

Bid Form

SUBMIT IN TRIPLICATE

BID TO: Cass County Memorial Hospital
ATTN: Lee Wyman
1501 East 10th Street
Atlantic, Iowa 50022

BID FROM:

(Bidder Name)

(Address)

(City, State, Zip)

PROJECT: Cass County Memorial Hospital

PROJECT NO. # 4233

Ladies and Gentlemen:

The undersigned, having familiarized themselves with the local conditions affecting the cost of the work and having examined the site and the Bidding Documents prepared by Rhoades Engineering Corporation, 4801 Henry Street, Muskegon, MI 49441 hereby propose to furnish all labor, material, equipment, taxes, and services required for the proper completion of the electrical service upgrades, including all addenda issued thereto, for the sum of:

TITLE Electrical Service Upgrades

_____ Dollars (\$ _____),

Said amount constituting the Base Bid.

TAXES: Bid sum includes all applicable taxes, including Michigan Sales Tax.

COST OF BONDS: Bid sum includes cost of furnishing a Performance Bond and a Material Payment Bond, each in the amount of 100% of the Base Bid for all bids exceeding \$50,000.00.

Price of performance, labor and material bond (included in Base Bid). . . . Dollars (\$ _____)

ACKNOWLEDGEMENT OF ADDENDA:

The following addenda have been received, are hereby acknowledged, and their execution is included in the above Base Bid:

Addendum No. _____ Dated _____ Addendum No. _____ Dated _____

Addendum No. _____ Dated _____ Addendum No. _____ Dated _____

VOLUNTARY ALTERNATES:

Identify in detail on appropriate attachment any Voluntary Alternates shown here:

A _____

B _____

C _____

BID SECURITY:

Accompanying this Bid, as required by the Instructions to Bidders, is a Bid Security in the form of (Certified Check / Cashier's Check / Bid Bond) in the amount of:

_____ Dollars (\$ _____)

Payable to the Owner, which is it agreed, shall be retained as liquidated damages, not as a penalty, by the Owner, if the undersigned fails to execute the Contract in conformity with the form of Contract incorporated in the Contract Documents and fails to furnish specified bonds within ten (10) days after date of issuance of Letter of Intent to Award to the undersigned.

CONSTRUCTION PROGRESS SCHEDULE:

If awarded the Contract, the undersigned agrees to commence Work within ten (10) days after date of issuance of Letter of Intent, which shall be considered as the Notice to Proceed, and agrees to complete the Work in accordance with the Construction Progress Schedule.

Endorses the Construction Progress Schedule: _____
(Bidder Initials)

Amends the Construction Progress Schedule as follows: _____

CONTRACTOR LABOR RATES:

In the event of a contract change during the course of the project, that will add or decrease from the Contract amount, we will apply the following hourly labor rates (total labor rate includes hourly wage rate plus all insurances, taxes, health and welfare contributions and other benefits - before overhead and profit mark-up) for each employee's job title:

Job Title	Labor Rate	Job Title	Labor Rate
_____	\$ _____/hr	_____	\$ _____/hr
_____	\$ _____/hr	_____	\$ _____/hr
_____	\$ _____/hr	_____	\$ _____/hr

CHANGE ORDER WORK:

For revisions to the contract, whether deleted or added, the contractor agrees to the following mark-ups for overhead and profit:

1. Direct (own forces) Labor _____ % (maximum of 10%)
2. Direct Material _____ % (maximum of 10%)
3. Subcontracted Work _____ % (maximum of 5%)
4. Equipment Rental _____ % (maximum of 5%)

CREDIT FOR WORK DELETED:

Should any work be deleted from the Contract by order of the Owner, full cost savings realized thereby will be credited to the Owner.

AGREEMENT:

The undersigned agree(s) to provide the post-bid information required within ten (10) days after receipt of the Notice of Intent to Award and to execute an agreement for work covered by this Proposal on a Subcontract Agreement (included in the Specifications for reference).

In submitting this bid, it is understood that the Owner reserves the right to reject any or all bids. It is further agreed that this bid is binding for a period of sixty (60) days from the opening thereof.

