allowed per connection, and without excess cord storage.

3.1.3 Telephone System:

Provide a system of telephone premises cabling as indicated on the drawings.

Provide and install patch cords to interconnect telephone system circuits to horizontal wiring connections as specified herein and as indicated on the drawings. Provide cross-connects between

the telephone service provider (example AT&T) connections and horizontal wiring connections to enable special circuits indicated on the drawings.

Coordinate all work with the Owner, the telephone service provider, and the Telephone System Provider.

3.1.4 Television System:

Provide a system of TV cabling as indicated on the drawings. The installed system shall comply with all standards set forth in F.C.C. Rules, Part 76.

See drawings for specific requirements.

Coordinate all work with the Owner and the CATV service provider.

3.1.5 Audio-Visual Systems:

Coordinate all work with the A/V System Provider.

3.1.6 intercom/PA System – see Section 17300. All Intercom/PA conduit shall be run continuously in conduit – see PA drawings for specific requirements.

3.1.7 Conduit Installation:

All horizontal and backbone cabling shall be run continuously in conduit. Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables. Rack conduits and run together wherever possible. Homerun conduits for horizontal cables shall be homerunned individually from each outlet and security camera as indicated on the drawings – homerun conduits shall not be combined to serve more than one outlet or security camera.

All conduit shall be installed by a licensed electrical contractor using tradesmen who are skilled and experienced in the types of conduit installations indicated in the bid documents.

Conduit shall be installed with top-grade workmanship, using factory bends or field bends made with the proper tools. Kinked, dented or otherwise improperly constructed bends will not be accepted. All bends shall have a minimum radius of six times the internal conduit diameter.

All conduit shall be routed parallel and perpendicular to building lines, up high and over piping, ductwork, conduit and other utilities. Conduit in exposed locations shall be run as high as possible, hard against the underside of wall, floor, roof or walkway structures at all times, secured with heavy duty galvanized two-hole supports, and otherwise installed to prevent damage from pulling, hanging, etc. Refer to drawings for specific prohibitions against running exposed conduit in areas with exposed roof structure or architectural ceiling features.

Install plastic insulating bushings on the ends of all indoor conduits prior to installing cables. Provide conduit end fitting with threaded end and threaded plastic insulating bushing.

All threaded conduit joints shall be made watertight. The ends of all conduit runs shall be plugged or capped, immediately after installation, with approved standard factory made plugs or caps to

prevent seepage of grout, water or dirt into them. Any conduit section having a defective joint shall not be installed.

All buried conduit shall be Schedule 80 electrical grade PVC conduit. All PVC conduit joints shall be cleaned and glued for a watertight connection. Terminate ends of PVC conduits ending at ground floor closets and at handholes with end bells. Seal ends of conduits terminating at ground floor closets after cables are installed to prevent water intrusion into the building.

Firestop all conduit penetrations of all floors and all conduit penetrations of all walls that extend to the underside of the floor or roof deck above. Accomplish firestopping using UL classified systems with fire rating equal to or greater than the fire rating of the floor or wall assembly penetrated. Firestop systems shall be 3M, Nelson or Architect/Engineer approved equal. Install in strict accordance with the manufacturer's printed instructions and the conditions of the UL approval for each firestop system used.

All other penetrations or openings in walls that do not extend to the underside of the floor or roof deck above shall be repaired and sealed with materials to match the wall construction.

Underground Conduit Validation:

Following installation of underground conduits, perform the following operation for each conduit:

Clean, lubricate and validate each installed conduit for serviceability by running a full size rubber duct swab through the conduit from end to end. Conduits that are obstructed may be cleaned using a wire brush mandrel, then revalidated with the full size rubber duct swab. Conduits that do not allow passage of the full size rubber duct swab shall be replaced.

Pull Tapes: As backbone cabling runs are installed, provide a continuous marked pull tape (Carlon TL3821800 lb. tensile strength) for the full length of the end-to-end cable run with 10 feet of slack at each end pulled in alongside cabling. Bundle slack neatly at each end and tie off to conduit support strut at each end. Provide continuous factory uncut lengths of pull tape from end-to-end - under no circumstances shall pull partial length section of pull tape be tied together.

Spare Conduits: For conduits that are indicated as spare, install a continuous marked pull tape (Carlon TL382 1800 lb. tensile strength) for the full length of the end-to-end conduit run with 10 feet of slack at each end, tie each end of the tape to a blank duct plug with rope tie tab, push slack tape back into conduit, and install a duct plug in each conduit end for a watertight seal.

The Contractor, in providing a bid for the system in accordance with the contract documents, agrees to install all cabling in the conduit and wireway paths indicated in the contract documents, or to provide larger conduit and wireway paths as he deems necessary, at no additional cost to the Owner. The Contractor shall be fully responsible for any and all damage to cabling that may occur during the installation, and shall replace any damaged cabling with new cabling of the type specified for the application.

3.1.8 Cabling Installation:

All horizontal and backbone cabling shall be run continuously in conduit. Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables. Rack conduits and run

together wherever possible. Homerun conduits for horizontal cables shall be homerunned individually from each communications outlet, TV outlet and security camera as indicated on the drawings – homerun conduits shall not be combined to serve more than one outlet or security camera. See Intercom/PA drawings for specific conduit requirements for speakers.

Firestop all cable penetrations of all floors and all cable penetrations of all walls that extend to the underside of the floor or roof deck above. Accomplish firestopping using UL classified systems with fire rating equal to or greater than the fire rating of the floor or wall assembly penetrated. Firestop systems shall be 3M, Nelson or Architect/Engineer approved equal. Install in strict accordance with the manufacturer's printed instructions and the conditions of the UL approval for each firestop system used.

All other penetrations or openings in walls that do not extend to the underside of the floor or roof deck above shall be repaired and sealed with materials to match the wall construction.

The Contractor, in providing a bid for the system in accordance with the contract documents, agrees to install all cabling in the conduit and wireway paths indicated in the contract documents, or to provide larger conduit and wireway paths as he deems necessary, at no additional cost to the Owner. The Contractor shall be fully responsible for any and all damage to cabling that may occur during the installation, and shall replace any damaged cabling with new cabling of the type specified for the application.

Provide wire management devices on backboards and racks as indicated and as required to facilitate organized routing of cables and patch cords. Bundle cables together behind racks and fan out to points of termination. The finished installation shall meet the approval of the Architect/Engineer for overall quality and neatness of appearance.

3.1.9 Identification and Labeling:

The Structured Cabling System Contractor shall purchase and use specific purpose professional labeling software and labeling products to generate all labels for this project, with the exception of engraved plastic tags and laminated paper tags, which shall be fabricated as indicated on the drawings, and elsewhere as indicated below. The Contractor shall determine the proper labeling product for each application and include a list of each product and application with the Pre-Installation Submittals.

All labels shall be produced using a laser printer and shall be clear and easily readable. Minimum text size shall be 12 point. Text font shall be ARIAL or ARIAL NARROW. Handwritten labels are not acceptable.

Label each horizontal cable and backbone cable using self-adhesive self-laminating polyester wrap-around labels with laser printed text as follows:

Label each Horizontal Category 6 and Coaxial TV cable at each end. Label text shall be based on the nomenclature indicated on the drawings.

Label each Communications Outlet using non-adhesive card labels with laser printed text. Insert labels under outlet manufacturer’s plastic label covers centered and straight. Label text shall be based on the Communication Outlet Identification Nomenclature and labeling details indicated on the drawings.

Label each Category 6 Horizontal Patch Panel port using non-adhesive or self-adhesive labels with laser printed text. The Contractor shall first attach the adhesive labels to the perforated paper labels supplied by the patch panel manufacturer, then insert the paper labels into the plastic covered icon-label holders supplied by the patch panel manufacturer. Label text for each patch panel port shall be based on the Horizontal Patch Panel Labeling Nomenclature and labeling details indicated on the drawings.

Label each Communications Panel, Rack, Enclosure/Cabinet, Voice Protector Block, Voice Backbone Patch Panel and other devices as indicated on the drawings.

Provide data sheets describing all proposed labeling products with Pre-installation Submittals.

3.2 CABLE TESTING

3.2.1 General:

Prior to installation of cabling, visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Return visibly damages goods to the supplier and replace with new.

If post-manufacture performance data has been supplied by the manufacturer of cables or connecting hardware, copies of such data are to be kept for inclusion in the Documentation and made available to the Owner upon request.

After cabling installation and labeling is complete, but prior to the installation of patch cords, the Contractor shall test all cables. *As part of cable test procedures verify all labeling and correct all inaccurate labeling*.

The Contractor's RCDD shall be in responsible charge of all cable testing procedures and shall provide an original signed letter in each project Operation & Maintenance (O&M) manual certifying that all cables have been tested in compliance with the contract documents and have met or exceeded the requirements stated therein.

Tests shall be performed in strict accordance with the test instrument manufacturer's printed instructions.

One hundred percent of all cables shall be tested.

Technicians performing testing shall be thoroughly trained in the use of the test instruments employed. Factory certification of technicians is mandatory. The Contractor shall provide evidence of training and copies of certificates to the Architect/Engineer.

The Contractor is responsible for supplying all test equipment and related materials required to test the entire Structured Cabling System. Test instruments shall be calibrated and traceable to the National Institute of Standards (NIST). Test instruments shall have been recently calibrated. The Contractor shall provide evidence of test instrument calibration if requested by the Architect/Engineer.

The requirement for this project is full compliance/zero tolerance. Cables that do not comply with

the stated standards shall be removed and replaced with new. Partial use of cables by claiming good pairs or strands and abandoning others is not allowable. Defective cables shall be removed and replaced with new.

Notify the Owner in writing not less than five days prior to commencing cable testing. The Owner may elect to be present for and witness cable testing.

The Contractor shall be required to retest installed cables in the Owner's presence to verify the Contractor's test documentation. The percentage of cables to be retested shall be determined by the Owner based on compliance of the installation with the contract documents, quality of workmanship, and results of initial cable tests. Retesting shall be performed as required until all cables, in the judgment of the Owner, comply with the requirements of the contract documents.

3.2.2 Cable Test Results:

All cable test results shall be provided as part of the project Installation and Maintenance (O&M) Manuals.

3.2.3 Category 6 UTP Cable Testing:

Testers:

Each Category 6 cable shall be tested with Fluke Networks DSP-4300 Digital Cable Analyzers utilizing Fluke Networks DSP-LIA101 Universal Permanent Link Interface Adapters and the appropriate Personality Modules. In addition, each tester shall be calibrated prior to commencing testing for this project using a Fluke Networks DSP-PLCAL Universal Permanent Link Calibration Kit and Fluke Networks ‘Cable Manager’ software.

Prior to testing, electronically update tester software using the tester manufacturer’s ‘Cable Manager’ software update utility. Update to the software version current at time tests are performed. Under no circumstances shall a tester with outdated software be used.

General:

Testing shall be of the Permanent Link. However, the Structured Cabling System Contractor and the Structured Cabling System Manufacturer shall warrant performance based on Channel performance and provide shall patch cords that meet Channel performance requirements.

All test results shall be maintained in the native file format of the tester manufacturer’s ‘Cable Manager’ software. Under no circumstances shall be data be modified by other software, edited in any manner, or exported to a database, spreadsheet, work processor program or any other type of program that would allow access to the data for modification. Hardcopy printouts of test reports in Summary Format shall be generated directly from the ‘Cable Manager’ software. Detailed test results in Text Format shall be provided to the Owner in native ‘Cable Manager’ data format on a CD. In addition, detailed test results in Text Format shall be provided to the Owner in Adobe Acrobat *.PDF format on a CD. CDs shall be included in the project Operation and Maintenance (O&M) manuals.

Record all test conditions and setup parameters and include in a typed discussion to be provided with test documentation.

Verify correct labeling of patch panels and communications outlets prior to and during testing. If any label is found to be in error, correct before proceeding with testing. Circuit Identification (cable I.D.) in cable test reports shall be exactly the same as the outlet labeling based on the nomenclature indicated on the drawings.

Testing:

After installation, termination and labeling of the Category 6 UTP cable is complete and approved by the Structured Cabling System Contractor's RCDD, test each cable in accordance with all applicable TIA/EIA standards for UTP Category 6, and complete all operations required for a Factory Certified Cabling System and 20 year Factory System Warranty.

Prior to testing, electronically update tester software using the tester manufacturer's 'Cable Manager' software update utility. Update to the software version current at time tests are performed. Under no circumstances shall a tester with outdated software be used.

Test each cable to verify compliance with TIA/EIA specifications for Category 6 UTP, Permanent Link configuration, Level III accuracy, with no allowable deviation. Test at the full range of frequencies indicated by TIA/EIA up to and including 250 MHz.

Test using the tester manufacturer's standard TIA/EIA Category 6 Autotest. Under no circumstances shall a Custom Cable Autotest designed by the tester manufacturer specifically for a given cable manufacturer or structured cabling system manufacturer be used to test cables. All tests and testing procedures for this project shall be strictly based on TIA/EIA standards. Enter the proper Nominal Velocity of Propagation (NVP) for the specific cable(s) installed. Test for the following parameters:

1. Wire Map – verify no shorts, opens, miswires, split, reversed or crossed pairs, and end-to-end connectivity is achieved.
2. Cable Length
3. Insertion Loss (attenuation)
4. NEXT Loss
5. PSNEXT Loss
6. ELFEXT Loss
7. PSELFEXT Loss
8. Return Loss
9. ACR
10. PSACR
11. Propagation Delay
12. Delay Skew

Documentation:

Test documentation for Category 6 cabling shall include the following:

1. An introductory discussion documenting each test instrument used, the Autotest routine used on each test instrument, qualifications of operators, test conditions, setup parameters, and any other pertinent information.

