SECTION 01-00-00
GENERAL REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01-30-00 – Administrative Requirements – Electrical

B. Section 01-70-00 – Execution and Closeout Requirements – Electrical

C. Section 01-78-00 – Closeout Submittals – Electrical

1.02 SCOPE

A. The Work to be performed under this section of the specifications includes the furnishing of all materials, labor, supervision, and tools necessary to install complete electrical systems in good operating order and in accordance with the plans, specifications, and applicable codes and standards.

1.03 CODES AND STANDARDS

A. All electrical Work performed under these plans and specifications shall be in conformance with:
   1. The National Occupational Safety and Health Administration requirements.
   2. The National Electrical Code (ANSI/NFPA 70), Latest Edition as Adopted by State and Local Jurisdiction.
   3. The International Building Code (IBC), Latest Edition as Adopted by State and Local Jurisdiction.
   4. The Life Safety Code (NFPA 101), Latest Edition as Adopted by State and Local Jurisdiction.
   5. The Standard for Electrical Safety in the Workplace (NFPA 70E), Latest Edition as Adopted by Owner.
   6. All other applicable Federal, State, and/or Local laws and ordinances.

1.04 CONTRACTOR QUALIFICATIONS AND REPRSENTATIONS

A. Contractor represents and warrants to Owner to be an established as a electrical contractor possessing valid Federal, State, and Local licensure required to perform Work within the jurisdiction and has previous experience in the satisfactory installation of at least three (3) systems of this type and size. Failure to possesses and maintain licensure during Work shall constitute a breach of contract.

B. Contractor represents and warrants to Owner to possess knowledge, experience, and skill of the craft necessary to furnish Owner a complete, functional, and code compliant installation.

C. To furnish this to Owner, Contractor represents and warrants to Owner to:
   1. Employ and maintain a competent level of supervision for the performance at the Work at the project site, including a superintendent who shall be present at the Project site at all times during which Work is being performed.
   2. Allow only fit and “qualified electrical workers” to perform the Work.

D. The Contractor shall be responsible to Owner for all electrical Work indicated by the Plans and Specifications, including specialized electrical trades with whom the Contractor may subcontract, such as a Certified Fire Alarm or Low-Voltage Security providers.

1.05 BID SUBMITTAL

A. Contractor shall examine Plans and Specifications relating the Work of all trades and become fully informed as to the extent and character of Work and its relation to all other work in the project. In addition, in preparing bid, the contractor shall carefully check the plans and specifications for compliance with applicable codes and other legal requirements. Contractor shall inform Owner in writing (email acceptable) of any discrepancy before bid is submitted.

B. Electrical Contractor should visit the site and familiarize themselves with the existing working conditions and scope of the project. Contractor shall inform Owner in writing (email acceptable) of any discrepancy before bid is submitted.

C. The submission of a bid by the Contractor will be evidence that that Contractor has inspected documents and site conditions. Later claims for labor (including qualified daily supervision), equipment or materials required for difficulties encountered which could have been foreseen will not be allowed.

1.06 PERMITS AND INSPECTIONS

A. The Bidder declares that it has examined the site of the Work, having become fully informed regarding all pertinent conditions, and that it has examined the Plans and Specifications (including all Addenda received) for the Work and the other Bid and Contract Documents relative thereto, and that it has satisfied itself relative to the Work to be performed.

B. Contractor shall obtain approval and permits for all work indicated on plans and in specifications from all AHJ, including (but not limited to) the Building Official, Electrical Inspector, or Fire Department. All licenses, permits, inspections, and other such requirements to lawfully perform the work shall be paid for by the Contractor. Failure to obtain necessary permits and inspections shall constitute a breach of contract.

C. Contractor shall cooperate with and assist the Owner in securing from an AHJ any special permission or interpretation needed to complete the Work.

D. After completion of the Work, Contractor shall submit to the Owner certificates of final inspection and approval from applicable AHJ.

E. Notwithstanding a satisfactory inspection by any AHJ, the responsibility to provide Owner with a complete, functional, and code–compliant installation remains solely with Contractor.

1.07 CONTRACTOR WARRANTIES – UNLESS SUPERSEDED BY CONTRACT

A. Material and Equipment: The Contractor warrants to the Owner that materials and equipment furnished for this project will be of good quality, new (unless otherwise permitted) with vendor warranties, and approved by Underwriters Laboratories (UL); that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform with the requirements of the contract documents, including plans and specifications. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective.

Manufacture warranties for electrical equipment follow product ownership. Although the Contactor warrants to assists Owner with warranty claims, the Contractor's warranty shall not extend beyond the scope of coverage of or remedies provided in the manufacture warranty. Additionally, the Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage.

B. Workmanship: Contractor warrants to Owner that all construction services provided will be performed in a good and workmanlike manner, by workers who are appropriately trained and experienced in the work being performed, and in accordance with all requirements of the contract documents, industry standards for projects of similar type and quality, and all applicable laws, codes, regulations and other requirements, including safety requirements. Work not conforming to these requirements may be considered by Owner to be defective.

C. Callback Remedy: If, within one (1) year after the date of Substantial Completion any of the Work is found to be not in accordance with the requirements of the contract documents, the Contractor shall correct it promptly after receipt of written notice from the Owner to do so unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. This obligation to remedy Work shall survive acceptance of the Work under the Contract and termination of the contract.

1. Nothing contained in this remedy shall be construed to establish a period of limitation with respect to other obligations which the Contractor might have under the Contract Documents. Establishment of the time period of one (1) year relates only to the specific obligation of the Contractor to correct the Work when notified by Owner, and has no relationship to the time within which an obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability under applicable Statutes of Limitations or Repose.

1.08 PLANS AND SPECIFICATIONS

A. Project Plans and Specification shall be considered as complimentary to each other. What is called for by one shall be as binding as if called for by both as each is incorporated by reference into the other. Where conflicts occur, Contractor shall secure clarification from Owner in advance of bidding or construction.

B. Plans and specification diagrammatically and descriptively indicate the extent, general character, and the approximate location of the work to be performed, but cannot reasonably show all details of construction or reference all code requirements necessary for a satisfactory installation. Items not specifically shown on the plans or mentioned in the specifications, but essential to the proper completion of the work, shall be furnished and installed as if specified and shown. Where work is indicated but minor details omitted from these plans and specification, Contractor shall furnish and install the work so as to perform its intended function.