Respectfully submitted,

(If a Corporation, affix seal)

Date _____, 2017

Firm Name _____

Address _____

By _____

Signed _____

Title _____

Telephone No. (_____) _____

Fax No. (_____) _____

Email Address _____

DIVISION 26 – ELECTRICAL

INDEX SHEET

- 26 0500 - COMMON WORK RESULTS FOR ELECTRICAL
- 26 0510 - BASIC ELECTRICAL MATERIALS AND METHODS
- 26 0511 - ELECTRICAL DEMOLITION FOR REMODELING
- 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES
- 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

- 26 2200 - LOW-VOLTAGE TRANSFORMERS
- 26 2413 - SWITCHBOARDS
- 26 2416 - PANELBOARDS

Applicable provisions of Bidding Requirements, Project Guidelines and General Requirements (Division 1) apply to the work specified in these Sections.

SECTION 26 0500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Applicable provisions of Bidding Requirements, Project Guidelines and General Requirements (Div. 1) apply to work specified in this Section.

1.2 DESCRIPTION

A. Work Included:

1. This Section includes all labor, materials, equipment, tools, supervision, start-up services, and Owner's instructions, including all incidental and related items necessary to complete installation and successfully test, start-up and operate in a practical and efficient manner, all electrical work and systems indicated on the drawings and described in each Section of Division 26 and conforming with all contract documents.
2. This Section defines certain terms used in these specifications and explains the language, abbreviations thereof, format and certain conventions used in the specifications and certain associated contract documents.

C. Site and Contract Document Examination: Submission of a Bid Proposal is considered to be evidence that the Contractor has visited the site, examined the drawings and specifications of all the trades and has fully informed himself as to all project and site conditions and is proficient, experienced and knowledgeable of all standards, codes, ordinances, permits and regulations which affect every trade's completion, cost and time required and that all costs are included in his Bid Proposal.

D. Responsibility:

1. The Contractor shall be responsible for all subcontractors and suppliers and shall include in his bid and apportion all materials, labor and equipment to the several trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions and secure compliance to all parts of the specifications and drawings regardless of sectional inclusion in these specifications.
2. Each electrical subcontractor and sub-subcontractor shall be responsible for all parts applicable to his trade in accordance with the specifications and drawings and for coordinating locations and arrangements of his work with all other relevant specifications, drawings, shop drawings and details.

E. Drawings and Specifications:

1. Drawings and specifications and intended to supplement each other and all work specified or indicated on/in either shall be provided.
2. Drawings are diagrammatic and indicate general arrangements of systems and work included in the contract and shall serve only as design drawings and not as working drawings for general layout of various equipment and systems.

Drawings do not necessarily indicate every required offset, junction box, pull box, mounting support, access panel, etc. which shall be provided as required.

3. Each subcontractor shall examine all drawings and specifications of his trade and drawings, shop drawings and field layouts of work of all other trades working on the project. If any discrepancies occur between these various drawings or between these drawings and these specifications, he shall report same to the Engineer in writing and shall obtain written instructions for changes in construction.

Should interferences develop during construction which cannot be avoided, the Engineer shall decide which work is to be relocated regardless of which was first installed. This work shall be performed at no extra cost to the Owners.

4. Should drawings disagree in themselves or with the specifications, the better quality or greater quantity of work shall be provided.
5. All schedules on the drawings or in the specifications are only for the convenience of the Contractor. The Contractor shall make his own count and, where fixtures and/or equipment are indicated on the drawings but not in the schedules, the Contractor shall provide like equipment and/or fixtures as are indicated for like rooms or used elsewhere on the project.
6. Manufacturer's Model Numbers:
 - a. Wherever, on the drawings or specifications, that a manufacturer's catalog number of model or type designation is made, it is intended as a general qualification. It shall remain the Contractor's responsibility, before the ordering of any material, to determine the proper type or model with arrangement, mounting and accessories applicable for each location on the project.
 - b. Approval of shop drawings by the Engineer does not obviate the Contractor's responsibility.
7. Drawings shall not be scaled for measurements and shall not serve as shop drawings.

F. Definitions:

1. Furnish: Supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar subsequent requirements.
2. Install: Operations at the project site, including unloading, unpacking, assembly, erection, placing, anchoring applying, working to dimension, finishing, protection, cleaning and similar requirements.
3. Provide: Furnish and install, complete and ready for the intended use.
4. Minimum Requirements:
 - a. Indicated requirements are for a specific minimum acceptable level of quality as recognized in the industry. Actual work must comply, within specified tolerances, or may exceed minimums within reasonable limits.
 - b. Refer uncertainties to the Engineer for decisions before proceeding.