2. A summary hardcopy printout for all cables using the tester manufacturer's standard 'Cable Manager' software to produce an "AutoTest Summary" report. The summary report shall include Project Name, Circuit I.D., Result (pass or fail) and the cable length. The report shall be printed directly out of the 'Cable Manager' program in native format and in *.PDF format – under no circumstances shall the data be exported to any other type of program at any time.

3. A full-page text only detailed test result for each cable using the tester manufacturer's standard 'Cable Manager' software to produce an "AutoTest Report". Each report shall be printed directly out of the 'Cable Manager' program in native format and in *.PDF format - under no circumstances shall the data be exported to any other type of program at any time. Each report shall include the following components:

   - Tester manufacturer, model, serial number, hardware version, and software version
   - Project Name
   - Operator Name
   - Cable manufacturer, cable part number/type and NVP
   - Circuit I.D.
   - Autotest specification used (must be standard TIA Category 6 autotest)
   - Identification of the tester interface used
   - Overall pass/fail indication
   - Date of Test
   - Wire Map
   - Cable Length in feet
   - Insertion Loss (attenuation)
   - NEXT Loss*
   - PSNEXT Loss*
   - ELFEXT Loss*
   - PSELFEXT Loss*
   - Return Loss*
   - ACR*
   - PSACR*
   - Propagation Delay
   - Delay Skew

   * Measure from both ends of each cable

5. A PASS or FAIL result for each parameter shall be determined by comparing the measured values with the specified test limits for that parameter. The test result for each parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer shall provide documentation as an aid to interpret results marked with asterisks.

   Each individual test that fails the relevant performance specifications shall be marked as FAIL or FAIL*. Any FAIL or FAIL* result yields a FAIL rating for the link-under-test. In order to achieve an overall PASS rating, the results for each individual test parameter must yield a PASS or PASS* result.

6. Cable identities (Circuit IDs) shall be based on the labeling nomenclature described on the drawings.

7. Transfer of Software to Owner: Provide tester manufacturer's 'Cable Manager' software, latest version, to the Owner for the Owner's use in viewing and managing test results.

8. Provide all Category 6 cable test documentation in the project O&M Manuals.

Category 6 Cable Performance Criteria:

If the test results for a given cable or cables, in the sole judgment of the Architect/Engineer, fail to confirm acceptable performance, the Contractor shall reconnectorize or replace with new the affected cables as required to achieve specified performance levels as demonstrated by retesting.

3.2.4 Fiber Optic Cable Testing:

General:

Clean all fiber optic connectors, sleeves and test cords prior to testing. Follow all other recommendations of the test instrument manufacturer for cable and instrument preparation.

Record all test conditions and setup parameters and include in a typed discussion to be provided with test documentation.

On-the-Reel-Testing:

Before commencing the installation and with the cable on the reel, test at least one fiber strand on each cable reel to verify that the cable is undamaged. Record and print test results for future reference.

Post-Installation Testing:

After installation, termination and labeling of fiber optic cable is complete and approved by the Structured Cabling System Contractor's RCDD, test each strand of fiber to verify that the installed cable meets the performance requirements described below. Test in accordance with TIA/EIA-568-B with the additional (and more stringent) requirements following:

Test fiber using the Fluke Networks DSP-4300 Digital Cable Analyzers specified for Category 6 UTP cable in combination with Fluke Networks DSP-FTA440S Gigabit Multimode Fiber Test Adapters. The DSP-FTA440S Fiber Test Adapter uses a VCSEL source at 850nm and a FP Laser light source at 1310nm for testing multimode fiber running Gigabit Ethernet. Test as follows:

1. Test two fiber links at the two specified wavelengths simultaneously. Perform bi-directional testing on both strands of the fibers-under-test and save results in one record.
2. Measure length for each cable link.
3. Measure attenuation for each cable link.
4. Utilize Fluke Networks 'Cable Manager' software to store test results and to generate reports.

Test results shall include all test parameters including length and attenuation at each wavelength for each fiber link (terminated strand). Attenuation shall be the worst case result yielded from bi-directional testing. All test results shall be maintained in the native file format of the tester manufacturer's 'Cable Manager' software. Under no circumstances shall be data be modified by

other software, edited in any manner, or exported to a database, spreadsheet, work processor program or any other type of program that would allow access to the data for modification. Detailed test results in Text Format shall be provided to the Owner in native 'Cable Manager' data format on a CD. In addition, detailed test results in Text Format shall be provided to the Owner in Adobe Acrobat *.PDF format on a CD. CDs shall be included in the project Operation and Maintenance (O&M) manuals.

Insert all fiber optic cable test documentation in the project O&M manuals.

Fiber Optic Cable Performance Requirements:

Each link of the installed fiber optic cabling, with mated connectors at each end, shall have a total attenuation (in db) less than or equal to the manufacturers' performance specifications for the cable and connectors called for in the contract documents, with the cable attenuation adjusted for the installed length, and with an allowable deviation of +1.0 db. If the test results for a given strand or strands, in the sole judgment of the Architect/Engineer, indicate excessive attenuation based on these requirements, the Contractor shall repolish, reconnectorize, or replace the affected cables as required to achieve the specified performance levels as demonstrated by retesting.

The Contractor should note that these specifications are more stringent than the TIA/EIA-568-B criteria for either horizontal or backbone fiber lengths in terms of allowable link attenuation, and plan the installation accordingly.

3.2.5 Multi-pair Telephone Cable Testing:

Test each conductor for end-to-end continuity. Test each cable for correct termination on a pin-by-pin basis. Verify no shorts, opens, miswires, split, reversed or crossed pairs. Document results of testing and submit to Architect/Engineer for review and approval. The test log shall include cable identifiers as indicated on the drawings, the test date, the initials of the technician who tested the cable, and the test results.

Insert all multi-pair telephone cable test documentation in the project O&M manual.

3.2.6 Coaxial TV Cable Testing:

Test each cable for continuity and attenuation. Check each cable for correct termination and remake all connectors that are not properly terminated. Verify proper grounding at service entrance and at all surge suppression devices.

Provide services of the lead TV technician to tune the TV system as indicated on the drawings, and complete the "TV Outlet Tuning Log Form". Provide copy of log, signed by the technician who performed the tests, to the Engineer following testing and include a copy in each O&M Manual.

3.3 Patch Cord Installation:

Prior to Equipment Verification, the contractor shall install patch cords in a neat and workmanlike manner using the wire management devices indicated on the drawings. The contractor shall work side by side with the Owner's technical personnel throughout the entire patch cord installation for purposes of coordination and training.

Prior to installation of patch cords, the contractor shall account for all patch cords in the presence of the Owner's Project Manager, and shall present to the Project Manager a typed inventory of the patch cords broken down by type and length as scheduled on the drawings. The Owner's Project Manager will verify patch cord types, quantities, and lengths and will sign the inventory indicating that the contractor has delivered patch cords to the job site in accordance with the requirements of the contract documents. The contractor shall provide a copy of the inventory, signed by the Owner's Project Manager, in the O&M Manuals.

The signature of the Owner's Project Manager does not indicate acceptance of ownership of the patch cords by the Owner. Ownership of patch cords shall be transferred to the Owner at the same time as the project as a whole.

Following verification of patch cords types, quantities and lengths by the Owner's Project Manager, the contractor shall complete the patch cord installations as follows:

3.3.1 Data Copper Patch Cords – CER:

Install data patch cords connecting each port of all data equipment from data equipment connections to horizontal patch panels. Horizontal wiring connections to be made active shall be as directed by the Owner's Project Manager in the field.

Provide a typed cross-reference list in Microsoft Excel spreadsheet format identifying data equipment ports and corresponding horizontal wiring connections – place hardcopy and CD of spreadsheet in three ring binder and mount binder on the backboard adjacent to the racks. Provide additional hardcopy and CD in O&M Manuals. Email copy of Excel Spreadsheet to the Architect/Engineer and the Owner's Project Manager.

Patch cords shall be neatly routed and bundled with black velcro at 6 inches on center in wire management devices from connection to connection. Patch cord lengths shall be selected by the Contractor from the stock supplied under the project to provide a neat installation in the racks and wire management systems without excess length. Note - Bundle data patch cords together – do not mix data patch cord bundles with voice patch cord bundles or fiber optic patch cord bundles. The entire installation shall require the site approval of the Architect/Engineer.

3.3.2 Voice Patch Cords – CER:

Install voice patch cords connecting telephone system station circuits from voice backbone distribution patch panels to horizontal patch panels. Horizontal wiring connections to be made active shall be as directed by the Owner's Project Manager in the field.

Provide a typed cross-reference list in Microsoft Excel spreadsheet format identifying telephone system station circuits to voice backbone distribution patch panel ports to horizontal wiring connections – place hardcopy and CD of spreadsheet in three ring binder and mount binder on the backboard adjacent to the racks. Provide additional hardcopy and CD in O&M Manuals. Email copy of Excel Spreadsheet to the Architect/Engineer and the Owner's Project Manager.

Patch cords shall be neatly routed and bundled with black velcro at 6 inches on center in wire management devices from connection to connection. Patch cord lengths shall be selected by the Contractor from the stock supplied under the project to provide a neat installation in the racks and wire management systems without excess length. Note - Bundle voice patch cords together – do

not mix voice patch cord bundles with data patch cord bundles or fiber optic patch cord bundles. The entire installation shall require the site approval of the Architect/Engineer.

3.3.3 Fiber Patch Cords – CER:

Install fiber optic patch cords to connect all data equipment fiber optic ports as directed by the Owner's Project Manager in the field. Patch cords shall be neatly routed and bundled with black velcro at 3 inches on center in wire management devices from connection to connection. Patch cord lengths shall be selected by the Contractor from the stock supplied under the project to provide a neat installation in the racks and wire management systems without excess length. Note - Bundle fiber optic patch cords together – do not mix fiber optic patch cord bundles with data patch cord bundles or voice patch cord bundles. The entire installation shall require the site approval of the Architect/Engineer.

3.3.4 Workstation Patch Cords

The Contractor shall, in coordination with the Owner's Project Manager, install workstation data patch cords in the locations designated by the Project Manager as described above for connection of equipment room data patch cords to horizontal wiring connections. In addition, the Contractor shall work side by side with the Telephone System Provider to install telephone line cords as telephone instruments are set.

3.4 EQUIPMENT VERIFICATION

After installation of patch cords and before System Startup, the Contractor shall assist the Owner to power-up all data equipment and verify proper operation. The Contractor shall coordinate with the Owner to verify all cable interfaces are working and operational with the equipment. The contractor shall make any cabling system changes and additions as necessary and/or provide patch cables as required to complete the installation.

3.5 SYSTEM STARTUP

After Equipment Verification and before Final Checkout, the Contractor shall start the systems up, and in coordination with the Owner make them fully operational.|

3.6 FINAL CHECKOUT

After System Startup and before the First Day of operation following System Startup, the Contractor shall perform a Final Checkout of all systems to verify that each is ready for use by Owner personnel. The Contractor shall utilize a Final Checklist to fully document Final Checkout. Provide a copy of the Final Checklist to the Architect/Engineer at the Final Inspection.

3.7 FIRST DAY of OWNER OPERATION

The Contractor shall have a senior technician present at the site for the first full 8 hour day of operation following the Final Checkout to train/assist Owner personnel and to verify/fine tune system operation. The senior technician shall make follow-up visits as required to bring the system into full operating condition to the satisfaction of the Owner's Project Manager and the Architect/Engineer. The System Startup shall be made at a time, approved in writing by the School District, when school is not in regular session.

3.8 FINAL CLEANUP

The General Contractor and the Structured Cabling System Contractor shall share full responsibility for protecting all communications outlets, the CER and all structured cabling system components from dust and debris during construction and until final completion of the project. The SCS shall not install racks, wire managers, patch panels, protector blocks, 66 blocks, or dress out and terminate cables until paint, backboards and tile floors in the CER and CCs are completely finished and those rooms are completely isolated from dust infiltration with plastic sheeting and duct tape. All COs jacks shall be protected by bagging and sealing dust tight at all times after connectivity devices are installed. All system components that, in the sole judgment of the Engineer, are exposed to excessive accumulation of construction dust/debris at any stage of the project shall be removed and replaced with new components at no additional cost to the Owner. It is recommended that lay-in ceiling grids in the CER be installed after conduits and cable trays and cable runways have been installed to allow the ceiling installer to trim around conduits. Lay-in ceiling tiles in these areas should follow completion of cable dressing into racks.

Prior to the Substantial Completion Inspection, perform final cleanup of all work and all areas in which work was performed. All work areas shall be left vacuum clean. All raceway, faceplates, jack assemblies, racks, panels, data equipment, and the like shall be thoroughly wiped down to remove small amounts of dust accumulated during the course of the project. Jacks, patch panels, wiring blocks and all data, voice and TV equipment shall be cleaned with a high powered vacuum cleaner to completed remove internal dust. All painted surfaces such as backboards shall be touched up with paint to remove scuff marks, pencil marks, scratches, etc. All factory surfaces shall be touched with matching paint.