C. Due to constraints imposed by an existing facility, it is not practicable to identity all existing site conditions and show them on plans and specifications. Site conditions or items may be discovered during construction that not shown on these documents. If the Contractor discovers site conditions or items not shown or identifies discrepancies with these documents, it is the Contractor's responsibility to promptly present them in writing (email acceptable) to Owner. If the Contractor proceeds with work without prior written approval Owner, the Contractor accepts liabilities resulting from nonconformance, including correcting construction defects without cost to the Owner.

D. Omissions from the plans and specifications or the misdescription of details of work which are evidently necessary to carry out the intent of the plans and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omissions and details of work; they shall be performed as if fully and correctly set forth and described in the plans and specifications.

E. Scales on plans should be used as a general reference and the locations shown on the plans should be considered approximate. The Contractor shall verify existing and actual conditions before beginning construction and promptly notify Owner in writing (email acceptable) of any discrepancies. Equipment dimensions shall come from manufacture's shop–drawings or the physical equipment involved in the work. Contractor shall select the actual locations for installation with due consideration for the features of the construction and the work of other trades. If interferences are found between the electrical work and that of other trades, the Owner shall decide which must be relocated. Where locations are dimensioned on the plans, locations may be changed only with the approval of the Owner.

F. These Plans and Specifications were developed in accordance with the agreement that engaged Higgins Electric, Inc. of Dothan to furnish professional engineering services to the Client. Engineering review is limited in nature and covers only the electrical systems, components, and studies contemplated in the Professional Services Agreement. Higgins Electric, Inc. of Dothan expressly disclaims responsibility for items not contemplated in the engagement.

G. These Plans and Specifications are released to the Client under the authority of both Higgins Electric, Inc. of Dothan, an Alabama corporation authorized to provide engineering services, and the licensed professional engineer whose signature and seal is affixed, but documents are released expressly for the purpose shown on the latest title block (i.e., Preliminary, Permit, Construction, etc.). Although documents may be signed and sealed, such documents are not authorized for use until they are approved by all applicable Authorities Having Jurisdiction.

H. An integrated design system is intended by the Plans and Specifications. Unauthorized modification, alteration, deletion, addition, or substitution affecting these documents could result in the failure or unsatisfactory performance of individual components or systems and result in property damage, bodily injury, or death. Revision to these documents requires a full review of the entire system by a licensed professional engineer. Be informed that failure to adhere to these documents likely creates a nonconformance or construction defect with liabilities arising under law and that an unauthorized change to these engineering documents likely constitutes the unlicensed practice of engineering, a crime set forth by State law.

1.09 EQUIPMENT SUBMITTALS

A. See Section 01-30-00 – Administrative Requirements for Electrical Systems for submittal procedures.

B. Electrical Engineer will furnish submittal reviews to Client in accordance with the Professional Services Agreement.

1.10 FIELD COORDINATION

A. It shall be the responsibility of the Contractor to coordinate the electrical service characteristics to each piece of electrically operated equipment with all trades providing electrically operated equipment.

B. Conductor and conduit sizes and associated calculations shown are based on load information provided to Engineer by Others during the design phase. Contractor shall verify the electrical characteristics on the nameplate of actual equipment to be connected and provide circuits and routing of conduits to suit job conditions. In all cases, Contractor shall strictly conform to the NEC 310.15 requirements for derating ampacity and NEC 300.17 requirements for conduit fill. Circuit wire sizes (including equipment grounding conductor per NEC 250.122(B)) shall be increased as required for a maximum of 3% voltage drop. Equipment is to be connected as specified by manufacturer instructions per NEC 110.3(B).

C. NEC 220.87 was applied during the design phase by Engineer to evaluate existing circuit and equipment loading If during construction loads are rearranged, additional loads are added, or equipment with different electrical characteristics is installed, then NEC Article 220 shall be followed to prevent overloading existing electrical circuits and equipment.

D. For interrupting rating of overcurrent protection and short-circuit current rating of equipment, Engineer relied upon existing short–circuit current values furnished by Others or performed a short–circuit study (in accordance with the Professional Services Agreement). In all cases, protective devices shall have an interrupting rating equal to or greater than the available fault current at the line side and equipment shall have a short-circuit current rating (SCCR) equal to or greater than the available fault current at the point of application per NEC 110.9 and 110.10, respectively.

E. For emergency lighting and exit signs as shown on plans, Engineer relied upon the means-of-egress specified by others. Should the means-of-egress change during the construction, the emergency lighting and exit signs shall be relocated to meet requirements of IBC and/or NFPA 101 subject to AHJ interpretation. In all cases, the electrical power to emergency lighting shall be in accordance with NEC Article 700 and NFPA 101, Sec. 7.9, and local AHJ requirements.

F. If the Contractor has questions or in his opinion discovers errors or omissions on drawings, it is his responsibility to present them in writing (email acceptable) to the Owner. If Contractor proceeds with changes without prior written approval from Owner, Contractor accepts all responsibility for any damages resulting from nonconformance with these plans and specifications and shall correct any nonconformance without any additional cost to Owner.

1.11 PROGRAMMABLE POWER SYSTEMS DEVICES

A. Unless otherwise denoted on plans, Contractor shall be responsible for developing and applying settings (or parameters) in accordance with NEC, industry standards, and manufacture recommendations to adjustable breakers, relays, overloads, motor controllers (e.g., variable frequency drives, soft–starts), automatic transfer switches, and other such programmable power system devices. This does not include programmable logic controllers (PLC). Contractor shall furnish "As-Left" settings (or parameters) in a written report to Owner for his future reference.

B. Electrical Engineer will furnish settings (or parameters) to Client in accordance with the Professional Services Agreement.

1.12 POWER SYSTEM STUDIES – INVALIDATION

A. This design change substantively modifies the existing electrical system and invalidates any existing Arc–Flash Hazard and Short–Circuit Studies and invalidates arc-flash hazard labels affixed to equipment showing these values. The Owner should reevaluate the electrical system in accordance with Owner's Policies and Procedures.

B. Electrical Engineer will furnish power system studies to Client in accordance with the Professional Services Agreement.

1.13 AS–BUILT DRAWINGS

A. See Section 01-30-00 – Administrative Requirements and Section 01-78-00 – Closeout Submittals – Electrical for As–Built requirements.

B. Electrical Engineer will furnish Record drawings to Client in accordance with the Professional Services Agreement.

1.14 ELECTRICAL TESTING REQUIREMENTS

A. Contractor shall perform insulation resistance test (Megger) on all new conductors in accordance with ANSI/NETA ATS – *Standard for Acceptance Testing Specifications for Electrical Power Equipment and System* (latest edition). Contractor shall submit written test report to Owner for his record.