5. Abbreviations and Plural Words:
 - a. Abbreviations, where not defined in the contract documents, will be interpreted to mean the normal construction industry terminology determined by recognized grammatical rules by the Engineer.
 - b. Plural words will be interpreted as singular and singular words will be interpreted as plural where applicable for the context of the contract documents.
6. Raceway: Conduit, wireway, channels, boxes, fittings, hangers, supports and items necessary or required in connection with and/or relating to raceway to provide a complete installation.
7. Concealed: Embedded in masonry or other construction below floor slabs, installed behind wall finishes, within double partitions or above hung ceilings, in trenches, tunnels or crawl spaces.
8. NIC: Items and/or areas shown on the drawings or identified within these specifications with "NIC" shall be considered by this Contractor as "Not In Contract". As a result, this Contractor shall take no action on those items identified as such.

G. Substitutions and Changes:

1. When a material, method or product is listed, shown or scheduled by trade name or catalog number for a use, it shall be the basis of design. Other "similar" manufacturers may or may not be listed as "acceptable", provided that the specific item is comparable with the basis and intent of the design.
2. Contractors shall base their bid proposals only on those items either:
 - a. Originally named, listed, shown or specified on/in the drawings/ specifications.
 - b. Named, listed, and/or shown in an official addendum to the drawings/ specifications. All other manufacturers or catalog numbers shall be bid as a voluntary alternate only. Any Contractor choosing to base his bid proposal on any item and/or system not either originally named or named in an official addendum as "acceptable" does so at his own risk and may be required to furnish and install the originally named product and, if applicable, bear all of the costs involved with removing the unauthorized product.
3. Contractor shall be considered liable for all added costs both to himself and to others (including those costs as incurred by the Engineer for redesigning or redrawings) resultant from the substitution of products not originally specified.
4. Contractor shall be responsible for the verification of adequate space (considering dimensions, required clearances, weights and roughing-in requirements) for the installation of any items or systems not originally specified. He shall be responsible for the timely advising of all other trades. He shall submit revised drawing layouts for the approval of the Engineer and shall not proceed without this approval.

1.3 STANDARDS, CODES AND PERMITS

- A. General: Compliance with standards, codes and permits shall be in accordance with General and Supplemental Conditions.

- B. Electrical Work: All work installed under Division 26 shall comply with the latest published edition of the applicable standards and codes of the following:
- ASA....American Standards Association
 - ASTM...American Society for Testing Materials
 - ANSI...American National Standards Institute
 - NFPA...National Fire Protection Association
 - UL.....Underwriter's Laboratories, Inc.
 - NEMA...National Electrical Manufacturer's Association
 - NESC...National Electric Safety Code
 - OSHA...Occupational Safety and Health Act
 - BOCA...Building Officials and Code Administrators
 - UBC....Uniform Building Codes
 - NEC....National Electrical Code
 - NECA...National Electrical Contractor's Association
 - NEMA...National Electrical Manufacturer's Association
- C. All labor, material and equipment shall comply with all applicable:
1. City, county and state laws, ordinances, codes and regulations.
 2. Applicable rules and regulations as required by the Department of Consumer and Industry Services – Fire Safety Division.
- D. Excess Quantities and Sizes: Where quantities, sizes or other requirements on drawings or in specifications are in excess of code requirements, drawings or specifications shall govern and the specified item or system shall be furnished and installed.
- E. Conflicts: Where conflicts are discovered to exist between referenced standards or specifications, the more stringent requirements shall govern. No extra compensation for such compliance will be allowed.
- F. Notices and Payments: The Electrical Contractor shall give all notices, file all drawings, obtain all necessary approvals, obtain all permits, pay all fees, deposits and expenses required for installation of all work under this contract. Within ten (10) days after award of the contract, the Contractor shall show proof that such permits have been obtained and appropriate fees paid.
- G. Inspections and Certificates of Inspection:
1. No work shall be covered or enclosed until work is tested in accordance with applicable codes and regulations and successful test witnessed and approved by authorized inspection authority.
 2. Provide for the Engineer's review evidence that the installation has been inspected and approved by the authorized governmental inspector having jurisdiction over that phase or system of work involved.
- H. UL Labels: In general, all material used on this project shall be labeled or listed by Underwriter's Laboratories, Inc.