3.9 CLOSE-OUT DOCUMENTATION

3.9.1 Operation & Maintenance Manuals:

Provide O&M Manuals as required by the architectural specifications and as follows.

The O&M Manuals shall contain sufficient information to permit Owner personnel to operate the system with or without assistance from the Contractor.

The Contractor shall provide O&M Manuals covering all equipment and materials furnished under this contract. The O&M Manuals shall contain all information necessary for the operation, maintenance, parts procurement, and parts replacement for the structured cabling system. The information shall include detailed documentation for firmware configuration.

Quantity: Three (3).

Format: *Provide 8-1/2" x 11" loose-leaf 3-ring binders with clear vinyl overlay designed to receive identification inserts. 3-ring binders shall be heavy- duty D-Ring type, over-sized to allow the insertion of additional system documentation in the future.*

Project Identification: Furnish project identification *inserted under the clear vinyl overlay on the front cover and the back spline as follows:*

Operating & Maintenance Manual

Project Name
Structured Cabling System Contractor

Project Information: On the front page, *enclosed in a 3-ring clear plastic sheet protector*, provide the following information:

Project Name
Structured Cabling System Contractor Name
Structured Cabling System Manufacturer Name
Electrical Contractor Name
Contractor's Project Manager
Contact list with name, address, contact person, phone number, and fax number for the each of the following:

Structured Cabling System Contractor
Structured Cabling System Manufacturer
Electrical Contractor

Index: On the second page, *enclosed in a 3-ring clear plastic sheet protector*, provide an index indicating the following section numbers and titles.

Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate number and title (typed) as follows:

Section 1 – Cuts Sheets:

Manufacturer's original data/cut sheets for each system component.

Section 2 – Data Equipment List:

Typed list of each item of data equipment (including Owner furnished data equipment) with brief description, serial number, and part number. Note where each item of equipment is installed (CER, CC or CP number, rack number and mounting position in rack). *Enclose in a 3-ring clear plastic sheet protector.*

Section 3 – Factory Manuals:

Manufacturer's printed Installation and Operating Manuals for each item of equipment provided by the Contractor. *Provide 3-ring zip-lock pockets for each manual that is not factory 3-ring hole punched*. Do not include manuals loose or inserted in binder pockets.

Section 4 - Warranties:

- Copy of Structured Cabling System Contractor and 3 year warranty. *Enclose in a 3-ring clear plastic sheet protector.*
- Copy of Manufacturer's printed warranty for each item of

equipment. *Enclose in a 3-ring clear plastic sheet protector.*

Section 5 - Transmittal of Loose Items:

Copy of transmittal of all loose items such as patch cords, spare surge protectors, spare parts, etc. signed-off by the Owner. *Enclose in a 3-ring clear plastic sheet protector.*

Section 6 - Documentation of Training:

Documentation of training signed-off by the Owner's Project Manager. *Enclose in a 3-ring clear plastic sheet protector.*

Section 7 - Cable Test Results:

Part 1 – RCDD Certification:

Provide written Certification of Contractor's RCDD, stating that all fiber optic, Category 6 and multi-pair telephone cables have been tested in compliance with the contract documents and have met or exceeded the requirements stated therein. *Enclose in a 3-ring clear plastic sheet protector.*

Part 2 – Executive Summary:

Provide Hardcopy Summary Report of test results in the following divisions:

- Category 6 Cabling – Generate report directly from Fluke Networks 'Cable Manager' software.
- Fiber optic horizontal cabling – Generate report directly from Fluke Networks 'Cable Manager' software.
- Fiber optic backbone cabling – Generate report directly from Fluke Networks 'Cable Manager' software.
- Multi-pair telephone cabling.
- TV System cabling

Enclose each report in a 3-ring clear plastic sheet protector.

Part 3 – Fiber Optic Cables:

Provide detailed printed test results for all fiber optic cables. *Test results shall be printed on a laser printer. Enclose hardcopy in a 3-ring clear plastic sheet protector.*

Part 4 – Category 6 Cables:

Provide CD with Category 6 cable text only test results in native Fluke Networks 'Cable Manager' software *.FCM format and in Adobe Acrobat *.PDF format. *Place CD in 3-ring clear plastic*

CD jacket.

Part 5 – Fiber Optic Horizontal Cables:

Provide CD with fiber optic horizontal cable test results in native Fluke Networks 'Cable Manager' software *.FCM format and in Adobe Acrobat *.PDF format. *Place CD in 3-ring clear plastic CD jacket.*

Part 6 – Fiber Optic Backbone Cables:

Provide CD with fiber optic backbone cable test results in native Fluke Networks 'Cable Manager' software *.FCM format and in Adobe Acrobat *.PDF format. *Place CD in 3-ring clear plastic CD jacket.*

Part 7 – Multi-pair Telephone Cables:

Provide Printed test results for all multi-pair telephone cables. *Test results shall be printed on a laser printer. Enclose hardcopy in a 3-ring clear plastic sheet protector.*

Part 8 – Coaxial TV Cables:

Provide completed 'TV Outlet Tuning Log Form' as indicated on drawings. *Test results shall be printed on a laser printer. Enclose hardcopy in a 3-ring clear plastic sheet protector.*

Section 8 - Patch Cord Spreadsheet (voice and data):

Provide Hardcopy and CD of Excel Spreadsheet file. *Enclose hardcopy in a 3-ring clear plastic sheet protector. Place CD in 3-ring clear plastic CD jacket.*

Section 9 – Annotated Adobe Acrobat *.PDF As-Built Drawings.

Provide 11"x17" hardcopy laser prints and CD of *.PDF files. *Enclose hardcopy in a 3-ring clear plastic sheet protector. Place CD in 3-ring clear plastic CD jacket.*

3.9.2 As-Built AutoCAD Drawings:

Provide the same AutoCAD drawings as required under paragraph "Pre-Installation AutoCAD Drawings". Modify and correct to accurately reflect the finished installation. Provide five (5) hard-copies and two (2) sets of electronic media.

Submit As-Built AutoCAD Drawings to the Architect/Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Architect/Engineer indicating that the Contractor is providing five (5) hard-copies and two (2) sets of electronic media of the As-Built AutoCAD Drawings.

3.9.3 Red-Line Record Documents:

Refer to paragraph "CONTRACTOR'S RECORD DOCUMENTS". Provide Record Documents, updated in red pen, to accurately reflect the finished installation.

Submit Red-Line Record Documents over to the Architect/Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Architect/Engineer indicating that the Contractor is providing one (1) set of Red-Line Record Documents.

3.9.4 Annotated Adobe *.PDF A-Built Drawings:

The Architect/Engineer will provide a full set of Adobe Acrobat *.PDF format As-Built Drawings to the Contractor. The Contractor shall be required to annotate (redline) the *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Architect/Engineer. The Contractor shall also provide 11”x17” hardcopy laser prints of *.PDF drawings in each O&M Manual.

3.10 SUBSTANTIAL COMPLETION

Complete Final Checkout of system operation, Final Checklist, Cable Test Results, O&M Manuals and Record Documents prior to Substantial Completion. The Contractor's project manager and project senior technician shall be present for the Substantial Completion Inspection.

3.11 OWNER PERSONNEL TRAINING

Owner personnel training shall be provided for the Structured Cabling System. The cost of training shall be included in the cost of the system. Two copies of all manuals and training material shall be supplied to the Owner’s Project Manager at no additional cost.

The Owner’s Project Manager shall be notified prior to each training session and may participate in the training at his or her discretion.

All instruction shall be presented in an organized and professional manner by personnel who are thoroughly familiar with the installation and who certified by the manufacturer of the specific system and/or equipment for which they are providing training.

The Structured Cabling System Contractor shall provide documentation of all training (including names of personnel present at each training session) to the Architect/Engineer at the Final Completion Inspection. The documentation shall be signed-off by the Owner. The documentation shall be three-hole punched and ready for insertion in the O&M manuals.

3.11.1 Structured Cabling System Training:

Subsequent to Substantial Completion but prior to Final Completion, the Contractor shall provide on-site training to Owner personnel on the operational use of the Structured Cabling System and the all related equipment.

The Structured Cabling System Contractor shall schedule a time to provide not less than four (4) hours of formal training to Owner personnel on the Structured Cabling System. The Structured Cabling System Contractor shall provide an additional two (2) hours of follow-up training on the system when requested by the Owner at any time during the warranty period.

Structured Cabling System training shall include a "walk-through" of the systems to identify and locate closets, panels, and important system components, a discussion of overall system concepts and configuration, specific instruction in labeling and patch cord move/changes, a review of the as-built drawings, a review of the system verification and acceptance documentation, and guidelines for basic trouble-shooting and operation of the Structured Cabling System and all related equipment.

3.12 FINAL COMPLETION

Following completion of punch list items generated by the Architect/Engineer following the Substantial Completion Inspection, the Contractor shall notify the Architect/Engineer in writing, stating that all punch list items have been completed.

3.13 WARRANTY

The Structured Cabling System Contractor warrants all work performed by him directly and all work performed for him by others for a period of three years. Any work, material or equipment which during the warranty period is, in the opinion of the Architect/Engineer or the Owner’s Project Manager, defective or inferior and not in accordance with the contract documents, shall be made good at no additional cost to the Owner, including any other work which may have been damaged because of such deficiencies. The Contractor shall be the contact person and the person responsible for coordinating all warranty work for the Owner.

When equipment cannot be repaired at the site, the Contractor shall be completely and solely responsible for the coordination and completion of equipment repairs, including pickup at the project site, transportation and shipping costs to and from the repair site, and reinstallation and reintegration into the system. Equal or better loaner equipment shall be provided and installed by the Contractor any time equipment cannot be repaired at the site, so that the system is maintained in continuous working order as before the equipment failed.

END OF SECTION 17000

SECTION 17300 – INTERCOM/PA SYSTEM

PART 1 – GENERAL

1.1 CONTRACTOR QUALIFICATIONS

The Structured Cabling System Contractor shall perform all work related to the Intercom/PA System and shall meet all qualifications specified in this section for the Intercom/PA System Contractor. Refer to Section 17000 – Communications Structured Cabling System for Structured Cabling System Contractor qualifications. See Section 17000 for additional requirements for the Intercom/PA System installation including conduit work.

The Intercom/PA System Contractor shall be an experienced firm regularly engaged in the layout and installation of Intercom/PA systems of similar size and complexity as required for this installation. The Intercom/PA System Contractor, under the same company name, shall have successfully completed the layout, installation, testing and warranty of not less than three Intercom/PA Systems of the scope of the largest system on this project for a minimum period of three years prior to the bid date, and shall have been regularly engaged in the business of Intercom/PA Systems contracting continuously since. The Intercom/PA System Contractor shall have an existing permanent office located within 100 miles of the job site from which installation and warranty service operations will be performed.

The Intercom/PA System Contractor shall be certified by Valcom as a qualified installer for 'Multipath' systems of the type required for this project and shall be experienced in programming and configuring 'Multipath' systems for multiple call zones.

1.1.6 Contractor Qualifications – Conduit Installation:

All conduit and related work shall be provided by a licensed electrical contractor using tradesmen who are skilled and experienced in the types of conduit installations indicated in the bid documents. If the Intercom/PA System Contractor is not a licensed electrical contractor, then a licensed electrical contractor shall provide all conduit and related work as a subcontractor to the Intercom/PA System Contractor.

1.2 PROOF OF CONTRACTOR QUALIFICATIONS

The Intercom/PA System Contractor shall provide the following documentation, to be presented with his bid, as evidence that the requirements for Intercom/PA System Contractor qualifications listed above are satisfied. If the bidder does not meet the requirements of this specification section for Intercom/PA system work, he shall provide the following documentation, to be presented with the bid, as evidence that the requirements listed above are satisfied by the Intercom/PA System Contractor he proposes to use as a subcontractor to perform work under this section. In either case, all work under this section shall be performed by permanent employees of the Intercom/PA System Contractor listed on the bid form, and shall not be performed by another subcontractor, employees of another company, or by temporary employees. The only exception to this requirement shall be for conduit work, which may be performed by a subcontractor meeting the minimum requirements of paragraph 1.1.6.

1.2.1 Provide a list of not less than five (5) references for jobs of similar size and complexity including project name, location, contact person and phone number.

1.2.2 Provide RCDD name, BICSI certification number, and qualifications.

1.2.3 Provide location of office from which installation and warranty work will be performed.

1.3 RELATED REQUIREMENTS

Drawings and general provisions of Contract apply to this section.

Division 16 Specification Sections regarding conduit and raceway apply to work under this section, with the additions and modifications specified herein and on the drawings. The special requirements indicated on the drawings and in this specification section for Intercom/PA system conduit and raceway shall take precedence over any requirements specified in Division 16 Specification Sections.

1.4 DESCRIPTION OF WORK

The work consists of all labor, materials, equipment and services necessary to provide, install, test and certify all systems as described in the contract documents. The Intercom/PA System Contractor shall provide systems complete and ready for operation. The installation shall include all accessories and appurtenances required to provide a complete and operational system. Any materials not specifically mentioned in these specifications or not shown on the drawings, but required for a complete and finished installation shall be furnished and installed at no additional cost to the Owner.