B. Contractor shall Perform fall-of-potential in accordance with ANSI/IEEE 81 or an alternative test on the main grounding electrode to remote earth accordance with ANSI/NETA ATS – *Standard for Acceptance Testing Specifications for Electrical Power Equipment and System* (latest edition). Contractor shall submit written test report to Owner for his record.

1.15 SITE–INSPECTIONS

A. Electrical Engineer will furnish site–inspections (e.g., substantial completion) to Client in accordance with the Professional Services Agreement.

B. If Work is not ready for inspection during a scheduled inspection and requires a re–inspection by Engineer, then the Contractor shall pay for the re–inspection in the amount determined by Engineer. Payment shall be made directly to Higgins Electric, Inc. of Dothan. Payment shall be received prior to Engineer scheduling re–inspection.

1.16 WORK SEQUENCE PLAN

A. This Work may require electrical outages to an existing facility. Facility production is to be prioritized during Work planning and Contractor shall minimize downtime associated with all necessary electrical outages. Contractor to coordinate with Owner and Utilities to develop phasing and sequencing plan for Work.

B. Electrical Engineer will furnish engineering review of phasing and sequencing plan to Client in accordance with the Professional Services Agreement.

1.17 POWER COMPANY COORDINATION

A. Contractor shall verify that the location, arrangement, voltage, phase and connections to utility service, as well as the required metering equipment, are coordinated with the applicable power company(ies). If power company requirements are at variance with plans or specifications, the contract price shall include any additional cost necessary to meet these requirements without extra cost to the Owner after the contract is entered into. Any charges for the electrical service to the facility by the utility company shall be included as a separate line item in the Contractor's bid price.

1.18 TEMPORARY POWER

A. Contractor shall be responsible for furnishing and installing equipment and material necessary for providing temporary electrical power and lighting where needed for the construction of the project. Contractor shall not be responsible for monthly utility bills.

B. Contractor shall coordinate with local jurisdiction and utility company(ies) and install temporary electrical systems in accordance with applicable codes and standards, including (but not limited to) NEC Article 590 and OSHA.

1.19 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): The governmental or nongovernmental organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, and installation, or a procedure. The Owner and his authorized representatives, such as his insurance carrier and design professionals are nongovernmental AHJs.

B. Contractor: The individual or legal entity lawfully licensed as an Electrical Contractor and possessing the necessary licensure to perform Work in the jurisdiction of the project.

C. Electrical Engineer: Higgins Electric, Inc. of Dothan possessing corporate engineering certification and a licensed professional engineer for the jurisdiction of the project, and providing electrical engineering services in accordance with Professional Services Agreement.

D. Owner: The individual or legal entity for whom the Work is ultimately performed. The term includes Owner's authorized representatives, such as the design professionals engaged by Owner.

E. Verify: The term as used in plans and specifications shall mean for the Contractor to establish the accuracy of an assumed or unknown condition, such as field-location of equipment in coordination with project parties or to establish the correct wiring requirements in accordance with manufacture submittals and NEC requirements before installation.

F. Work: The electrical construction and services required of the Contractor by these Plans and Specifications or contract with Owner as are necessary to provide the required electrical construction and services to Owner and includes all labor, materials, supplies, equipment, and other items and services.

END OF SECTION

SECTION 01-30-00
ADMINISTRATIVE REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01-00-00 - General Requirements – Electrical

B. Section 01-70-00 - Execution and Closeout Requirements for Electrical Systems – Electrical

C. Section 01-78-00 - Closeout Submittals for Electrical Systems – Electrical

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Make the following types of submittals to Owner:
   1. Requests for Interpretation (RFI).
   2. Material, Systems, and Equipment
   3. As-Built Drawings

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 REQUESTS FOR INTERPRETATION (RFI)

A. Definition: A request seeking one of the following:
   1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
   2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
   1. Prepare a separate RFI for each specific item.
      a. Review, coordinate, and comment on requests originating with subcontractors and/or materials suppliers.
      b. Do not forward requests which solely require internal coordination between subcontractors.

C. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
   1. Include in each request Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
   2. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response, with an explanatory notation.

D. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
   1. Project Name
   2. Issue date, and requested reply date.
   3. Reference to particular Contract Document(s) requiring additional information/interpretation. Identify pertinent drawing and detail number and/or specification section number, title, and paragraph(s).
   4. Annotations: Field dimensions and/or description of conditions which have engendered the request.
   5. Contractor's suggested resolution: A written and/or a graphic solution, to scale, is required in cases where clarification of coordination issues is involved, for example; routing, clearances, and/or specific locations of work shown diagrammatically in Contract Documents. If applicable, state the likely impact of the suggested resolution on Contract Time or the Contract Sum.

E. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

F. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
   1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
   2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.

3.02 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Final Correction Punch List for Substantial Completion.

B. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01-78-00 - Closeout Submittals for Electrical Systems:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.

3.03 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Provide a Contractor's statement certifying that Contractor has verifed the products and materials, investigated field dimensions and site conditions, and reasonably believes the equipment submitted is in accordance with the requirements of the work and Contract Documents.
      a. By transmitting submittals, the Contractor represents to Owner and Electrical Engineer that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Contract Document.
      b. Submittals from sources other than the Contractor, or without Contractor's statment of review will be recognized, and will be returned "Not Reviewed".
   3. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
   4. Identify variations from Plans and Specifications and product or system limitations that may be detrimental to successful performance of the completed work.
   5. When revised for resubmission, identify all changes made since previous submission.
   6. Submittals not required by project specifications will be recognized, and will be returned "Not Reviewed"

3.04 SUBMITTAL REVIEW

A. Submittal review will be furnished by Electrical Engineer to Client in accordance with the Professional Services Agreement.

B. Contractor will review and approve each submittal as a condition precedent for Engineering review.
   1. Contractor review is for the purpose of determining and verifying materials, field measurements and field construction criteria related thereto and checking and coordinating the information contained within submittals with the requirements of the Contract Documents.

C. Owner will review and approve each submittal as a condition precedent for Engineering review.
   1. Owner review is for the limited purpose of preferred color, finish, or other aesthetic selections and conformance with any specific technical or functional requirements that have not been incorporated into project specifications.

D. Submittals for Review: Engineer will review each submittal, and approve, or take other appropriate action.
   1. Engineering review is for the limited purpose of checking conformance with information given and the design concept expressed in the Contract Documents. Engineering review is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor. The Contractor shall not be relieved of responsibility for errors or omissions of within submittals, by approval of the Engineer. Engineering review shall not constitute approval of safety precautions or of any construction means, methods, techniques, or procedures. Engineering approval of a specific item shall not indicate approval of an assembly of which the item is a component.