1.4 SUBMITTALS

A. Shop Drawings:

1. After the schedules of equipment and Subcontractors are submitted and approved, submit shop drawings covering all equipment, systems and materials to be furnished and installed on this project.
2. Shop drawing submittals shall at the time they are submitted to the Engineer for review, include signatures or stamps of Contractor (and Subcontractor, where applicable) certifying that he/they has/have inspected submittals and have coordinated required space, services and work of other trades for the equipment or system being submitted.
3. Submit complete manufacturer's shop drawings of all equipment, accessories and controls, including (but not limited to) weights, dimensions, capacities, construction details, installation and maintenance instructions, wiring diagrams, available finishes, all applicable manufacturer's warranties and all details involving other trades.
4. General catalog cuts without detailed engineering and installation details will not be accepted.
5. Submittal sheets containing or showing items not applicable to the specific project must be clearly marked to show the equipment or system being submitted. Sheets not so marked will be returned unreviewed.
6. Submittals on items or systems clearly belonging together (such as lighting fixtures) shall be submitted as a booklet or grouping, with each "set" containing components arranged in a logical sequence. The Engineer will not assemble such booklets but will rather return unsorted submittals unreviewed. Submittals shall be maximum size of 36" x 24".
7. Engineer's review of shop drawing submittals is a free service to the Contractor only and, as such, shall not be construed to be a guarantee of compliance with or a relief of the required compliance with the basic responsibilities of the Contractor under the contract documents. Review of submittals shall not be considered to be an approval of changes in time or cost.
8. After review, the Contractor shall provide information to all affected trades.

- B. Extra Copies of Submittals: Refer to "Final Acceptance, Guarantees and Warranties" later in this Section for requirements of extra copies of shop drawings and operating and maintenance information.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Delivery, storage, and handling shall be in accordance with the General and Supplementary General Conditions.
- B. Inspection: Inspect all items upon delivery and remove and replace all items impossible to repair so that they are equal and indistinguishable from new items.
- C. Protection: Protect electrical materials and products and installation work against dirt, water, or mechanical damage before, during, and after installation.
- D. Repairs: All damage inflicted prior to date of final acceptance shall be repaired or replaced in a manner acceptable to the Engineer at no cost to the Owner by the Contractor or Subcontractor whose work is involved.

1.6 STANDARDS

A. General:

1. All electrical material, equipment, and accessories installed under this project shall be new and shall conform to all applicable standards, requirements, and codes and all applicable local, state, and federal specifications.
2. All products shall be of established manufacturers regularly engaged in the making of the type of materials to be provided. All products shall be complete with all parts, accessories, supports, trims, connections, etc., reasonably incidental to the product and necessary for installation.
3. All products shall be properly tested, cleaned, adjusted, and put in complete working order ready for service before acceptance will be considered.
4. All electrical work shall be installed in a first-class workmanlike manner.
5. Due to the difficulty in showing the exact locations on the drawings of all raceways, offsets, boxes, fittings, or accessories, coordinate the installation with all trades and, where conflicts occur, obtain the Engineer's approval before installation. Failure to do this shall result in rework to meet the Engineer's approval at no additional cost to the Owner's or Engineer's
6. All conductor and raceway sizes shall meet National Electrical Code (NEC) requirements.

1.7 INSPECTION AND PREPARATION

A. General:

1. Prior to starting his work, the Electrical Contractor shall:
 - a. Examine all conditions of all areas in which his work is to be installed.
 - b. Verify all dimensions indicated of the drawings.
 - c. Make all field measurements required for his work.
 - d. Report, in writing to the Engineer, any and all discrepancies or required corrections.
2. Do not proceed with the work until acceptable conditions have been provided.
3. The commencement of work by the Electrical Contractor shall signify the Electrical Contractor's acceptance of all existing conditions.

B. Laying Out of the Work:

1. Lay out work and be responsible for lines, elevations, and measurements for installation of the work. Construct work in conformity with lines and elevations as indicated on the drawings.
2. Record all data on project record documents set.