Provide system complete with full configuration and programming of paging groups, class change schedules, system tones and all system features. Adjust all speaker volumes to the satisfaction of the Owner's Project Manager and the School Principal. Coordinate paging groups with the Owner's Project Manager and the School Principal.

Provide the services of a senior PA technician who shall assist school staff in the proper operation of the system, shall trouble-shoot and correct any problems with the system, and shall fine-tune system programming to the satisfaction of school staff.

1.4.1 Special Scheduling:

The Intercom/PA System Contractor shall become thoroughly familiar with the overall project schedule, and shall complete his work and make all systems fully operational prior to the date of occupancy of the facilities by the Owner. The Intercom/PA System Contractor shall provide adequate training of the Owner’s forces prior to the date of occupancy, and shall provide follow-up training after occupancy. Total training time shall be as prescribed by this specification as a minimum requirement.

1.5 EXAMINATION OF SITES AND TOTAL SYSTEM RESPONSIBILITY

Prior to providing a proposal for this work, the Contractor shall visit the proposed sites of work to become familiar with any condition that may affect the work to be performed in any way. No allowances shall be made because of lack of knowledge of these conditions.

The Contractor shall have total system responsibility to assure a fully operational system. Any

additional labor and components required for the installation of complete operating systems but not specifically required by the bid documents shall be provided and the cost borne by the Contractor.

The Contractor shall remain the sole owner of the system and all of its components provided under this contract and is responsible for all risk of loss or damage of the system for the entire contract period up to and including the date and time of Final Acceptance by the Engineer and the Owner's Authorized Representative. After the date of Final Acceptance, the Owner shall assume full ownership of the system with all components, and the warranty period shall commence.

1.6 QUALITY ASSURANCE

Materials shall be new and shall be the best of their respective kinds. All work shall be accomplished in a workmanlike manner in keeping with the best practices and highest standards of the telecommunications industry.

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Engineer and the Owner.

1.7 CODES AND STANDARDS

Refer to Section 17000 for listing of Codes, Standards and Guidelines. All work done under this contract shall be performed in accordance with the most recent issue of the listed codes, standards and guidelines. Where there is a perceived conflict between a standard or guideline and the contract documents, the Contractor shall perform the work as directed by the Engineer.

1.8 PRE-INSTALLATION SUBMITTALS

1.8.1 Manufacturer's Catalog Data:

Submit five (5) copies of manufacturer's standard descriptive data sheets to the Engineer for review and approval prior to commencing work. Furnish complete data sheets bearing the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the data sheets for the specific product being provided with an identifying mark, arrow, or highlighting. The following items shall be submitted:

1. Conduit and Pull Boxes, Fittings, Related Hardware & Accessories, Each Type
2. Cable Runway, Fittings, Related Hardware & Accessories, Each Type
3. Surface Raceway with all Fittings, each type
4. Racks, Related Hardware & Accessories, each type
5. Copper Wiring/Patch Blocks, each type
6. Category 3 UTP Cable, each type
7. Cable End Connectors, each type
8. Surge Protectors, each type
9. Cross-connect Wiring, each type
10. Wire Management Devices, each type

11. Intercom/PA Headend Equipment
12. Intercom/PA Speakers, each type
13. Intercom/PA Power Supplies, each type
14. Firestopping Systems, each type
15. Labeling Products, each type
16. All other materials and equipment indicated to be furnished under this section, whether specifically listed here or not.

1.8.2 Pre-Installation Drawings:

As part of the Intercom/PA System installation, the Contractor shall provide detailed documentation to facilitate system administration, maintenance, and future moves, adds and changes. Drawings shall be provided which incorporate all information in the Contract Drawings, and which fully document all Engineer approved changes in materials and methods made by the Contractor. Drawings are not required if no changes to the design are made by the Contractor. Changes to the design shall not be made without the prior written approval of the Engineer. Drawings shall provide the same level of detail as the bid documents. *Electronic files of the Engineer's AutoCAD drawings will not be provided to the Contractor*.

Drawings shall be prepared using AutoCAD Release 14 or higher and shall be furnished in hard-copy format and on industry standard CD or ZIP drive media.

Submit five (5) copies of pre-installation drawings to the Engineer for review and approval prior to commencing work.

1.9 CONTRACTOR'S RECORD DOCUMENTS

The Intercom/PA System Contractor shall maintain a full set of contract documents at the job site at all times, consisting of specifications, drawings, addenda, pre-installation submittals, change orders, and engineering directives. The record documents shall be updated by the Contractor, in red pen and on a daily basis, to show the following:

1. Final location of all speakers.
2. Final conduit routing.
3. Final location of all pull boxes, and access doors.
4. Any changes to the work authorized by the Engineer.
5. Any other pertinent information that may be of value to the Owner in operating and maintaining the system.

The Contractor's record documents shall be available for viewing by the Engineer or the Owner at the site at any time, and shall be presented and reviewed by the Contractor at each construction progress meeting. The record documents shall be clearly marked "Record Set", shall be kept in a protected location, and shall not be used for general construction purposes. The record documents shall be provided to the Engineer at the close of the project.

The Engineer will provide a full set of Adobe Acrobat *.PDF format drawings to the Contractor. The Contractor shall be required to annotate (redline) the Adobe Acrobat *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the Adobe Acrobat *.PDF files on CD with each set of O&M Manuals and shall provide an additional

copy on CD to the Engineer. The Contractor shall also provide 11”x17” laser prints of Adobe Acrobat *.PDF drawings in each O&M Manual.

PART 2 - PRODUCTS

2.1 GENERAL

All materials, equipment, and devices shall be new and unused, of current manufacture and of the highest grade, free from defects.

All products shall be the manufacturer and model or part number specified. Where a model or part number is indicated in error for any reason, the Contractor shall verify the intent of the Engineer prior to providing a proposal, and shall provide the product intended by the Engineer. Where a manufacturer has updated or improved a product subsequent to issuance of the bid documents by the Engineer, the Contractor shall provide the updated or improved product at no additional cost to the Owner

Provide new equipment and materials only. Each component shall be the most recent model number, revision, or update offered by the manufacturer at the time of purchase by the Contractor. Newly manufactured containing used or rebuilt parts, remanufactured, rebuilt, reconditioned, used, shopworn, demonstrator or prototype equipment is not acceptable and will be rejected. Each major component of Intercom/PA systems equipment provided under this contract shall include a certification from the manufacturer stating that the equipment is new and referencing the serial number of the delivered equipment. The Contractor shall track the placement of each major component in the field, and shall provide the Owner a list identifying each component by manufacturer, model number, serial number, and installed location (example rack number and rack position).

All materials, equipment and devices shall meet the requirements of UL where UL standards are established for those items, and the requirements of NFPA 70.

All like items of material or equipment shall be the same product of the same manufacturer, model number and production series.

All materials and equipment shall be a standard catalogued product of a manufacturer regularly engaged in the manufacture of similar products.

2.2 PRODUCT SPECIFICATIONS

See drawings for all product requirements not indicated in these specifications. The Intercom/PA Contractor shall be responsible for providing and installing all components indicated in these specifications and on the drawings and as required for a completely functional system whether specifically called for or not.

2.2.1 Intercom/PA System:

Provide all system components as indicated the drawings. To insure a uniform basis for bidding, and to standardize the Owner’s facilities, base all bids on the particular systems, equipment and materials specified.

In order to expedite warranty service and maximize support to the Owner, the Intercom/PA System Contractor shall procure all performance related components from a distributor with an existing distribution center located within 100 miles of the job site. The distributor shall have an established relationship with the Intercom/PA System Manufacturer as a Stocking Distributor.

PART 3 - EXECUTION

3.1 GENERAL

The installation shall be in strict accordance with all applicable codes and standards, the respective manufacturer's written recommendations, and the contract drawings and these specifications.

Workmanship shall be of the highest grade in accordance with the best modern practice and the highest standards of the telecommunications industry.

The installed system shall be neat, clean, and well organized in appearance. Provide working clearances for normal system operation, reconfiguration and repair.

The completed installation shall meet with the approval of the Owner's Authorized Representative and the Engineer.

The Contractor shall be fully responsible for protecting all system components from dust and debris during construction and until final completion of the project and acceptance by the Owner. All system components that, in the sole judgment of the Engineer, are exposed to excessive accumulation of construction dust/debris shall be removed and replaced with new components at no additional cost to the Owner.

3.1.1 Delivery:

Protect materials and equipment from physical or environmental damage during shipping, storage and installation. Equipment and materials shall be received at the site in new condition in original factory sealed cartons, and shall be maintained in new condition throughout the installation process. Damaged or deteriorated equipment and materials will not be acceptable. The Contractor shall be responsible for receiving and storing of all equipment and materials, and shall be responsible for the safety and condition of all materials and equipment, whether stored or installed, until Final Acceptance by the Engineer and the Owner.

3.1.2 Job-Site Conditions:

The Contractor shall be required to coordinate working hours at each site with the School Principal. Work at the site shall not be allowed during hours when school is in session, unless specifically approved by the School Principal on a day-by-day and case-by-case basis. Work on weekends will not be allowed unless specifically approved by the School Principal on a case-by-case basis. The Contractor shall work at night (or at any time school is not in session) to meet these requirements at no additional charge to the Owner.

The Contractor shall be responsible for ensuring that his employees and any subcontractors:

- Refrain from smoking or the use of tobacco in any facility, property or vehicles owned by the School District. Any person wishing to use tobacco products must leave School District

property to do so.

- Refrain from the use of vulgarities while on School District property.
- Wear proper attire. Clothing shall have no vulgarities or sexually suggestive graphics.
- Refrain from contact with students or staff. Communications with staff shall be limited to that related to the work.

The School District retains the right to require that the Contractor dismiss any of his employees or any employee of his subcontractors deemed incompetent, careless, insubordinate or otherwise objectionable, or any personnel whose actions are deemed to be contrary to the public interest or inconsistent with the best interest of the School District.

The Contractor shall be responsible for all damages to any building, equipment, furnishings, or other property of the School District that are caused by the Contractor or his subcontractors. The Contractor shall, as directed by the Engineer or the Owner's Authorized Representative, repair or replace with new any damaged item at the Contractor's expense. Any item which the Engineer or the Owner's Authorized Representative allow to be repaired shall be restored to the condition which existed prior to the damage occurring, or better.

3.1.3 Daily Cleanup:

Upon completion of the work on a task-by-task basis, and as a minimum on a daily basis, the Contractor shall reconnect any utilities, equipment, or appliances removed in the course of work and replace all furniture, etc., moved for the performance of the work. Debris and rubbish caused by the work shall be removed and the premises left vacuum clean. All furniture, work surfaces, computers and the like shall be wiped down to remove dust generated by the work.

3.1.4 Intercom/PA System:

Provide a system of cabling as indicated on the drawings.

Install and properly mount all equipment in racks, backboards and enclosures as indicated on the drawings.

Provide cross-connects to interconnect wiring and equipment as indicated on the drawings.

3.1.5 Conduit Installation:

See Section 17000 for conduit requirements.

3.1.6 Cabling Installation:

All Intercom/PA cabling shall be installed continuously in conduit. Do not pull cables in conduits until plastic insulating bushings have been installed. Cables installed in conduits without plastic insulating bushings shall be removed and replaced with new cables. Rack conduits and run together wherever possible.

3.1.7 Identification and Labeling:

- All labels shall be produced using a laser printer and shall be clear and easily readable. Minimum text size shall be 12 point. Text font shall be ARIAL. Handwritten labels are not acceptable.

  Label each Horizontal Category 3 cable at each end. Label text shall be based on the 'Speaker Identification Nomenclature' indicated on the drawings.

- Label each indoor speaker using adhesive labels based on the labeling nomenclature indicated on the drawings. Apply labels to the speaker housing above the ceiling.

- Label each speaker Block using the manufacturer's labels as indicated on the drawings.

  Label each Main Conduit at each end with ½" high bold text printed on heavy stock paper and secured to conduit with clear self-adhesive sheets covering the label and extending out beyond the label 1" all around for adhesion to the conduit. Label text shall be based on source (CER) and each destination.

3.2 CABLE TESTING

3.2.1 General:

Prior to installation of cabling, visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Return visibly damages goods to the supplier and replace with new.

After cabling installation and labeling is complete, but prior to the installation of patch cords, the Contractor shall test all cables. *As part of cable test procedures verify all labeling and correct all inaccurate labeling*.

The Contractor's RCDD shall be in responsible charge of all cable testing procedures and shall provide an original signed letter in each project Operation & Maintenance (O&M) manual certifying that all cables have been tested in compliance with the contract documents and have met or exceeded the requirements stated therein.

Tests shall be performed in strict accordance with the test instrument manufacturer's printed instructions.

One hundred percent of all cables shall be tested.

Technicians performing testing shall be thoroughly trained in the use of the test instruments employed. Factory certification of technicians is mandatory. The Contractor shall provide evidence of training and copies of certificates to the Engineer.

The Contractor is responsible for supplying all test equipment and related materials required to test the entire Intercom/PA System. Test instruments shall have been recently calibrated. The Contractor shall provide evidence of test instrument calibration if requested by the Engineer.

The requirement for this project is full compliance/zero tolerance. Cables that do not comply with

the stated standards shall be removed and replaced with new. Partial use of cables by claiming good pairs or strands and abandoning others is not allowable. Defective cables shall be removed and replaced with new.