E. Submittals for Review: Specialized Systems
   1. Engineering review of fire alarm and notification submittals is limited to verifying the provider NICET licensed within the project jurisdiction. Engineer relies upon the specailized knowlege of NICET designer to approve fire alarm and notification submitals and does not perform technical level review of the submittals.
   2. Engineering review of low–voltage submittals is limited to ensuring provider is properly licensed. Engineer relies upon the specialized knowlege of liscensed low voltage provider to approve low–voltage submittals and does not perorm technical level review of the submittals.
   3. Engineering review of lightning protection systems is limited to verify the provider is LPI certified. Engineer relies upon the specialized knowledge of LPI certified designer to approve lightning protection submittals and does not perform technical level review of the submittals.

F. Engineer's actions will be reflected by marking each submittal using a submittal review sheet.

G. Engineer's actions on items submitted for review:
   1. Authorizing purchasing, fabrication, delivery, and installation:
      a. "Reviewed - No Exceptions Taken", or language with the same legal meaning.
      b. "Reviewed - Exceptions Taken - See Comments", or language with the same legal meaning.
   2. Not Authorizing fabrication, delivery, and installation:
      a. "Reviewed - Exceptions Taken - Resubmittal Required", or language with the same legal meaning.
      b. "Reviewed - Rejected - Resubmittal Required", or language with the same legal meaning.

3.05 AS-BUILT AND RECORD DRAWINGS

A. Definitions:
   1. As-Built Drawing: As-built drawings are prepared by the Electrical Contractor in accordance with project contracts. As-built drawings show the field changes to the original construction documents. This term is not synonymous with "Record" drawing.
   2. Record Drawing: Record drawings are prepared by the Electrical Engineer and reflect the field changes the electrical contractor annotated in the as-built drawings. Record drawings are complied into CAD and submitted to Client for record. This term is not synonymous with "As-Built" drawing.

B. See Section 01-78-00 - Closeout Submittals for Electrical Systems for specific As-Built drawing requirements.

C. Record drawings will be prepared by Electrical Engineer and provided to Client in accordance with the Professional Services Agreement.

END OF SECTION

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SECTION 01-70-00
EXECUTION AND CLOSEOUT REQUIREMENTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01-00-00 - General Requirements – Electrical

B. Section 01-30-00 - Administrative Requirements for Electrical Systems – Electrical

C. Section 01-78-00 - Closeout Submittals for Electrical Systems – Electrical

1.02 COORDINATION

A. Notify affected utility companies and comply with their requirements.

B. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with plans and specifications, to minimize disruption of Owner's activities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 SAFETY

A. Electrical Contractor is to exercise complete control and supervision of all electrical work as pertains to the safety of all persons, equipment, and real property. Only "qualified persons" (as defined by OSHA and NFPA) who are familiar with the construction and installation of electrical power distribution, equipment, and control systems and shall perform electrical work.

B. The Contractor shall enforce safety procedures, strict discipline, and good order or acting on its behalf. The Contractor will remove from its employment on the Project any person who deliberativley or persistently produces non-conforming Work or who fails to conform to reasonable rules of personal conduct implemented by Owner.

3.02 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.

D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

E. Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install products as specified and in accordance with manufacturer's instructions per NEC 110.3, and so as to avoid waste due to necessity for replacement.

B. Work shall be performed in a neat and workmanlike manner in complicance with NEC 110.12 and latest edition of ANSI/ NECA –1, *Standard for Good Workmanship in Electrical Construction.*

3.04 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching. Coordinate with other trades as work progresses so cutting and pathching will not be required or be minimal.

B. Where cutting and pathaching is required, provide cutting and patching uner the supervision of the general contractor as required for electrical work.

C. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

3.05 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.06 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

B. Provide special protection where specified in individual specification sections.

C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings when moving electrical equipment.

E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.

F. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.07 SYSTEM TESTING AND STARTUP

A. Contractor shall coordinate schedule for start-up of various equipment and systems.

B. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

C. Execute start-up under supervision of applicable Contractor personnel and Owner's personnel in accordance with manufacturers' instructions.

D. When specified, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

E. Contractor shall provide all testing instruments, equipment and all materials, connections, labor, etc., required to perform tests.

F. Contractor's personnel experienced with system should energize equipment and system for the first time. If short circuit conditions caused by damage or poor installation practices have not been detected, serious personal injury and damage can occur when the power is turned on.

G. The following is general industry guidance. The Contractor shall perform specific start-up activities in accordance with his work practices and safety procedures.

H. Prior to energization,

1. Verify that power system devices have proper settings (parameters) and submit settings report to Owner.
2. Verify each piece of equipment and systems for freedom from grounds, shorts, and open circuits. Verify that circuits and equipment have been tested (Meggered) satisfactorily. Note that some electronic equipment (metering, SPD, etc.) may be damaged by this testing. Submit final written insulation resistance (Megger) to Owner.
3. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
4. Make certain that all foreign material, including blocks and packing materials used for shipment, tools for construction activities, trash, dirt, or debris have been removed from equipment.
5. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely. If devices with self-test function are installed, perform test and verify proper operation per the manufacturer’s instructions.
6. Turn off all of the downstream loads in switchgear, panelboard, and equipment disconnects to limit and prevent equipment damage if the electrical characteristics are not as expected when the system is first energized.

I. After energization,
1. Perform voltage tests, meter readings, and observe other indications to confirm that the systems electrical characteristics agree with those required by plans and specifications or the equipment or system manufacturer.
2. The equipment should be energized in sequence by starting at the source end of the system and working towards the load end. In other words, energize the main devices, then the feeder devices, and then the branch-circuit devices. Do NOT energize the system without verifying proper voltage and phase sequence at first disconnect.
3. After the electrical system is sufficiently loaded, safely measure or observe voltage at switchgear, panelboards, equipment, and outlets. Make, or request the utility company make, final transformer tap adjustments based on these measurements.

3.08 DEMONSTRATION AND INSTRUCTION

A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location to Owner's personnel.

3.09 CLOSEOUT PROCEDURES

A. Electrical Engineer will furnish Certificate of Substantial to Client in accordance with Professional Services Agreement.

B. Contractor will submit written certification to Owner stating that plans and specfification have been reviewed, Work has been self-inspected and found to be in accordance with plans and specifications, and Work is ready for Owner's Substantial Completion inspection.