1.8 BASIC INSTALLATION METHODS

- ### A. Equipment Clearance:
- Coordinate mechanical and electrical equipment locations to ensure that adequate clearance for installation, inspection, and required service is provided. Ensure that adequate clearance is maintained around equipment as required by the National Electrical Code and all applicable state and

local codes.

B. General Supports: Provide all necessary angles, channels, brackets, or Unistrut supplementary steel as required for adequate support of all raceway, specialties, and equipment which is hung or mounted above the floor. Secure written approval from the Engineer before welding or bolting to steel framing or anchoring to concrete structure.

C. Wall, Floor, and Ceiling Openings:

1. Place all sleeves and advise affected trades of details and templates of all openings necessary for the installation of the electrical work.
2. Cracks and rough edges left following installation of the equipment shall be caulked, covered, or repaired to the satisfaction of the Engineer.
3. Do not locate any sleeves in any structural member without written approval of the Engineer. Use rotary type drilling tools and concrete cutting saws to cut concrete and masonry walls. Do not use torches for cutting steel.
4. Where piping or equipment is suspended from a metal deck, use "Ramset" or "Hilti" equipment as required.
5. Floor sleeves shall be rigid galvanized steel conduit with the bottom end flush and caulked with glass wool; sealed at the top and bottom.
6. Wall sleeves shall be the same as floor sleeves except that they shall be installed so as to be flush on both sides of the wall.
7. All sleeves shall have an inside diameter one (1) inch larger than the outside diameter of the raceway passing through them.
8. Where exposed pipes pass through floors, walls, or ceilings, this contractor shall be responsible for repairs and finish of all holes placed.
9. All conduits penetrating through slabs shall be waterproofed and sealed to prevent the transfer of water. Use a grout mixture to seal the concrete or "Duxseal" to seal the sleeves.
10. Where conduits and sleeves pass through fire rated partitions, floors, and/or walls, the space between the pipe and the sleeve shall be sealed with an approved material and system such as 3M Fire Barrier Penetration Sealing system as manufactured by the Electro-Products Division/3M, St. Paul, MN 55144.

D. Cutting and Patching:

1. Cutting and patching shall be in accordance with Division 1, Cutting and Patching, and this section.
2. Cutting and patching required by the installing Contractor or Subcontractor shall be performed by the installer under the direct supervision of the General Contractor. Patching shall be, in general, to the same standards of finish and appearance as the adjacent undisturbed material.

Should it be necessary to achieve this condition, the installer shall employ those specialty workmen as may be required at no additional cost to the Owners.

E. Access Panels:

1. Items of equipment which require accessibility, adjustment, maintenance, or observation such as

junction boxes, controls, etc., shall be located and arranged for ready access either directly or through the use of access doors.

2. Notify the Engineer and all affected trades where and of what size and/or configuration access doors will be installed. Secure the approval of the Engineer for these locations and configurations.
3. Such access doors/panels shall meet or exceed the fire barrier rating of the floor, wall, or partition into which they are inserted.

F. Protection:

1. Each Contractor or Subcontractor shall protect his work, fixtures, equipment, and materials at all times and be responsible for all damages caused either directly or indirectly by his workmen or by project conditions.
2. All raceway openings shall be kept tightly closed with caps or plugs (not paper) during installation whenever openings are left unattended.

G. General Cleaning:

1. It shall be the duty of this Contractor to keep the premises free of accumulations of surplus material or rubbish caused by his operations and/or the operations of his Subcontractors. Combustible rubbish and debris shall be removed immediately. The trades shall remove their rubbish and debris from the project site promptly upon its accumulation; in no event later than the Friday of each week.
2. Upon completion of the installation, the Contractor shall thoroughly clean all fixtures, equipment, boxes, and raceways.
3. All patching, repairing, and painting required of surfaces damaged or allowed to deteriorate in the performance of this work made by this Contractor, where directed by the Engineer, at this Contractor's expense.
4. If a Contractor does not remove rubbish or clean the systems as specified above, the Construction Manager reserves the right to have the work performed by others, with the cost back-charged to the Contractor who made the removal or cleaning necessary.
5. Clean all fixtures, boxes, controls, devices, cabinet interiors, enclosures, and other applicable equipment and accessories free of all foreign material.