Notify the Owner in writing not less than five days prior to commencing cable testing. The Owner may elect to be present for and witness cable testing.

The Contractor shall be required to retest installed cables in the Owner's presence to verify the Contractor's test documentation. The percentage of cables to be retested shall be determined by the Owner based on compliance of the installation with the contract documents, quality of workmanship, and results of initial cable tests. Retesting shall be performed as required until all cables, in the judgment of the Owner, comply with the requirements of the contract documents.

3.2.2 Cable Test Results:

All cable test results shall be provided as part of the project Installation and Maintenance (O&M) Manuals.

3.2.3 Category 3 UTP Cable Testing:

Test for the following parameters:

1. Wire Map – verify no shorts, opens, miswires, split, reversed or crossed pairs, and end-to-end connectivity is achieved.
2. Cable Length
3. Insertion Loss (attenuation)

Documentation:

Test documentation for Category 3 cabling shall include the following:

1. Tester manufacturer, model, serial number, hardware version, and software version.
2. Project Name
3. Operator Name
4. Circuit I.D.
5. Date of Test
6. Wire Map
7. Cable Length in feet
8. Insertion Loss (attenuation)

3.2.4 Multi-pair Cable Testing:

Test each conductor for end-to-end continuity. Test each cable for correct termination on a pin-by-pin basis. Verify no shorts, opens, miswires, split, reversed or crossed pairs. Document results of testing and submit to Engineer for review and approval. The test log shall include cable identifiers as indicated on the drawings, the test date, the initials of the technician who tested the cable, and the test results.

Insert all multi-pair cable test documentation in the project O&M manual.

3.3 SYSTEM STARTUP

The Contractor shall start the systems up, and in coordination with the Owner make them fully operational. The System Startup shall be made at a time, approved in writing by the School District, when school is not in regular session.

3.4 FIRST DAY of OWNER OPERATION

The Contractor shall have a senior technician present at the site all day on the day before the first day of school and on all day on the first day of school to train/assist school personnel and to verify/fine tune system operation. The senior technician shall make follow-up visits as required to bring the system into full operating condition to the satisfaction of the School Principal, the Owner's Project Manager and the Engineer.

3.5 FINAL CLEANUP

Prior to the Final Completion Inspection, perform final cleanup of all work and all areas in which work was performed. All work areas shall be left vacuum clean. All equipment shall be wiped down to remove dust accumulated during the course of the project. All painted surfaces such as backboards shall be touched up with paint to remove scuff marks, pencil marks, scratches, etc. All factory surfaces shall be touched with matching paint.

3.7 CLOSE-OUT DOCUMENTATION

3.7.1 Operation & Maintenance Manuals:

Prior to the Substantial Completion Inspection, complete Operation & Maintenance (O&M) Manuals. Submit O&M Manuals to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing three (3) sets of O&M Manuals.

The O&M Manuals shall contain sufficient information to permit school personnel to operate the system with or without assistance from the Contractor.

The Contractor shall provide O&M Manuals covering all equipment and materials furnished under this contract. The O&M Manuals shall contain all information necessary for the operation, maintenance, parts procurement, and parts replacement for the Intercom/PA system. The information shall include detailed documentation for firmware configuration.

Quantity: Three (3).

Format: *Provide 8-1/2" x 11" loose-leaf 3-ring binders with clear vinyl overlay designed to receive identification inserts. 3-ring binders shall be heavy- duty D-Ring type, over-sized to allow the insertion of additional system documentation in the future.*

Project Identification: Furnish project identification *inserted under the clear vinyl overlay on the front cover and the back spline as follows:*

Operating & Maintenance Manual
Project Name

General Contractor
Electrical Contractor
Intercom/PA System Contractor

Project Information: On the front page, *enclosed in a 3-ring clear plastic sheet protector*, provide the following information:

Project Name
General Contractor
Intercom/PA System Contractor Name
Intercom/PA System Manufacturer Name
Electrical Contractor Name
Contractor's Project Manager
Owner's Project Number or Purchase Order Number
Contact list with name, address, contact person, phone number, and fax number for the each of the following:

General Contractor
Intercom/PA System Contractor
Intercom/PA System Manufacturer
Electrical Contractor

Index: On the second page, *enclosed in a 3-ring clear plastic sheet protector*, provide an index indicating the following section numbers and titles.

Sections: All sections shall be separated with an appropriate tabbed section divider with the appropriate number and title (typed) as follows:

Section 1 – Cuts Sheets:

Manufacturer's original data/cut sheets for each system component.

Section 2 – Factory Manuals:

Manufacturer's printed Installation and Operating Manuals for each item of equipment provided by the Contractor. *Provide 3-ring zip-lock pockets for each manual that is not factory 3-ring hole punched*. Do not include manuals loose or inserted in binder pockets.

Section 3 - Warranties:

- Copy of Intercom/PA System Contractor's 3 year warranty. *Enclose in a 3-ring clear plastic sheet protector.*
- Copy of Manufacturer's printed warranty for each item of equipment. *Enclose in a 3-ring clear plastic sheet protector.*

Section 4 - Documentation of Training:

Documentation of training signed-off by the School's Technology Specialist or Principal. *Enclose in a 3-ring clear plastic sheet protector.*

Section 7 - Cable Test Results:

Part 1 – RCDD Certification:

Provide Hardcopy Summary Report of test results in the following divisions:

- Category 3 Cabling
- Multi-pair cabling.

Section 9 – Annotated Adobe Acrobat *.PDF As-Built Drawings.

Provide 11"x17" hardcopy laser prints and CD of *.PDF files. *Enclose hardcopy in a 3-ring clear plastic sheet protector. Place CD in 3-ring clear plastic CD jacket.*

3.7.2 As-Built AutoCAD Drawings:

Provide the same AutoCAD drawings as required under paragraph "Pre-Installation AutoCAD Drawings". Modify and correct to accurately reflect the finished installation. Provide five (5) hard-copies and two (2) sets of electronic media.

Submit As-Built AutoCAD Drawings to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing five (5) hard-copies and two (2) sets of electronic media of the As-Built AutoCAD Drawings.

3.7.3 Red-Line Record Documents:

Refer to paragraph "CONTRACTOR'S RECORD DOCUMENTS". Provide Record Documents, updated in red pen, to accurately reflect the finished installation.

Submit Red-Line Record Documents over to the Engineer at the Substantial Completion Inspection. Provide transmittal letter addressed to the Engineer indicating that the Contractor is providing one (1) set of Red-Line Record Documents.

3.7.4 Annotated Adobe *.PDF As-Built Drawings:

The Engineer will provide a full set of Adobe Acrobat *.PDF format As-Built Drawings to the Contractor. The Contractor shall be required to annotate (redline) the *.PDF format drawings using Adobe Acrobat to reflect all changes recorded in the field as required by the paragraph "CONTRACTOR'S RECORD DOCUMENTS". The Contractor shall provide a copy of the *.PDF files on CD with each set of O&M Manuals and shall provide an additional copy on CD to the Engineer. The Contractor shall also provide 11"x17" hardcopy laser prints of *.PDF drawings in each O&M Manual.

3.8 INTERCOM/PA SYSTEM TRAINING

Subsequent to Substantial Completion but prior to Final Completion, the Contractor shall provide on-site training to Owner personnel on the operational use of the Intercom/PA System and the all related equipment.

The Intercom/PA System Contractor shall schedule a time to provide not less than four (4) hours of formal training to school personnel on the Intercom/PA System.

Intercom/PA System training shall include a "walk-through" of the systems to identify and locate closets, panels, and important system components, a discussion of overall system concepts and configuration, specific instruction in labeling, a review of the as-built drawings, a review of the system verification and acceptance documentation, guidelines for basic trouble-shooting and detailed instructions in the operation of all aspects of the Intercom/PA System and all related equipment.

3.9 WARRANTY

The Intercom/PA System Contractor warrants all work performed by him directly and all work performed for him by others for a period of 1 year from the date of Final Completion of the project and Final Acceptance by the Owner.

Any work, material or equipment which during the warranty period is, in the opinion of the Engineer or the Owner’s Authorized Representative, defective or inferior and not in accordance with the contract documents, shall be made good at no additional cost to the Owner, including any other work which may have been damaged because of such deficiencies. The Contractor shall be the contact person and the person responsible for coordinating all warranty work for the Owner.

When equipment cannot be repaired at the site, the Contractor shall be completely and solely responsible for the coordination and completion of equipment repairs, including pickup at the project site, transportation and shipping costs to and from the repair site, and reinstallation and reintegration into the system. Equal or better loaner equipment shall be provided and installed by the Contractor any time equipment cannot be repaired at the site, so that the system is maintained in continuous working order as before the equipment failed.

The services of qualified technicians shall be available to make necessary warranty repairs in a timely manner during the warranty period.

END OF SECTION 17300

AUDIO-VISUAL SYSTEMS

PART 1 GENERAL

1. RELATED SECTIONS

(A) The Drawings, General, Special and Supplementary Conditions of the Contract to the Work of this Section.

(B) All project construction documents correspond to this Section.

(C) The Specification Sections of other disciplines correspond to this Section, insofar as contractor coordination and the requirements for interconnection with the work of other contractors are required, and insofar as they apply.

(D) Division 16000 – Electrical Systems

2. SYSTEM DESCRIPTION

(A) Audio-visual system consists of loudspeakers, digital audio processing platform, remote control, presentation switcher/scaler, wide aspect LCD projector and motorized screen, cabling, rigging materials, and wiring.

(B) Integration of any owner furnished equipment (noted as OFE) and furnishing and installation of specified products, as well as incidental equipment, hardware and cabling required providing complete and fully functional systems. Furnish, deliver, erect, and connect all the material and equipment described herein and in the drawings, and also all other incidental material and tools, transportation, etc. required to make work complete, in accordance with these plans and specifications, as required to leave the system in first class operating condition, excluding those items designated WORK BY OTHERS (WBO) or NOT IN CONTRACT (NIC).

(C) Verify dimensions and conditions at the job site prior to installation, and perform installation in accordance with these specifications, manufacturers' recommendations and all applicable code requirements.

(D) The audio-visual systems include the following major items:

a) Digital signal processor
b) Wall mounted remote control
c) LCD wide aspect projector & lens
d) CD player with iPod dock
e) DVD/VCR player
f) Presentation switcher/scaler
g) Loudspeakers and loudspeaker mounting or support hardware
h) Motorized projection screen with LVC
i) Cables, Connectors, Plates, and Wiring
j) Preparation of submittal information
k) Installation in accordance with the contract documents, manufacturer's recommendations, and all applicable code requirements
l) Initial tests and adjustments, demonstration for approval, final adjustments and documentation
m) Instruction of operating personnel; provision of manuals

n) Maintenance services; warranty

(E) Provision of system testing, system documentation and instruction of Owner Personnel.

(F) Guarantees and Warranties.

3. REFERENCES

In addition to the references in Division 1, all requirements of the latest published edition, unless otherwise noted, including but not limited to the following, shall apply. In the event of conflict between cited or referenced standards, the more stringent shall govern.

a) National Electric Code (N.E.C).

b) Federal Communications Commission (F.C.C.) Rules and Regulations, Part 76.

c) Society of Cable Television Engineers (S.C.T.E.)

d) Society of Motion Picture and Television Engineers (S M P.T.E.)

e) American Society for Testing Materials (A.S.T.M.)

f) National Cable Television Association (N.C. T. A.)

g) Electronic Industries Association (E.I.A)

h) Telecommunications Industries Association (T. I.A.)

i) “Handbook for Riggers”, 1977 Revised Edition, Newberry, W. G., Calgary, Alberta Canada.

j) “Basic Principles for Suspended Loudspeaker Systems”, Technical Notes Volume 1, Number 14, JBL Professional.

k) Davis, Don and Carolyn, Audio system Engineering, Second Edition, Howard W. Sams and Co., Indianapolis, Indiana, 1986.

l) DOE Standard DOE-STD-1090-99 Hoisting and Rigging

4. SUBMITTALS

(A) Provide shop drawings and record drawings using the following scales:

a) Details – not less than 1/4”=1’-0”

b) Plans – not less than 1/8”=1’-0”

(B) Mark all submittal documents to show the project name, date, Architect, Contractor, Sub-Contractor, and this specification Section number.

(C) Make each specified submittal as a coordinated package complete with all information. Uncoordinated sets will be returned without review.

(D) Cable and Connector Submittal: Submit sample cable with connections and wire labels. Cable sample should be 18” in length. Submit cable/connector assemblies for each type of cable to be used on the project. Manufacturer’s cable jacket ID lettering must be included on the sample cable.

(E) Product Data: Submit manufacturer’s product data sheets for each item of equipment that will be provided as part of this contract. Provide a complete list of proposed equipment broken down by system. Provide a budget summary page listing price by system. Binders shall be 3-ring binders sized to handle materials plus 34% excess. All cut sheets shall be

arranged by system type and then by specification number with tabbed dividers between sections. A table of contents shall appear at the front of the binder.

(F) Submit heat load calculations showing how loads were derived if requested by Owner or Owners Representative.

(G) Custom Software Programming including Graphical User Interface (as required). Provide for approval at least three (3) weeks prior to system commissioning, electronic copies of all custom software. It is the Contractor's responsibility for all custom software programming for the systems they are controlling. Coordination with the Consultant is required for the development of this software.