C. Contractor will support Substantial Completion inspection as required by Owner.

D. Contractor will correct items listed in Final Correction Punch List and submit to Owner.

E. Notify AHJ when work is considered ready for final inspection and obtain satsifactory inspection.

F. Complete any outstanding items of work determined by Owner listed in the executed Certificate of Substantial Completion.

END OF SECTION

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SECTION 01-78-00
CLOSEOUT SUBMITTALS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 01-00-00 - General Requirements - Electrical

B. Section 01-30-00 - Administrative Requirements for Electrical Systems – Electrical

C. Section 01-70-00 - Execution and Closeout Requirements for Electrical Systems – Electrical

1.02 CLOSEOUT SUBMITTALS

A. Submittal of satisfactory Project Closeout Submittals to Owner is a condition precedent for Contractor receiving final payment. Illegible or incomplete submittals will be returned to Contractor for correction.

B. Project Record Documents: Submit the following Closeout Submittals to Owner with claim for final Application for Payment.
   1. As-Built Drawings
   2. Underground Survey (GPR) Report and Drawings
   3. Ground Resistance Test Report
   4. Pictures of Concealed Work

PART 3 EXECUTION

2.01 PREPARATION OF AS-BUILT DRAWINGS

A. Contractor shall maintain on site the following documents and on these shall indicate all field changes ("redlines") made in any portion of the work during the course of construction, regardless of the reason for the change.

B. Contractor shall maintain on site the following documents and on these shall indicate all field changes ("redlines") made in any portion of the work during the course of construction, regardless of the reason for the change.
   1. Drawings.
   2. Specifications.
   3. Change Orders and other modifications to the Contract.

C. Ensure entries are complete and accurate, enabling future reference by Owner.

D. Record information concurrent with construction progress so as to maintain an accurate As-Built documentation of the project. Particular attention shall be given to concealed work that would be difficult to measure and record at a later date.

E. General Requirements
   1. The drafting of changes on the drawings shall be done neatly with the aid of appropriate drafting tools (CAD not required), so that they are legible and readily understood.
   2. Cross out words such as "equal to" and document the specific equipment information.
   3. Provide complete and accurate explanation to describe changes. Avoid abbreviations or shorthand notes that would not be understood by Owner or others.

F. As-Built Product Specifications: Legibly mark and record the actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized (as approved by Owner).

G. As-Built Drawings: Legibly mark each item to record actual construction including:
   1. Record actual locations of grounding electrode system components and record location and depth (in.) of of bonding connections. Measured horizontal and vertical locations of concealed equipment will be referenced to permanent surface improvements.
   2. Record actual routing and depth (in.) for conduits installed underground on site–layout, conduits embedded within concrete slabs, and routing for exposed conduits 2-inch or larger. Measured horizontal and vertical locations of concealed equipment will be referenced to visible and accessible features.

3. Record actual installed locations of switchboards, panelboards, transfer switches, and other equipment and final adjustable settings.
4. Length (ft.) and size (AWG, kcmil) of all installed conductors.
5. Field details not on original drawings helpful to future reference by Owner.

H. To ensure all drawings were reviewed for changes by the Electrical Contractor, each As-Built drawing sheet shall have the date was reviewed and the name of the reviewer in the lower right-hand corner, whether or not there are field changes on the sheet.

I. By submitting As-Built information, the Contractor represents to Owner that the Contractor has completely and accurately documented changes and information that will enable future reference by the Owner.

2.02 RECORD DRAWINGS

A. Higgins Electric, Inc. of Dothan shall prepare and furnish Record drawings to the Client in accordance with Professional Service Agreement.

END OF SECTION

SECTION 26-05-19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUBMITTALS

A. See Section 01-30-00 - Administrative Requirements for Electrical Systems, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. As-Built Documents: Record actual installed circuiting arrangements and sizes. Record actual routing for underground circuits and depth.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

E. Conductors for Grounding and Bonding: Also comply with Section 26-05-26.

F. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

G. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 100 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 250 feet: 10 AWG, for voltage drop.
         4) 20 A, 277 V circuits longer than 400 feet: 8 AWG, for voltage drop.
         5) Where phase conductors are increased in size for voltage drop, wire type equipment grounding conductors shall be increased in size proportional to the increase in circuilar mil area of the phase conductor.
   2. Control Circuits: 14 AWG. 1

H. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

I. Conductor Color Coding:
   1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
   2. Color Coding Method: Integrally colored insulation.

3. Color Code:
    a. 208Y/120 V, 3 Phase, 4 Wire System:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
        4) Neutral/Grounded: White.
    b. 240/120 V, 1 Phase, 3 Wire System:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Neutral/Grounded: White.
    c. Equipment Ground, All Systems: Green.
    d. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
    e. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
    1. Feeders and Branch Circuits:
        a. Size 14 AWG and Smaller: Solid or Stranded w/ Crimp Termination.
        b. Size 12 AWG and Larger: Stranded.
    2. Control Circuits: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
    1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2.

2.04 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
    1. Size 14 AWG and Smaller: Solid.
    2. Size 12 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Grounding: Full-size integral equipment grounding conductor.

F. Armor: Aluminum or steel, interlocked tape.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26-05-26.

C. Wiring Connectors for Terminations:
    1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
    2. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
    3. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
    4. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.

5. Conductors for Control Circuits: Use crimped terminals for all connections.

D. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

E. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that work likely to damage wire and cable has been completed.

B. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

C. Verify that field measurements are as indicated.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
      a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
      b. Increase size of conductors as required to account for ampacity derating.
   6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install metal-clad cable (Type MC) in accordance with NECA 120.

C. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

D. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.

E. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

F. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.

G. Install conductors with a minimum of 12 inches of slack at each outlet.

H. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

K. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

L. Insulate ends of spare conductors using vinyl insulating electrical tape.

M. Identify conductors and cables in accordance with Section 26-05-53.

N. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.03 FIELD QUALITY CONTROL

A. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors only required for conductors larger than _____. The resistance test for parallel conductors listed as optional is not required required.
   1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.

B. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26-05-26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

A. Section 26-05-36 - Cable Trays for Electrical Systems: Additional grounding and bonding requirements for cable tray systems.

1.02 REFERENCE STANDARDS

A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System 2012.

B. IEEE 142 - IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems 2007, with Errata (2014).

C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings 2022.

D. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems 2021.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

F. NFPA 780 - Standard for the Installation of Lightning Protection Systems 2023.

G. UL 467 - Grounding and Bonding Equipment Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Compliance with NEC 250.50 and with the concrete-encased electrode requirments below requires early coordination with other trades to ensure concrete-encased electrodes are properly incorporated into the grounding electrode system. Coordinate the work with other trades as required to achieve compliance.

1.04 SUBMITTALS

A. See Section 01-30-00 - Administrative Requirements for Electrical Systems for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.

C. Field quality control test reports.

D. As-Built Documents: Record actual locations of grounding electrode system components and connections.

E. Submit satisfacory "As-Left" fall-of-potential ground resistance test report performed in accordance with ANSI/IEEE 81 or an alternative test on the combined grounding electrode system to remote earth accordance with ANSI/NETA ATS – *Standard for Acceptance Testing Specifications for Electrical Power Equipment and System*. Contractor shall submit written test report to Owner.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.

B. Do not use products for applications other than as permitted by NFPA 70 and product listing.

C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

E. Grounding System Resistance:
   1. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method or alternate test described in IEEE 81. (Reference ANSI/IEEE ATS Standard 142 and ANSI/NETA ATS Standard). Contractor to provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

F. Grounding Electrode System (GES)
   1. Provide connection to required and supplemental grounding electrodes (new and existing) to form a complete GES.
   2. Concrete-Encased Electrode ("UFER Ground"):
      a. As shown on drawings, provide connection to concrete-encased electrode consisting of not less than 20 feet of steel reinforcing bars embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
   3. Ground Rod Electrode:
      a. The term "ground rod" as used in this specification shall mean (2) 3/4 inch diameter x 10 foot length sectional ground rods connected together so as to form a single 20 ft. ground rod.
      b. The separation between any two ground rods (or a ground rod to another type of ground electrode) shall be at least the sum of their driven depths, where practicable. If this spacing is not practicable due to site-conditions, use greatest achievable spacing distance so as to maximize electrical coupling to remote earth.
   4. Ground Rod Triad
      a. Provide three electrodes in an equilateral triangle configuration ("triad").
      b. Unless otherwise indicated, install ground rods such that the top of ground rod is not less than 24 inches below finished grade. Install 2 AWG copper connecting each ground in a trench not less than 24 inches below grade.
      c. Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.

G. Grounding Electrode Conductor (GEC)
   1. For each service disconnect, provide grounding electrode conductor (GEC) to connect neutral (grounded) service conductor to the grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
   2. Install grounding electrode conductors (GEC) in accordance with NEC 250.64. Install GECs in raceway where exposed to physical damage. Where GEC is placed in ferrous metal raceway, both ends of raceway shall be bonded to conductor with listed connector to create an electrically parallel path.
   3. GEC shall be sized in accordance with NEC 250.66, but for buildings or structures less than 75 feet in height GEC shall NOT be smaller than 2 AWG copper and for buildings or structures greater than 75 feet in height, GEC shall NOT be less than 2/0 AWG copper.

H. Steel Structures (unless otherwise indicated on drawings):
   1. Rebar–type concrete–encased electrodes shall be made and connected to steel columns around the perimeter of the structure at intervals averaging not more than 60 feet. Bonding jumper connection to steel columns shall be by welding, brazing, or drilling and tapping with 0.5 inch bolts.
   2. Connect steel columns to the a rebar–type concrete–encased electrode through hold–down ("anchor") bolts. Hold–down bolts shall be connected to the rebar–type concrete–encased electrode by welding, exothermic welding, the usual steel ties, or other approved means.

3. Ground rods shall be provided and bonded to the rebar–type concrete–encased electrodes or bonded to steel columns where concrete–encased electrodes are created. Connect bonding jumper to steel columns shall be by welding, brazing, or drilling and tapping with 0.5 inch bolts.

I. Wood Structures (unless otherwise indicated on drawings):
   1. Concrete–encased electrodes shall be made in accordance with NEC 250.52(3) at the service entrance location with an additional steel reinforcement bar (rebar) section extended upwards through the concrete foundation or footing to an accessible location. The additional steel reinforcement bar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by the usual steel tie wires, exothermic welding, welding, or other effective means.
   2. Concrete–encased electrode to other electrodes shall be created at each corner of the concrete pad. Provide a ground rod connected to rebar with a 2 AWG copper at each with top of ground rod driven 24 in. below grade.
   3. Provide three ground rod electrodes in an equilateral triangle configuration ("triad") as described above. Interconnect "triad" to all other grounding electrode type present (new or existing) to form a single, interconnected GES.

J. Separate Building or Structure Supplied by Feeder(s) or Branch Circuits (NEC 250.32):
   1. Provide equipment grounding conductor (EGC) routed with branch or feeder conductors.
   2. A separate building or structure supplied by a feeder or branch circuit is NOT a Separately Derived System (SDS). DO NOT make any connections between neutral (grounded) conductors and ground at the building or structure.
   3. For a separate building or structure supplied by a feeder circuit (i.e., having local disconnecting means at the building or structure), install a local GES consisting of either a concrete-encased electrode or a ground-rod triad type electrode system (unless otherwise indicated) or provide a bare copper bonding jumpers to the main GES.
   4. Connect GEC to equipment ground bus in the disconnecting means enclosure to the locally installed GES. DO NOT connect the GES to neutral bus. The GEC shall be sized in accordance with NEC 250.66, but for buildings or structures not exceeding 75 feet in height the GEC shall NOT be smaller than 2 AWG copper and for buildings or structures exceeding 75 feet in height, the GEC shall NOT be less than 2/0 AWG copper.
   5. If the separate building or structure has a metal frame, then a bonding jumper shall be attached from building steel to the ground bus in the disconnecting means enclosure. Do NOT connect bonding jumper to the neutral bus. The bonding jumper shall be sized in accordance with NEC 250.102(C)(1), except that it shall not be required to be larger than 3/0 AWG copper. The bonding jumper shall be installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The point of attachment to building steel shall be accessible unless the attachment is installed in compliance with NEC 250.68(A) Exception No. 2.

K. Auxiliary Grounding Electrodes (NEC 250.54):
   1. Provide equipment grounding conductor (EGC) routed with branch conductors even where auxillary grounding electrodes are installed.
   2. Metallic equipment located remote from the building subject to receive a stroke of lightning (e.g., metal towers, light poles) shall be connected to at least least one auxiliary ground electrode.
   3. For concrete equipment pads located outside the building, connect at least one auxiliary ground rod(s) to the steel reinforcement bars in the associated concrete equipment pads. If steel reinforcement bars are not required in associated concrete equipment pads, provide concrete-encased electrode consisting of not less than 20 feet of 4 AWG copper embedded within concrete foundation in accordance with NEC 250.52(3) and connect an auxiliary ground rod.
   4. Auxiliary grounding electrodes are NOT required to be incorporated into the the main GES associated with the main service (i.e., no seperate bonding jumper is required routed in trench and connected back to the main GES).