1.9 FINAL ACCEPTANCE, GUARANTEES AND WARRANTIES

A. General: Final acceptance of the systems, guarantees and warranties shall be in accordance with General Conditions (Division 1), this section and other applicable sections.

B. Final Acceptance: Final acceptance of the systems will be made only after final punch list completion and receipt at the Engineer's office of:

- . All guarantees and/or warranties.
- . Operating and maintenance instructions.
- . Record drawings.
- . Certificates of Inspection.
- . Test reports.

- . Health Department approval.
- . Required affidavits for State Fire Marshal.

C. Guarantees and Warranties: Guarantees shall be in accordance with the applicable specification section and the following:

1. All labor, materials and equipment shall be guaranteed by the Contractor and/or warranted by the manufacturer for one (1) calendar year after date of final acceptance, except where specific, longer periods are specified. Contractor shall secure such warranties from all suppliers.
2. Acceptance data of substantial completion or Owner occupancy shall be as determined by Engineer.
3. Make all necessary alterations, repairs, adjustments and replacements during guarantee period as directed by Engineer to comply with drawings and specifications. Such work shall be at no cost to the Owner.
4. Repair or replacements made under guarantee shall bear one (1) year extended guarantee from date of acceptance of repair or replacement.

D. Operating and Maintenance Instructions and Manuals:

1. Submit to the Engineer operating and maintenance instructions, including the following:
 - a. Periodic maintenance items.
 - b. Seasonal maintenance items.
 - c. Preventative maintenance items.
 - d. List of service agents for all major equipment.
 - e. List of suppliers for replacement/service parts.
2. Provide the service of factory-trained personnel for such period(s) of time as required to instruct and train the Owner's personnel in the operation and maintenance procedures for all major pieces of equipment, i.e., lighting control panel, variable speed drives, etc.
3. Provide instructions to the Owner on locations of hand valves, fire dampers and other concealed or partially concealed items, etc.
4. Provide instructions to the Owner on the location and function of all control devices, fuses, disconnects, etc.
5. A letter from the installing Contractor, certified by the Owner, shall be submitted to the Engineer when all instructions have been given.

E. Operating Personnel and Maintenance: This Contractor shall provide operating personnel and required maintenance for building equipment being used by him, such as for temporary electricity, etc. After all or portions of the equipment or systems have been granted a date of substantial completion, the Contractor shall provide operating personnel and maintenance for such equipment or systems.

F. Record Drawings:

1. Provide a clean and neat set of record drawings which shall show all changes, all main control devices, all disconnecting means, all buried conduits (with dimensioned references to building lines and grades). Record drawings shall be recorded daily.

2. Record all elevations and locations prior to concealment.
3. Provide these drawings to the Engineer for his transmittal to the Owner for his use.

G. Affidavits: The Contractor(s) shall submit notarized affidavits as required by the State Fire Marshal regarding the use of approved plastic materials required to complete this work.

1.10 SUPERVISION

- A. This Contractor shall have in charge of the work at all times during construction a thoroughly competent Field Superintendent with long experience in the work to be installed under this contract.

Any person not deemed capable by the Engineer shall be replaced immediately, upon the request of the Engineer, by some person who is satisfactory to the Engineer. After such person has been assigned, he shall not be withdrawn or reassigned without the consent of the Engineer.

END OF SECTION 26 0500

SECTION 26 0510 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Electrical equipment coordination and installation.
 - 2. Sleeves for raceways and cables.
 - 3. Sleeve seals.
 - 4. Common electrical installation requirements.

1.3 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

- A. Test Equipment Suitability and Calibration: Comply with NETA ATS, "Suitability of Test Equipment" and "Test Instrument Calibration."

1.5 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.

- D. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

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 manufacturers specified.

2.2 SLEEVES FOR RACEWAYS AND CABLES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.3 SLEEVE SEALS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Metraflex Co.
 - d. Pipeline Seal and Insulator, Inc.
 - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
 - 3. Pressure Plates: Stainless steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require a different clearance.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

3.3 SLEEVE-SEAL INSTALLATION

- A. Install to seal underground, exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIELD QUALITY CONTROL

- A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work.