(H) Provide Panel Fabrication Details including panel engraving schedule to Owner and Consultant prior to ordering panels.

(I) Any technical questions in regards to the proposal/systems shall be submitted in written form to the AV Consultants:

Walthall & Associates, Inc.
2180 Creighton Road
Pensacola, Florida 32504
Electronic mail: chuck@walthallcorp.net
Telephone (850) 478-9002

5. QUALIFICATIONS

(A) Bidder shall be an A/V systems contractor, normally engaged in the full time business of A/V systems installation. Show proof that bidder has been in the communications system installation business for a period of no less than five years and has completed projects of similar size and scope. The Owner and/or Owner's representative reserves the right to reject any bids submitted by firms without sufficient experience in projects of this size, complexity, or any other terms the owner or owner's representative may deem relevant.

(B) No sub-contractor or contract employees will be permitted to perform the contractor's responsibilities as defined herein, unless specifically identified in the bid submission and approved by the Owner and/or Owner's representative. The contractor shall have sole responsibility for the satisfactory execution of the work, even though he may have sub-contracted a portion of the work, or had certain manufacturers install their own products.

(C) The Contractor shall provide resumes of the project coordinator (manager) and lead installer planned to be used for this project. This shall be presented at the presentation of proposal. The Contractor shall maintain the same project manager and lead installer throughout the course entire course of the project. If a personnel change is required the Contractor shall notify the Owner and/or Owner's representative and the General Contractor 30 calendar days prior to the change.

6. QUALITY ASSURANCE

(A) Review architectural, civil, structural, mechanical, electrical, and other project documents relative to this work.

(B) Verify all dimensions on the site.

(C) Coordinate the specified work with all other trades.

(D) Provide all items not indicated on the drawings or mentioned in the specifications that are necessary, required or appropriate for this work to realize complete, stable and safe

operation.

(E) Review project documentation and continuously make known any conflicts discovered and provide all items necessary to complete this work to the satisfaction of the Owner and/or Owner's representative without additional expense. In all cases where a device or item or equipment is referred to in singular number or without quantity, each such reference shall apply to as many such devices or items as are required to complete the work.

(F) Provide additional support or positioning members as required for the proper installation and operation of equipment, materials and devices provided as part of this work as approved by the Owner and/or Owner's representative, without additional expense.

(G) Regularly examine all construction, and the work of others, which may affect the work to ensure proper conditions for the equipment and devices before their manufacture, fabrication or installation. Contractor shall be responsible for the proper fitting of the systems, equipment, materials, and devices provided as part of this work.

(H) Promptly notify the Owner and/or Owner's representative of any difficulties that may prevent proper coordination or timely completion of this work. Failure to do so shall constitute acceptance of construction as suitable in all ways to receive this work, except for defects that may develop in the work of others after its execution.

(I) The Systems Contractor shall maintain the same Project Coordinator (Manager) and Field Supervisor throughout the entire project. The Systems Contractor shall provide contact information to the client, AV Consultant, General Contractor and Electrical Contractor, for both parties prior to commencing on-site project work.

(J) Source Limitations: Obtain as many products as possible from a single manufacturer. Obtain each item as a completely newly manufactured unit, including necessary mounting hardware, manuals and accessories.

7. OWNER'S RIGHT TO USE EQUIPMENT

(A) The Owner reserves the right to use equipment, material and services provided as part of this work prior to final acceptance without incurring any obligation to:

a) Accept material and equipment or completed systems until all punch list work is completed and all systems are acceptable.

b) Pay additional cost or charge.

c) Commence the warranty period for any system or device provided as part of the work.

8. PERMITS AND INSPECTIONS

(A) Obtain all required permits and inspections.

(B) Furnish material and workmanship for this work in conformance with all code requirements

(C) Perform all tests required herein, or as may be reasonably required to demonstrate conformance with the specifications.

9. DELIVERY, STORAGE, AND HANDLING

(A) Store equipment and materials safely and securely inside at the job site in a manner that will not interfere with the work of other trades.

(B) Replace all damaged or defective work or material at no additional cost, prior to acceptance.

(C) Check, and if necessary, clean all systems, equipment, devices and components included in the work after acceptance and completion of the work of all other trades.

(D) Store materials in designated areas.

(E) Provide and maintain suitable barriers, guards, fences and signs wherever necessary for the safety of others relative to and/ or for the protection of this work.

(F) Protect all materials and equipment to prevent the entry or adhesion of concrete, plaster, unintended paint, or other damaging debris or materials.

10. SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

(A) Submit shop drawings, product data and samples together in one package within thirty (30) days after award of the Contract and prior to ordering equipment.

(B) Submit catalog data sheets, neatly bound with title page, space for submittal stamps, and tabbed dividers between Sections. Provide a complete list of proposed equipment. Provide a summary of pricing broken down by system. Denote all substitutions.

(C) Submit rack layouts indicating the proposed arrangement of mounted equipment including junction boxes and locations of conduit penetrations.

(D) Submit construction details of all custom fabricated items and approved equipment modifications. Include complete parts lists, schematic diagrams, and all dimensions required for proper assembly.

(E) Submit finish schedule indicating proposed color selections and finishes for custom fabricated items, wall plates and custom labels.

(F) Submit mounting and support details for all items mounted overhead, including loudspeakers complete with parts lists and dimensions. Include a full plan view, front elevation and side elevation of each unique item with corresponding support structure and mounting hardware.

(G) Approval of shop drawings or submittal indicates only the acceptance of the manufacturer and quality. Specific requirements, arrangements, and quantities still must comply with the intent of the contract documents as interpreted by the Owner and/or Owner's representative unless specifically approved in writing.

(H) Submittals, which are incomplete, deviate significantly from the requirements of the Contract Documents, or contain numerous errors, will be returned without review for rework.

11. PROJECT RECORD DRAWINGS (As Built Drawings)

(A) Approved shop drawings, updated to accurately document the final conditions of the system installation. Legibly mark to record actual construction:

a) Field changes of dimension and detail.

b) Changes made by Revision Order, Directive or other modifications.

c) Details not in original contract drawings.

d) Any other miscellaneous items installed under this contract. At a minimum, the ends of each line should have the type of termination, coordinate and elevation indicated.

e) Layouts of system devices showing actual device locations.

f) Results of all Field Quality Control Tests in this Section.

12. OPERATION MANUALS

(A) Operation manuals shall include, but not limited to the following sections:

a) Table of Contents.

b) Typed description of system including key features and operational concepts (e.g. remote control features, switching functions, and mixing capabilities).

c) Setup diagrams and typed instructions for use in typical situations as directed by the Owner.

d) Small scale plans showing locations and circuit numbers for all system outlets and receptacles.

e) Single-line block diagrams showing all major components of the systems.

f) Manufacturer's operation manuals for user-operated equipment (tape decks, processors, communication equipment, etc.).

13. MAINTENANCE MANUALS

(A) Provide the owner any maintenance manuals that come packaged with equipment.

14. PROJECT CONDITIONS

(A) If project conditions indicate a need to vary from the Specifications or Drawings, notify the Owner and/or Owner's representative, make recommendations, and proceed with the necessary changes only after receipt of approval from the Owner and/or Owner's representative.

(B) All accessories provided by equipment manufacturer shall retain the property of the owner. Collect, inventory and present to owner after Acceptance Testing.

15. WARRANTY

(A) Provide a one (1) year System Warranty, and the following, at no additional cost to the Owner.

(B) Warranty shall contain the following:

a) Date, project title and number.

b) Contractor's name, address, telephone number and point of contact.

c) Title and number of each as-built document.

d) Signature of contractor, or its authorized representative.

e) Include the name of a contact person for service or maintenance and define the limits of the system warranty.

(C) During the System Warranty period, answer all service calls and requests for information within twenty-four (24) hours. Repair or replace faulty items and correct faulty workmanship on site within twenty-four (24) hours of all service calls.

(D) Conduct all warranty repairs and service at the job site unless in violation of manufacturer's warranty. In the latter event, provide substitute systems, equipment, and/or devices, acceptance to the Owner, for the duration of such off site repairs. Transport warranty materials, parts, and personnel to and from the job site at no additional cost.

(E) For products with manufacturer's warranties lasting more than one (1) year, register warranties in the Owner's name.

16. SUBSTITUTIONS

(A) Denote any substitutions for consideration by the Owner or Owner's representative.

18. BRAND NAMES AND ACCEPTABLE ALTERNATIVES

(B) The brand name(s) and model number(s) mentioned are used in this specification as a measure of quality and performance. Any brand or manufacture of acceptable or better quality and performance than that specified will be considered for acceptance by the Owner and/or Owner's representative at time of Bid. However, the Owner and/or Owner's representative reserves the right to reject and deny any substitution that it may, in it's sole discretion, deem unequal, and the findings in this regard shall be accepted by the bidder as final and binding.

19. OWNER FURNISHED EQUIPMENT (O.F.E.)

(A) Certain equipment may be identified as Owner Furnished (OFE or Existing). This Owner Furnished Equipment may presently be part of the Owner's system, or will be provided by the Owner, and will be delivered to the contractor's off-site construction facility, delivered to the contractor's on-site secured storage area, or installed on site by others, as appropriate, for incorporation into the system.

(B) Clean and inspect the OFE, and notify the Owner and/or Owner's representative of damage or defect and the extent of repair and/or adjustment required to bring the OFE to original specification. Service OFE only if directed by the Owner and/or Owner's representative under the arrangements of a separate contract.

(C) Connect, terminate and properly incorporate OFE into the proper system for its type. Reconnect any equipment disconnected for installation of new equipment. Verify proper operation and control functions as before removal.

20. INSURANCE

(A) Insure materials against theft, vandalism, damage due to the elements, fire, etc., to their full value. Materials and the flawless condition of materials shall remain the responsibility of the contractor until acceptance of the system by the Owner.

(B) Contractor shall be responsible for having in force the following insurance protection, this protection shall also be required for any subcontractors the Contractor may hire. Certificates of insurance shall be provided within five (5) calendar days upon request.

a) Workers Compensation Coverage for all workers

b) General, Automobile and Excess or Umbrella Liability Coverage

c) General Liability Coverage – Occurrence Form Required

d) Business Automobile Liability Coverage

21. WORK BY OTHERS (WBO, BY OTHERS) NOT IN CONTRACT (NIC)

(A) As noted on drawings and in project documentation

22. BEST VALUE ITEMIZED PROPOSAL

(A) As noted elsewhere, the AV contractor shall furnish items meeting or exceeding the specifications, items which are new and of the latest technology.

(B) Each item or system group of items shall be individually priced with the understanding **THE CITY OF GULF BREEZE** may select any single or any combination of items as required meeting any budget constraints. Where the contractor chooses, an alternate item or system may be proposed in addition to the items specified.

(C) Award will be based on best value to **THE CITY OF GULF BREEZE**, so proposers are required to attach literature as required, on each individual component proposed and may include with each a narrative explaining the merits of the component.

PART 2 PRODUCTS

1. GENERAL

(A) All equipment, except OFE, and materials shall be new, latest version at time of bid, and shall conform to applicable UL, CSA, or ANSI provisions. Re-manufactured or "B" stock equipment will not be accepted without prior written consent from the Owner and/or Owner's representative. Evidence of unauthorized re-manufactured, or "B" stock equipment on the project site will be deemed evidence of the contractor's Failure to Perform the Work. Take care during installation to prevent scratches, dents, chips or disfiguration.

(B) Regardless of the length or completeness of the descriptive paragraph herein, each device shall meet all of its published manufacturer's specifications. Verify performance as required.

(C) Asbestos Prohibition: No Asbestos containing materials shall be used under this section. The contractor shall insure that all materials incorporated in the project are Asbestos free unless specifically authorized in writing by the Owner and/or Owner's representative.

(D) All products listed below are listed for sole source information and establishment of the level of quality required by this project. Refer to the project drawings to establish quantities.

(E) Install all rack mounted equipment with black steel 10-32, button head machine screws with plastic cup washers protecting equipment panel. Do not over torque, round out, strip or mar screws.

(F) Provide and install an escutcheon ring around all pipes, poles and mounts that penetrate the ceiling. Color to be determined by owner.

(G) Some rack-mounted equipment may require shaft locks, covers, or removal of knobs; provide and install during Acceptance Testing

(H) Provide plastic permanent approved labels at the front and rear of all rack-mounted power amplification and signal processing equipment. Mount labels on the equipment rack or equipment chassis, and attach in a neat, plumb, and permanent manner. Embossed labels will not be accepted. Label equipment with schematic enumeration reference, and with descriptive information regarding its function or area it is serving. Similarly, provide permanent approved labels at the rear only of equipment mounted in furniture consoles.

(I) All engraving shall be 1/8" block lettering unless noted otherwise. On dark panels or pushbuttons, letters shall be white. Letters shall be black on stainless steel, brushed natural aluminum plates or light-colored push buttons.

(J) All accessories provided by equipment manufacturer shall retain the property of the owner. Collect, inventory and present to owner after Acceptance Testing.

(K) Per IEC-268 standard, all XLR connectors not mounted on equipment shall be wired pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).

2. AUDIO SYSTEMS MATERIALS

(A) The materials or description of work in this section is typical for all systems in this section and all following specification sections.