L. Separately Derived System (SDS) Grounding:

1. Separately derived systems include, but are not limited to:
    a. Transformers (except autotransformers such as buck-boost transformers).
    b. Generators, when neutral is switched in the transfer switch.
2. Provide grounding electrode conductor sized in accordance with NFPA 70 to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
4. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
5. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
6. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.

M. Bonding and Equipment Grounding:
1. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
2. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
3. Where a bonding jumper is placed in ferrous metal raceways, both ends of raceway shall be bonded to conductor with listed connector to create an electrically parallel path.
4. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do NOT use raceways as sole equipment grounding conductor.
5. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
6. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
7. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do NOT terminate on neutral (grounded) or isolated/insulated ground bus.
8. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
9. If a Lightning Protection System (LPS) is provided, bond the LPS and GES together in accordance with NEC 250.106.

N. Lightning Protection Systems, in Addition to Requirements of Section 26-41-13: (As applicable)
1. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.

O. Cable Tray Systems: Also comply with Section 26-05-36. (As applicable)

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use exothermic welded connections or compression connections for underground, concealed and other inaccessible connections.

C. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   2. Material: Copper-bonded (copper-clad) steel.
   3. Size: (2) 3/4 inch diameter by 10 feet length (20 foot sectionalized).

PART 3 EXECUTION

3.01 INSTALLATION

A. Where practicable, grounding electrodes should be placed along the drip line of the building or structure where the soil moisture promotes lower soil resistivity and coupling to earth. Typically, 2 ft. from buidling wall.

B. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

END OF SECTION

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SECTION 26-05-29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 03-30-00 - Cast-in-Place Concrete: Concrete equipment pads.

B. Section 05-50-00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

C. Section 26-05-33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

D. Section 26-05-33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

E. Section 27-05-29 - Hangers and Supports for Communications Systems.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2023.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

E. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03-30-00.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.

3. No exposed threads. All threaded rods shall be sleeved with rigid aluminum conduit as to limit the amount of exposed threads.
4. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
    a. Indoor Dry Locations: Use rigid aluminum unless otherwise indicated.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel unless otherwise indicated.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: See Section 05-50-00.

C. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; aluminum.
2. Conduit Clamps: Aluminum bolted type unless otherwise indicated.

D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    a. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
    b. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
    c. Trapeze Support for Multiple Conduits: 3/8-inch diameter.

F. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
2. Stainless Steel: Use machine bolts or welded threaded studs.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Unless specifically indicated or approved by Engineer, do not provide support from roof deck.

F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
1. Use metal, fabricated supports to support equipment as required.
2. Use rigid aluminum angle to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
3. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Secure fasteners in accordance with manufacturer's recommended torque settings.

I. Remove temporary supports.

END OF SECTION

SECTION 26-05-33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Galvanized steel intermediate metal conduit (IMC).

C. Flexible metal conduit (FMC).

D. Liquidtight flexible metal conduit (LFMC).

E. Galvanized steel electrical metallic tubing (EMT).

F. Rigid polyvinyl chloride (PVC) conduit.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.03 SUBMITTALS

A. See Section 01-30-00 - Administrative Requirements for Electrical Systems for submittals procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

C. As-Built Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications.

C. Underground:
   1. Under Slab on Grade: Use rigid PVC conduit.
   2. Exterior, Direct-Buried: Use rigid PVC conduit.
   3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit or intermediate metal conduit (IMC) where emerging from underground.
   4. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows for bends.

D. Embedded Within Concrete:
   1. Within Slab on Grade: Not permitted.
   2. Within Slab Above Ground: Not permitted.
   3. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC) where emerging from concrete.

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

F. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

G. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), aluminum rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or stainless steel intermediate metal conduit (IMC).

H. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

I. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC) or galvanized steel intermediate metal conduit (IMC).

J. Exposed, Exterior, Not Subject to Severe Physical Damage: Use galvanized steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT).

K. Corrosive Locations Above Ground: Use stainless steel rigid metal conduit (RMC), stainless steel intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit (RMC), stainless steel electrical metallic tubing (EMT), or reinforced thermosetting resin conduit (RTRC).

L. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
   1. Maximum Length: 6 feet.

M. Flexible Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit (FMC).
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
   3. Maximum Length: 6 feet unless otherwise indicated.

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4-inch trade size.
   3. Control Circuits: 3/4 inch (19 mm) trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

2.04 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

2.07 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

2.09 ACCESSORIES

A. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

B. Foam Conduit Sealant:
   1. Removable, two-part, closed-cell foam, specifically designed for sealing conduit openings against water, moisture, gases, and dust.
   2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.

C. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

D. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive conduits.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Conduit Routing:
   1. Conduit routing indicated on plans is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.
   4. Arrange conduit to maintain adequate headroom, clearances, and access.
   5. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
   6. Arrange conduit to provide no more than 150 feet between pull points.

7. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.

B. Conduit Support:
   1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
   2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.

C. Connections and Terminations:
   1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
   2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
   3. Use suitable adapters where required to transition from one type of conduit to another.
   4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
   5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
   6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
   7. Secure joints and connections to provide mechanical strength and electrical continuity.

D. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.

E. Underground Installation:
   1. Provide trenching and backfilling.

F. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.
      d. Where conduits may transport moisture to contact live parts.
   2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
      a. Where conduits pass from outdoors into conditioned interior spaces.
      b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

G. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

H. Provide grounding and bonding; see Section 26-05-26.

END OF SECTION

SECTION 26-05-53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

1.02 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. UL 969 - Marking and Labeling Systems Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain whose designations are changed as part of the new work.

B. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
   2. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".

C. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26-05-19.
   2. Identification for Communications Conductors and Cables: Comply with Section 27-10-00.
   3. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
   4. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
      a. Within boxes when more than one circuit is present.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

B. Format for Equipment Identification:
   1. Minimum Size: 1 inch by 2.5 inches.

2. Legend:
    a. Equipment designation or other approved description.
3. Text: All capitalized unless otherwise indicated.
4. Minimum Text Height:
    a. Equipment Designation: 1/2 inch.
5. Color:
    a. Normal Power System: White text on black background.

2.03 WIRE AND CABLE MARKERS

A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.