END OF SECTION 26 0510

SECTION 26 0511 – ELECTRICAL DEMOLITION FOR REMODELING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Interior demolition, removal and abandonment of interior electrical systems.
- B. Cleaning and repair of existing equipment to remain.

PART 2 - EXECUTION

2.1 EXAMINATION

- A. Verify that abandoned wiring and equipment serve only abandoned facilities.
- B. Beginning of demolition means installer accepts existing conditions.

2.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary wiring and connections to maintain existing systems in service during construction.

2.3 DEMOLITION EXISTING ELECTRICAL WORK

- A. Remove existing installations to accommodate requirements for new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- E. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.

2.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.

END OF SECTION 26 0511

SECTION 26 0519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Senator Wire & Cable Company.
 - 4. Southwire Company.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper complying with NEMA WC 5; stranded conductor.
- D. Conductor Insulation Types: Type THHN-THWN complying with NEMA WC 5.

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. AMP Incorporated/Tyco International.
 - 3. Hubbell/Anderson.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. 3M Company; Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- D. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Control Circuits: Plenum rated cable.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.3 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.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before 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 7.3.1. Certify compliance with test parameters.

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions 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 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.

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. Apache Grounding/Erico Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erico Inc.; Electrical Products Group.
 - g. Framatome Connectors/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Harger Lightning Protection, Inc.
 - j. Hastings Fiber Glass Products, Inc.
 - k. Heary Brothers Lightning Protection Co.
 - l. Ideal Industries, Inc.
 - m. ILSCO.
 - n. Kearney/Cooper Power Systems.
 - o. Korn: C. C. Korn Co.; Division of Robroy Industries.
 - p. Lightning Master Corp.
 - q. Lyncole XIT Grounding.
 - r. O-Z/Gedney Co.; a business of the EGS Electrical Group.

- s. Racco, Inc.; Division of Hubbell.
- t. Robbins Lightning, Inc.
- u. Salisbury: W. H. Salisbury & Co.
- v. Superior Grounding Systems, Inc.
- w. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- G. 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.
- H. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

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: Bolted-pressure-type connectors, or compression type.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

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.
- B. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:
 - 1. Single-phase motor.
 - 2. Three-phase motor.
 - 3. Flexible raceway runs.
 - 4. Armored and metal-clad cable runs.

3.3 INSTALLATION

- A. 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.
- B. 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.
- C. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- D. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- E. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

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. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. 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.
- C. Non-contact 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- D. 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.
- E. 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.
- F. 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. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells.

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.

- a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526

SECTION 26 0533- RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. LFNC: Liquidtight flexible nonmetallic conduit.
- F. RNC: Rigid nonmetallic conduit.

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. Comply with NFPA 70.

1.5 COORDINATION

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Steel Set-Screw
- E. FMC: Aluminum.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

- A. Manufacturers:
 - 1. American International.
 - 2. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 3. Aruco Corp.
 - 4. Cantex Inc.
 - 5. Certaineed Corp.; Pipe & Plastics Group.
 - 6. Condux International.
 - 7. ElecSYS, Inc.
 - 8. Electri-Flex Co.
 - 9. Lamson & Sessions; Carlon Electrical Products.
 - 10. Manhattan/CDT/Cole-Flex.
 - 11. RACO; Division of Hubbell, Inc.
 - 12. Spiralduct, Inc./AFC Cable Systems, Inc.
 - 13. Thomas & Betts Corporation.
- B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.
- C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

- D. LFNC: UL 1660.

2.4 METAL WIREWAYS

- A. Manufacturers:
 - 1. Hoffman.
 - 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS

- A. Manufacturers:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
- B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

2.6 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating and enamel finish.

1. Manufacturers:
 - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
 - b. Thomas & Betts Corporation.
 - c. Walker Systems, Inc.; Wiremold Company (The).
 - d. Wiremold Company (The); Electrical Sales Division.

- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.7 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers:
 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 2. Emerson/General Signal; Appleton Electric Company.
 3. Erickson Electrical Equipment Co.
 4. Hoffman.
 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 6. O-Z/Gedney; Unit of General Signal.
 7. RACO; Division of Hubbell, Inc.
 8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet-PLM Division.
 10. Spring City Electrical Manufacturing Co.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Floor Boxes: Cast metal, fully adjustable, rectangular.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
- H. 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.