(B) All equipment items required providing a fully functional system may not be listed below. Confirm your quote includes all listed equipment, equipment documented in the system drawings and any required equipment not listed or shown. Report any missing equipment required to the Owner or Owner's representative prior to submitting your quote.

(C) Mounting Hardware exposed to the weather shall be aluminum, brass, and epoxy painted galvanized steel, or stainless steel. Apply corrosion inhibitor to all threaded fittings.

(D) AUDIO EQUIPMENT LIST

Verify with system drawings, on-site inspection and requirements to provide a fully functional system.

Provide AV (turn-key) pricing for each of the following systems. Submit pricing on the AV Bid Price Worksheet and refer to Section 01230 Bid Alternates.

Gymnasium AV System - BASE

Qty	Make	Model	Description
1	Chief Mfg	RPA	Projector mounting kit
1	Chief Mfg	PG3A	Extra large projector cage
1	Da-Lite	36908	Motorized screen 18' x 10'
1	Digital Projection	EVision WXGA600	Video projector & Lens
1	Extron	60-770-01	AVT 200HD digital cable tuner
1	Extron	42-166-01	V/YC/RGB/HDMI input module
1	Extron	60-1026-81	Ethernet control processor
1	Extron	60-1048-01	V/YC/RGB/HDMI RX
1	Extron	60-1054-01	Audio DSP DMP64
1	Extron	60-1075-01	Audio extractor
1	Extron	60-546-02	Touch Panel Wall Control
2	Extron	60-604-02	1RU rack shelf
1	Extron	60-806-01	HDMI Extender set
1	Extron	60-835-01	Digital Switcher
1	Extron	22-214-03	DTP26 digital twisted pair cable
1	Extron	22-141-03	Skew-free twisted pair cable
1	Extron	26-612-01	HD15 and DVI Y-adapter
2	Extron	26-614-01	HDMI-DVI adapter cable 3'
1	Extron	26-614-02	DVI-HDMI adapter cable 6'
1	Extron	26-667-03	HDMI cable 3'
1	Hoffman	CSD12126LG & WHK	Wall box with key lock handle
1	Leviton	24pt	RJ45 Patchbay 24 point
1	Whirlwind	1G2FXLR	Dual XLR microphone plate
1	QSC	CX1202V	Power amplifier
2	Shure	1/2 wave antenna	1/2 wave antenna
2	Shure	UA221	Passive Ant Splitter

2	Shure	ULXP124/85	Handheld (SM58) & Lavalier (WL185) combo syste
1	Linksys	Current	Gigabit switch
AR	West Penn	#4245	CAT5E CABLE
AR	West Penn	#291-1000	3 conductor 22 gauge cable
AR	West Penn	#225-1000	2 conductor 16 gauge cable
AR	West Penn	#25225-1000	2 conductor 16 gauge cable - plenum
AR	West Penn	#226-1000	2 conductor 14 gauge cable
AR	Contractor	Misc	Materials & connectors
AR	Contractor	Cabling	Wire & cable
AR	Contractor	Rigging	Rigging materials
AR	Contractor	Programming	Control system programming
AR	Contractor	Labor & Training	Installation Labor & 2 Hours Training

Gymnasium 001 Loudspeakers			***Add to BASE price***
16	Soundtube	RS890i	Pendant loudspeaker

Gymnasium 116 Loudspeakers			***Add to BASE price***
20	Soundtube	RS890i	Pendant loudspeaker

Multipurpose Room AV System - BASE			
Qty	Make	Model	Description
1	Chief Mfg	RPA	Projector mounting kit
1	Da-Lite	34548	Motorized screen 69" x 110"
1	Digital Projection	EVision WXGA600	Video projector & Lens
1	Extron	60-770-01	AVT 200HD digital cable tuner
1	Extron	42-166-01	V/YC/RGB/HDMI input module
1	Extron	60-1026-81	Ethernet control processor
1	Extron	60-1048-01	V/YC/RGB/HDMI RX
1	Extron	60-1054-01	Audio DSP DMP64
1	Extron	60-1075-01	Audio extractor
1	Extron	60-546-02	Touch Panel Wall Control
2	Extron	60-604-02	1RU rack shelf
1	Extron	60-806-01	HDMI Extender set
1	Extron	60-835-01	Digital Switcher
1	Extron	22-214-03	DTP26 digital twisted pair cable
1	Extron	22-141-03	Skew-free twisted pair cable
1	Extron	26-612-01	HD15 and DVI Y-adapter
2	Extron	26-614-01	HDMI-DVI adapter cable 3’
1	Extron	26-614-02	DVI-HDMI adapter cable 6’

1	Extron	26-667-03	HDMI cable 3’
1	Hoffman	CSD12126LG & WHI	Wall box with key lock handle
1	Leviton	24pt	RJ45 Patch bay 24 point
1	Whirlwind	1G2FXLR	Dual XLR microphone plate
2	Shure	1/2 wave antenna	1/2 wave antenna
2	Shure	UA221	Passive Ant Splitter
2	Shure	ULXP124/85	Handheld (SM58) & Lavalier (WL185) combo syste
1	Linksys	Current	Gigabit switch
AR	West Penn	#4245	CAT5E CABLE
AR	West Penn	#291-1000	3 conductor 22 gauge cable
AR	West Penn	#25225-1000	2 conductor 16 gauge cable - plenum
AR	Contractor	Misc	Materials & connectors
AR	Contractor	Cabling	Wire & cable
AR	Contractor	Rigging	Rigging materials
AR	Contractor	Programming	Control system programming
AR	Contractor	Labor & Training	Installation Labor & 2 Hours Training

Multipurpose 004			***Add to BASE price***
2	Atlas	MS-12CE	Floor microphone stand
1	Extron	60-572-01	3 x 1 Audio mixer
2	Shure	SM58	Handheld microphone
2	Shure	MX202BP/C	Suspended stage microphone
11	Soundtube	CM82-EZ	Ceiling loudspeaker
1	QSC	CX302V	Power amplifier - 70v
2	Whirlwind	M425	XLR microphone cable 25’

Multipurpose 016			***Add to BASE price***
9	Soundtube	CM82-EZ	Ceiling loudspeaker
1	Extron	60-883-02	Power amplifier - 70v

Multipurpose 113			***Add to BASE price***
6	Soundtube	CM82-EZ	Ceiling loudspeaker
1	Extron	60-883-02	Power amplifier - 70v

Multipurpose 104			***Add to BASE price***
9	Soundtube	CM82-EZ	Ceiling loudspeaker
1	Extron	60-883-02	Power amplifier - 70v

Portable AV Cart & Equipment			
1	Middle Atlantic	PTRK-14	Portable AV cart
1	Panasonic	DMR-EZ48VK	DVD/VCR combo

1	Tascam	CD-200i	CD/DVD/iPod Player
AR	Contractor	Misc	Materials & connectors
AR	Contractor	Cabling	Wire & cable
AR	Contractor	Labor & Training	Installation Labor & 2 Hours Training

AV Rack #1			
9	Middle Atlantic	BL1	1RU blank panel
1	Middle Atlantic	BL2	2RU blank panel
2	Middle Atlantic	BL3	3RU blank panel
1	Middle Atlantic	ERK2725AV	Equipment Rack (Complete)
1	Middle Atlantic	PD-920R	Rack mount power strip 20amp

AV Rack #2			
16	Middle Atlantic	BL1	1RU blank panel
1	Middle Atlantic	ERK3525AV	Equipment Rack (Complete)
2	Middle Atlantic	PD-920R	Rack mount power strip 20amp

AV Rack #3			
11	Middle Atlantic	BL1	1RU blank panel
2	Middle Atlantic	BL3	3RU blank panel
1	Middle Atlantic	ERK2725AV	Equipment Rack (Complete)
1	Middle Atlantic	PD-920R	Rack mount power strip 20amp

AV Rack #4			
15	Middle Atlantic	BL1	1RU blank panel
1	Middle Atlantic	ERK3525AV	Equipment Rack (Complete)
2	Middle Atlantic	PD-920R	Rack mount power strip 20amp

AV Matrix Option			
6	Extron	60-345-02	UTP Transmitter
6	Extron	60-450-01	UTP Receiver
1	Extron	60-835-01	UTP 8 x 8 matrix
AR	Contractor	Misc	Materials & connectors
AR	Contractor	Cabling	Wire & cable
AR	Contractor	Labor & Training	Installation Labor & 2 Hours Training

AV BID PRICE WORKSHEET

AV Contractor's Contact Information:

Name _____ Phone _____

Address _____ Fax _____

City, St, Zip _____ Email _____

Gulf Breeze Community Center	AVL Bid Proposal
AV Systems	Turn-key Price per drawings & specifications
Gymnasium 001 (BASE & loudspeakers) + AV Equipment Rack #1	$
Gymnasium 116 (BASE & loudspeakers) + AV Equipment Rack #4	$
Multipurpose 004 (BASE & loudspeakers) + AV Equipment Rack #2	$
Multipurpose 016 (BASE & loudspeakers) + AV Equipment Rack #2	$
Multipurpose 113 (BASE & loudspeakers) + AV Equipment Rack #3	$
Multipurpose 104 (BASE & loudspeakers) + AV Equipment Rack #4	$
Portable AV Cart & Equipment (Price Qty 1)	$
AV Matrix Option	$

_____

Signed Printed Date

3. CABLES AND CONTROL WIRING

(A) All electrical conductors installed under this contract, except where otherwise specified, shall be soft drawn annealed stranded copper having a conductivity of not less than 98% of pure copper and shall be Anaconda, Triangle, General or approved equal for power, and Alpha, Belden, or West Penn for low voltage. Cables in plenum rated ceilings outside conduit shall be similar to those listed above, except plenum rated.

(B) Homerun ALL Loudspeaker Cables, Reinforcement Loudspeaker Cables, Monitor and Foldback Loudspeaker Cables. Cables between loudspeakers interconnect junction boxes and racks to be at least No. 12 AWG jacketed pair equal to West Penn CL3 rated product or as shown on the AV drawings.

(C) Other Loudspeaker Cables to be at least No. 16 AWG jacketed pair equal to West Penn CL3 rated product or as shown on the AV drawings.

(D) Line Level and Microphone Level Cables to be at least No. 22 AWG shielded jacketed pair equal to West Penn CL3-452 or CL3-291 or as shown on the AV drawings.

(E) Multi-conductor High Resolution Video Cable shall be manufactured by Extron Electronics or West Penn CDT.

(F) Coaxial Cable for video and RF transport shall be RG-6 quad-shielded with a solid copper center conductor. Any other cable if installed shall be removed and replaced with approved cable at no additional expense to the owner.

(G) Low Voltage Control Cabling to be at least No.18AWG shielded CL3 rated cable, conductor count to be determined by application.

(H) All cables that are not in conduit and are run through plenum rated spaces shall be plenum rated cable of the gauge and conductor count required for the application.

4. ADD OPTIONS

(A) Provide pricing on the following add option for purchasing consideration by the Owner. Ensure pricing includes all necessary components, parts and labor to provide a fully functional system.

a) ***Refer to Section 01230 Bid Alternates***

5. DELETE OPTIONS

(A) Provide pricing on the following delete options for purchasing consideration by the Owner. Ensure pricing includes all necessary components, parts and labor to provide a fully functional system.

a) DELETE OPTIONS are at Owner’s discretion upon receipt of proposal.

6. FABRICATION

(A) Equipment Racks

a) Pre-assemble and test all racks before delivery to the job site, provide a written report on pre-assembly and test results to Owner/Owner’s Representative.

b) Verify the depth of each rack prior to assembly to ensure that mounted equipment will fit completely inside with the front and rear door closed.

7. SOURCE QUALITY CONTROL TESTS

(A) Use the following test equipment meeting the following minimum specifications to perform the

Source Quality Control Tests and Field Quality Control Tests. Furnish the same test equipment for the performance of Acceptance Testing.

a) Digital Multimeter

DC to 20 kHz bandwidth
300 V range, 100 mV resolution
10 megohms input impedance
Direct reading of dBm across 600-ohm load
DC resistance to .1 ohm
Dual Trace Oscilloscope *(if required or requested)*
100 MHz bandwidth
1 mV/CM sensitivity
Dual time base capability

b) Sine/Square Wave Generator

5 Hz to 5 kHz bandwidth
Output level of 0 dBm with less than .5% THD

c) Impedance Bridge

Range: 1 ohm to 1 megohm
Three test frequencies, minimum, ranging from 250 Hz to 4 kHz

d) Sound Level Meter

ANSI Type 2 with one-octave filter set

(B) Measurements

a) Measure and record impedances curves for each loudspeaker line entering rack at 1000 Hz.

b) Grounding System tests as described in the Technical Systems Specification.

8. MISCELLANEOUS CONNECTORS

(A) Certain connectors not identified in specific paragraphs, or indicated on the drawings, are specified by generic “type”. At all times, match connector types used in adjacent project areas, including existing audio, television and audiovisual systems.

a) D(*)F - Switchcraft D(*)F or Neutrik NC(*)F
b) D(*)M - Switchcraft D(*)M or Neutrik NC(*)MP
c) TRS-F - Switchcraft 121
d) TRS-M - Switchcraft 280 or Neutrik NP3C-BAG
e) TRS-FJ - Switchcraft 14B or Neutrik NJ3FP6C-BAG
f) S4FC - Neutrik NL4FC
g) S4MP - Neutrik NL4MP
h) BNC - Canare BCJ-R
i) BNCL - Canare BCP-S4
j) BNC-R - Canare BCJ-RU

PART 3 EXECUTION

1. INSTALLATION

(A) Verify existing conditions before starting work.