B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.

C. Legend: Power source and circuit number or other designation indicated.

D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.

E. Minimum Text Height: 1/8 inch.

F. Color: Black text on white background unless otherwise indicated.

2.04 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
1. Surface-Mounted Equipment: Enclosure front.
2. Flush-Mounted Equipment: Inside of equipment door.
3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
4. Elevated Equipment: Legible from the floor or working platform.
5. Interior Components: Legible from the point of access.
6. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

END OF SECTION

SECTION 27-05-29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 2 PRODUCTS

1.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. TIA-569.
      b. NFPA 70.
      c. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
   3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported with minimum safety factor of _____. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
      a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
      b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.

C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

D. Metal Channel/Strut Framing Systems:
   1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
   2. Comply with MFMA-4.

E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.

F. Anchors and Fasteners:
   1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

END OF SECTION

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SECTION 27-05-33.13
CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stainless steel rigid metal conduit (RMC).

B. Aluminum rigid metal conduit (RMC).

C. Stainless steel intermediate metal conduit (IMC).

D. Liquidtight flexible metal conduit (LFMC).

1.02 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC) 2020.

B. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A) 2020.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit 2018.

D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition 2022.

E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

F. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition 2020.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction 2015.

H. NECA 102 - Standard for Installing Aluminum Rigid Metal Conduit 2004.

I. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable 2014.

J. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. TIA-568.0 - Generic Telecommunications Cabling for Customer Premises 2020e.

L. TIA-569 - Telecommunications Pathways and Spaces 2019e.

M. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel Current Edition, Including All Revisions.

N. UL 514B - Conduit, Tubing, and Cable Fittings Current Edition, Including All Revisions.

O. UL 1242 - Electrical Intermediate Metal Conduit-Steel Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of cables to be installed.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

B. Sequencing:
   1. Do not begin installation of communications cables until installation of conduit between termination points is complete.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, TIA-569, BICSI ITSIMM, BICSI TDMM, manufacturers' instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Exposed, Interior, Not Subject to Physical Damage: Use aluminum rigid metal conduit (RMC) or stainless steel intermediate metal conduit (IMC).

D. Exposed, Interior, Subject to Physical Damage: Use aluminum rigid metal conduit (RMC) or stainless steel intermediate metal conduit (IMC).
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 20 feet in Production Areas.

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70 and TIA-569.

B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.

C. Provide products listed, classified, and labeled as suitable for purpose intended.

D. Maximum Number of Communications Outlet Boxes per Continuous Conduit Homerun: Three.

E. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Communications Outlet Box: 3/4-inch trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

2.03 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
   2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   3. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
   4. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

2.04 ALUMINUM RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC aluminum rigid metal conduit complying with ANSI C80.5 and listed and labeled as complying with UL 6A.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A
   2. Material: Use aluminum.
   3. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
   4. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
      a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.05 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
3. Connectors and Couplings: Use threaded fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.
4. Conduit Bodies: Standard conduit bodies designed for electrical raceways are not permitted.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.

C. Install aluminum rigid metal conduit (RMC) in accordance with NECA 102.

D. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

E. Connections and Terminations:
1. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
2. Use suitable adapters where required to transition from one type of conduit to another.
3. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
4. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
5. Secure joints and connections to provide mechanical strength and electrical continuity.

F. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
4. Conceal bends for conduit risers emerging above ground.
5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07-84-00.

G. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

H. Provide grounding and bonding.

END OF SECTION

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SECTION 27-10-00
STRUCTURED CABLING - COMMSCOPE SYSTIMAX/UNIPRISE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Copper Cable and Terminations:
   1. Copper twisted pair cables.
   2. Copper twisted pair patch cords.

1.02 RELATED REQUIREMENTS

A. Section 27-15-23.13 - Powered Fiber Cable System - CommScope: Hybrid copper/fiber cables.

1.03 REFERENCE STANDARDS

A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition 2019.

B. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set 2020.

D. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards 2009c, with Addendum (2016).

E. TIA-569 - Telecommunications Pathways and Spaces 2019e.

F. TIA-606 - Administration Standard for Telecommunications Infrastructure 2021d.

G. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises 2019d.

H. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances Current Edition, Including All Revisions.

I. UL 444 - Communications Cables Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate work to avoid placement of other utilities or obstructions within spaces dedicated for communications equipment.
   2. Coordinate arrangement of communications equipment with dimensions and clearance requirements of actual equipment to be installed.
   3. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 QUALITY ASSURANCE

A. Supplier Qualifications: Authorized by structured cabling system manufacturer.

1.06 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions before, during, and after installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design: CommScope, Inc; www.commscope.com/#sle.

2.02 STRUCTURED CABLING SYSTEM - GENERAL REQUIREMENTS

A. Comply with the following:
   1. TIA-568 (SET).
   2. TIA-569.
   3. TIA-607.
   4. NFPA 70.

5. Requirements of authorities having jurisdiction.
6. Applicable local codes.

2.03 COPPER CABLE AND TERMINATIONS

A. Copper Twisted-Pair Cables:
   1. Comply with TIA-568.2; listed as complying with UL 444.
   2. Cable Applications:
      a. Plenum Applications: Use listed NFPA 70 Type CMP plenum cable.
      b. Riser Applications: Use listed NFPA 70 Type CMR riser cable or Type CMP plenum cable.
      c. General Purpose Applications: Use listed NFPA 70 Type CM/CMG general purpose cable, Type CMR riser cable, or Type CMP plenum cable.

B. Copper Twisted Pair Patch Cords:
   1. Description: Factory-fabricated, 4-pair cable assemblies with RJ45, 8-position modular jacks terminated at each end; length as indicated or as required.
   2. Comply with TIA-568.2.
   3. Wiring: T568B.
   4. Plug Insertion Life: 750 times, minimum.
   5. Flammability: Comply with UL 94.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's written instructions.

B. Comply with BICSI N1 and TIA-568 (SET).

C. Cable Installation in Raceway:
   1. Do not damage cables or exceed manufacturer's recommended maximum pulling tension.
   2. Use wire-pulling lubricant recommended by manufacturer where necessary.

D. Identify components in accordance with TIA-606.

E. Provide grounding and bonding in accordance with TIA-607.

3.02 FIELD QUALITY CONTROL

A. See Section 01-40-00 - Quality Requirements for additional requirements.

B. Provide equipment, tools, and supplies required to accomplish inspection and testing.

C. Test copper twisted pair cables in accordance with TIA-568.2.

END OF SECTION