2.8 FACTORY FINISHES

- A. Finish: For raceway, enclosure or cabinet components provide manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: For raceway, enclosure or cabinet components provide manufacturer's standard grey paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - 4. Damp or Wet Locations: Rigid steel conduit.
 - 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- B. Minimum Raceway Size: 1/2-inch trade size.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches of 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. Run conduit larger than 1-inch trade size parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 4. Change from nonmetallic tubing to Schedule 80 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
1. Use insulating bushings to protect conductors.
- K. Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- N. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor.

Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

- O. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- P. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- Q. Set floor boxes level and flush with finished floor surface.
- R. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533

SECTION 26 2200 – LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
 - 1. Distribution transformers.

1.3 SUBMITTALS

- A. Product Data Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Shop Drawings: Wiring and connection diagrams.
- C. Source quality-control test reports.
- D. Output Settings Reports: Record of tap adjustments specified in Part 3.

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. Comply with IEEE C 57.12.91.
- C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturer:

1. Square D/Groupe Schneider NA.
2. Cutler Hammer

2.2 MATERIALS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices, except for taps.
 1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Cores: One leg per phase.
- C. Enclosure: Ventilated, dripproof, NEMA 250, Type 2.
- D. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."
 1. Finish Color: ANSI 49 gray.
- E. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.
- F. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- G. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install floor-mounting transformers level on floor.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power 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.

3.4 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

END OF SECTION 26 2200

SECTION 26 2413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes service and distribution switchboards rated 600 V and less.

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. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 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 for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of switchboards and overcurrent protective devices.
 - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - e. Utility company's metering provisions with indication of approval by utility company.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring.

- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including 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.
- E. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain switchboards through one source from a single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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 2, "Deadfront Distribution Switchboards."
- E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subjected to weather, cover switchboards to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchboards; install electric heating (250 W per section) to prevent condensation.
- D. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 110 deg F.
 - 2. Altitude: Not exceeding 6600 feet.
- C. Service Conditions: NEMA PB 2, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.8 COORDINATION

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

1.9 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. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.

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 manufacturers specified.

2.2 MANUFACTURED UNITS

- A. Manufacturer:
 - 1. Square D.
 - 2. Cutler Hammer

- B. Front-Connected, Front-Accessible Switchboard: Fixed, individually mounted main device, panel-mounted branches, and sections rear aligned.
- C. Nominal System Voltage: 480Y/277V-3Ø-4w.
- D. Main-Bus Continuous: 2500A.
- E. Enclosure: Steel, NEMA 250.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish, over a rust-inhibiting primer on a treated metal surface.
- G. Insulation and isolation for main bus of main section.
- H. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.
- I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- J. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder line connections.
 - 2. Load Terminals: Insulated, rigidly braced, silver-plated, copper runback bus extensions equipped with pressure connectors for outgoing circuit conductors.
 - 3. Ground Bus: 1/4-by-2-inch-minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder.
 - 4. Contact Surfaces of Buses: Silver plated.
 - 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, 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. Adjustable magnetic trip setting for circuit breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and 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 display, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400A and smaller; 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; 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. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- C. Molded-Case Circuit Breaker: NEMA AB 3, 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. Adjustable magnetic trip setting for circuit-breaker frame sizes 250A and larger.

2.4 IDENTIFICATION

- A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

2.5 INSTRUMENTATION

- A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive switchboards 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. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install and anchor switchboards level on concrete bases, 4-inch nominal thickness. Concrete base is specified in Division 26 Section "Basic Electrical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
 - 2. For switchboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to switchboards.
- C. Comply with mounting and anchoring requirements specified in Division 16 Section "Electrical Supports and Seismic Restraints."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- F. Install overcurrent protective devices.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each switchboard 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, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. 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.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. 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 26 2413

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. 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. Product Data: For each type of panelboard, overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. 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.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including 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.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," 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. Refer to Division 1 Section "Product Requirements."

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.

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.
2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

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.

1.8 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. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Manufacturer:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Square D.
 - b. Cutler Hammer

2.2 MANUFACTURED UNITS

- A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.
 - 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 - 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- 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.

- 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.
 - 3. Feed-Through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 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.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: UL 489, 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. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and 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; 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; 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim 74 inches 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. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power 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.

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 26 2416