(B) Execute all work in accordance with Part 1.3 References in this guideline, and with all local and state codes, ordinances, and regulations.

(C) Install equipment according to manufacturer's recommendations.

(D) Install all rack-mounted equipment with black steel 10-32, button head machine screws, using plastic cup washers to protect equipment panel.

(E) Rack mounted equipment shall be mounted into racks and fully wired and tested, before delivery to job site. *(Does not apply when racks are existing)*

(F) Install flat black blank panels in all unused rack positions. Use no larger then a two space panel.

(G) Ensure that levels and impedances are properly matched between components.

(H) Choose colors and finishes of all exposed and custom fabricated items and labels to blend in with the surroundings as approved by the Owner and/or Owner's representative.

(I) Firmly and permanently attach electrical boxes, enclosures and permanent equipment to the building. Rigidly mounted equipment and devices shall be level, plumb and square.

a) Set "flush-mounted" units so that the face of the cover, bezel, or escutcheon is in the same plane as the surrounding finished surface.

b) Mount boxes, panels and trim so that there are no gaps, cracks, or obvious lines between the trim and the adjacent finished surface, and ready them to receive final finish, as applicable.

c) Provide access panels where needed to access boxes, panels and enclosures in walls or ceilings, as indicated and dimensioned on the shop drawings.

d) Finish panels to match the surrounding surfaces.

(J) Supports and mounts for equipment to be installed over public areas shall be permanently attached to suitable building structure adequate to support the equipment loads with a safety factor of at least five.

(K) Use attachment hardware with a minimum SAE Grade 5 load rating. Do not use formed eyebolts or lag screws for support or connection of suspended equipment.

(L) Verify capacity of mounting methods used in the work and associated liabilities. All attachments, attachment points, reinforcement requirements, and hardware selection shall be executed in accordance with the references in PART 1.

2. GROUNDING, SHIELDING AND ISOLATING

(A) Mount and enclose all electrical and electronic equipment in metal enclosures, pedestals or equipment racks.

(B) All junction boxes shall be bonded to the building safety ground.

(C) Use EMT type conduit for all wiring outside of equipment racks except plenum rated wiring above a lay-in ceiling, and outdoor conduits and raceways, where separate insulated ground wiring shall be supplied.

(D) Use flexible conduits and PVC fittings to provide insulated connections of the building electrical raceways to equipment racks. Mount all equipment racks at the job site in a manner that provides electrical isolation from the building structure and electrical raceways.

(E) Electronics racks and cabinets shall be boned to the isolated ground technical power system

only. Refer to Section 16770 for coordination and test with the Electrical Contractor.

(F) In the case where a metal equipment cabinet or rack is located on a suspended, concrete or bonded flooring system, the enclosure shall be placed on a Santoprene isolating mat with a minimum thickness of 3/32” and a Durometer of 80A,.

3. WIRING PRACTICES

(A) Where specific instructions are not given, perform all wiring in strict adherence to standard broadcast and sound engineering practices in accordance with the references listed in PART 1.

(B) Group all wiring into the following classifications by power level or signal type:

a) Microphone Level: less than -20 dBm.

b) Line Level Audio and DC Control Circuits: -20 dBm to +30 dBm.

c) Speaker Level: greater than +30 dBm.

d) AC Mains Power Circuits

(C) Separate wiring of differing classifications by at least six (6) inches, wherever possible. Wherever lines of differing classification must come closer together than six (6) inches, cross them perpendicular to each other.

(D) Neatly harness wires together within racks by power level classification using horizontal and vertical wiring supports as required. Rigidly support all wires within 6” of fixed connection points. Leave service loops of sufficient lengths to allow rack hinges or slides to fully extend to facilitate access to rear panel connectors from the front of each rack. Do not use self-adhesive anchor pads for support of cables.

(E) Observe consistent polarity throughout the audio systems as follows:

a) Use only balanced differential inputs throughout all audio systems unless otherwise noted.

b) Use approved transformers where directed to reduce objectionable system noise to acceptable levels.

(F) Exercise care in wiring to avoid damaging the cables and equipment. Use grommets around cutouts and knockouts where conduit or chase nipples are not installed. Use bushings where conduit terminal connections are exposed in or out of junction boxes.

(G) Cut off unused wire ends approximately one-half inch (1/2“) past the wire jacket. Fold them back over the jacket, and secure in place with heat-shrink tubing. In multi-conductor cables, preserve all unused conductors for future use. Failure to do so may result in replacement of cables at the contractor’s expense.

(H) Provide a minimum 6” service loop or enough cable to allow for three (3) subsequent terminations which ever is greater.

(I) All cable jacket exposed stripped ends shall be dressed with the appropriate sized heat shrink.

(J) All drain cables shall be protected from the jacket strip to the point of termination. Exposed bare wire is not acceptable.

(K) Make all connections using rosin-core solder in conjunction with approved mechanical connectors unless other is specified by manufacturer. Connect microphone, control, and line level wiring through approved connectors. Connect speaker level wiring using approved terminal barrier strips. Mount all terminal devices on a non-conductive (electrically) rigid surface. Provide 10% spare terminals at each location. Label each terminal with a unique number.

(L) Make all power amplifier output connections directly into amplifier binding posts, friction fit

connectors are not acceptable. In the event the amplifier doesn't have binding posts, and has barrier strip connections, crimp and solder the appropriate fork lug to the cable and torque screws to manufacturer's specification.

(M) All fiber optic cable splicing shall utilize the fusion splice method. The maximum allowable loss per fusion splice shall be 0.5 dB.

4. LABELING

(A) Label products in a logical, legible, and permanent manner corresponding to the Drawings. Wording, format, style, color, and arrangement of text will be subject to the Owner and/or Owner's representative's approval. Submit samples and labeling schedule for approval. Labeling will be verified at final adjustment and equalization

(B) Label all wall plates for input, output, and control receptacles as well as connector mounting plates in all boxes using 1/8" engraved lettering filled with black or contrasting paint, as approved.

(C) Use engraved plastic labels similar to Lamicoid, squarely and permanently attached, to label the following:

a) Patch panel designation strips.

b) Front and back of all rack mounted equipment including controls

c) Barrier strips, terminals, transformers, switches, relays, volume controls, and similar devices.

(D) Label pushbutton switches with engraved lettering filled with contrasting color paint.

(E) Label all permanently installed wires on both ends with approved permanent clip-on type or sleeve type markers. Wrap-around adhesive labels will not be accepted unless completely covered with clear heat shrink tubing.

(F) Label all portable equipment with engraved block letters using initials and/or words. Label all portable cables similarly with printed heat-shrinkable tags located 12 inches from the male connector end. Verify lettering through the Owner and/or Owner's representative prior to engraving or printing.

(G) Label access panels and backboards with designations corresponding to the drawings. Where devices are concealed above access ceilings, provide permanent lamicoid labels, on the ceiling supports corresponding to the drawings in finishes and sizes approved by the Owner and/or Owner's representative.

5. FIELD QUALITY CONTROL TESTS

(A) Maintain a competent supervisor and supporting technical personnel, acceptable to the Owner and/or Owner's representative during the entire installation.

(B) Before connecting any equipment to AC power outlets, measure the AC voltages between hot, neutral, and ground and verify correct voltage and polarity of AC power. Equipment damaged by connecting to improperly wired outlets shall be replaced at no addition cost to the Owner.

(C) Upon completion of the system installation, it shall be the responsibility of the contractor to perform the necessary adjustments and balancing of all signals and amplifier gain, and other level controls to ensure proper system operation. The Owner shall physically inspect the system and/or Owner's representative to assure that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications.

(D) Determine the proper sequence of energizing systems to minimize the risk of damage.

(E) After successfully energizing the systems, make all preliminary adjustments and document the setting of all controls, parameters of all corrective networks, voltages at key system

interconnection points, gains and losses, as applicable.

(F) Verify the performance parameters of the individual systems following established professional procedures, in addition to those specified herein.

(G) Measure and record impedance curves of all loudspeaker lines at amplifier rack terminal barrier strips prior to connecting to amplifier outputs. If self-powered loudspeakers, verify signal cable(s) impedance is 'open' (not shorted) prior to connecting to loudspeaker input and processor output.

(H) Apply a sine-wave sweep signal to each loudspeaker system, sweeping from 50 Hz to 5000 Hz at a sound pressure level which is 10 dB below the loudspeaker's rated electrical input power. Listen for rattles or objectionable noise and correct if apparent.

(I) Using a +4 dBm sine-wave input, set controls of each component to produce a +4 dBm sine-wave output. Under these conditions (unity gain), the presence of any waveform, distortion, interference signals, or oscillations shall be unacceptable.

(J) Check for proper polarity of ceiling mounted loudspeakers by applying music program or pink noise to each system and walking through the transition areas of coverage from one loudspeaker to the next. Transition should be smooth with no apparent shifting of source from one loudspeaker to the next.

(K) Drive each ceiling distributed loudspeaker system with one octave of pink noise centered at 1000 Hz at a sound pressure level which is at least 10 dB above the ambient noise. Adjust power amplifiers to provide uniform distribution of sound throughout the seating areas within a tolerance of ±3 dB. Use an ANSI Type 2 sound level meter set for slow meter damping to take readings at seated ear height.

(L) Individually drive each reinforcement loudspeaker with one octave of pink noise centered at 1000 Hz at a sound pressure level, which is at least 10 dB above the ambient noise. Adjust power amplifiers to provide an equal sound pressure level from each loudspeaker on its aiming axis in the seating area. Use an ANSI Type 2 sound level meter set for slow meter damping to take readings at seated ear height.

(M) Upon completion of initial tests and adjustments, notify the Owner and/or Owner's representative the system is ready for final equalization and acceptance testing.

6. TEST EQUIPMENT

(A) Provide the following test equipment on site during construction and available to the Owner and/or Owner's representative during final adjustment and acceptance testing:

a) Digital Multi-meter

b) 100 MHz Dual Trace Storage Oscilloscope

c) Video Test Pattern Generator *(XGA, Component, YC and Composite)*

d) Sine/Square Wave Generator

e) Impedance Bridge

f) Sound Level Meter - ANSI Type 2 with one-octave filter set

7. FINAL ADJUSTMENT AND EQUALIZATION

(A) Schedule a time for the Owner and/or Owner's representative to perform the Final Adjustment and Equalization. Notify the Owner and/or Owner's representative and Consultant at least fourteen (14) days in advance.

(B) Furnish project lead installer to assist the Owner and/or Owner's representative during the Final Adjustment and Equalization.

(C) Audio Systems acceptance tests shall employ an approved sound level meter, and spectrum

analyzer and digital multi-meter to be provided by the contractor. Measurements shall be made at the combined output of the amplifiers and at selected locations throughout the facility.

(D) Record final settings on all equipment and submit with contract closeout documents.

8. CLEAN UP

(A) Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed on a daily basis unless designated for storage.

(B) Clean all areas around system equipment and be sure that the inside of each equipment rack is free of cut wire ends, solder splatters, and other debris.

9. DEMONSTRATIONS AND TRAINING

(A) Furnish a technician who is qualified to operate and maintain the systems specified in this Section to instruct Owner designated personnel regarding the design features and proper operation of the systems. Provide a minimum of 4 hours of hands-on instruction to the Owner or Owner designated personnel.

(B) Furnish the same technician/instructor during the first formal use of the audio system to further instruct and assist Owner personnel in system operation.

(C) Upon completion of the Work, the Owner and/or Owner's representative may elect to verify test data as part of the acceptance procedure. Provide personnel and equipment, at the convenience of the Owner and/or Owner's representative, to reasonably demonstrate system performance and to assist with such tests without additional cost to the Owner and/or Owner's representative.

10. FINAL PROCEDURES

(A) Perform any and all remedial work to correct inadequate performance or unacceptable conditions of, or relating to any of this work, as determined by the Owner and/or Owner's representative, at no additional expense to the Owner and/or Owner's representative.

(B) Furnish all portable and loose equipment to the Owner along with complete documentation of the materials presented. All portable equipment shall be presented in the original manufacturers packing, complete with all included instructions and miscellaneous manuals and documents.

(C) Test Reports and Certificates:

a) Document all acceptance testing, calibration and correction procedures described herein with the following information:

b) Parameters measured and their values, including values measured prior to calibration or correction, as applicable.

c) Parameters associated with calibration or corrective networks, components, or devices.

d) All software shall have certified backups and escrow provisions reviewed with the Owner and/or Owner's representative and equipment supplier.

e) Provide all operational software, configuration files, source code, and final settings and adjustment, in Compact Disc format, sleeved in the final documentation binder. The configurations, and source code become the sole property of the owner at project completion

f) A list of all equipment, indicating manufacturer, model number, serial number and equipment location (rack/room number). Update following acceptance testing if modified.

(D) Present, review and clarify all materials to the Owner and/or Owner's representative and/or

operating personnel and fully demonstrate the operation and maintenance of the systems, equipment, and devices specified herein.

(E) Check, inspect, and if necessary, adjust all systems, equipment, devices and components specified, at the Owner's convenience, approximately thirty (30) days after the Owner acceptance of this work.

END OF SECTION