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INVITATION FOR BIDS

FOR

ORANGE COUNTY CONVENTION CENTER CHAPIN THEATER AUDIO SYSTEM REPLACEMENT

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PART H
TECHNICAL SPECIFICATIONS

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PART H
Volume II

Orange County Convention Center
Chapin Theater Audio System Replacement

December 2018
100% Construction Documents

SGM ENGINEERING GROUP
MEP CONSULTING ENGINEERS

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SECTION 01 10 00 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.
2. Use of premises.
3. Owner's occupancy requirements.
4. Work restrictions.
5. Specification formats and conventions.

B. Related Sections include the following:
1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The scope of work includes replacing existing theater sound system in its entirety, including a permanent install of all equipment, programming and structural support. The Sound System required for this venue is a large format concert/corporate audio system that will cover the entire audience seating area with in the full sound spectrum (20Hz-20,000Hz) at 116 dbA/ +/- 3db at any listening position with in the theater. The coverage must include every seat within the seating section from the first row to the last row in the balcony with less than a 3 db variance. The system will have the ability to steer the array’s sound off of the walls, this action is to be done at each of the cabinets. Digital steering is an option, physical steering is preferred. The system will be free from audio artifacts within the low and high end spectrum of this audio system. The sound system will provide natural sound and be free from comb filtering or phase shifting effects within the listening area included moving around the venue. Front of House (FOH) system shall not rely on either stage or floor mounted sub woofers to achieve specified coverage parameters. FOH sub woofers are required to be mounted to either structural steel or in existing catwalk platforms in the proscenium catwalk in the spaces depicted in drawings. The subwoofers need to be capable of providing solid LF to 25 hertz. The audio signal drive for the amplifiers can consist of Dante, XLR, AES50, AVB, AES/EBU so the system will net to have flexibility within the input stage. The system will interfaced with fiber as the main audio driver to the sound system and use XLR as the backup facilitating a seamless transfer of audio signal from the main to back up system should the need arise. The System is required to have a front end processor with a redundant drive with seamless switchover. This system is required to receive input from existing fire alarm system for override in the form of all programming,

relays, and final testing. The sound system will have all fire safety parameters in place for fire interrupt allowing fire safety announcements to be played of the sound system. The sound system, after the clearing of the fire alarm signal the system should immediately revert to normal sound system operation. All necessary system hardware and software are to be provided by the contractor at the FOH mixing position. SPL read outs for 95 dbA, 105 dbA, and 115 dbA are to be provided.

1.4 TYPE OF CONTRACT

A. Project will be constructed under a single prime contract.

1.5 USE OF PREMISES

A. General: Contractor shall have limited use of premises for construction operations as indicated on Drawings by the Contract limits.

B. Use of Site: Limit use of premises to work in areas indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Owner Occupancy: Allow for Owner occupancy of Project site and use by the public.
2. Driveways and Entrances: Keep driveways, parking areas, loading areas, and entrances serving premises clear and available to Owner, Owner's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

C. Use of Existing Building: Maintain existing building in a weathertight condition throughout construction period. Repair damage caused by construction operations. Protect building and its occupants during construction period.

D. In addition to protection of all existing systems, components, devices, etc. contractor shall maintain a clean work environment.

1.6 OWNER'S OCCUPANCY REQUIREMENTS

A. Full Owner Occupancy: Owner will occupy site and existing building during entire construction period. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with Owner's day-to-day operations. Maintain existing exits, unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and authorities having jurisdiction.

2. Provide not less than 72 hours' notice to Owner of activities that will affect Owner's operations.

1.7 WORK RESTRICTIONS

A. On-Site Work Hours: Work shall be generally performed inside the existing building during normal business working hours of 8p.m. to 5 a.m., except otherwise indicated.

1. Weekend Hours: To be coordinated with Owner as needed to keep from obstructing Owners occupancy during change out of equipment or any outage requirements.
2. Hours for Utility Shutdowns: to be coordinated with Owners Representative with a minimum of 72 hours required for shut down.

1.8 Maintenance of Traffic (MOT)

A. Maintenance of traffic shall be in accordance with the manual of uniform traffic control devices (latest edition and revision) and the Florida Department of Transportation roadway design standards (latest edition and revisions)

B. Contractor shall submit a maintenance of traffic plan that is designed, signed and sealed by a professional engineer registered in the State of Florida, for review and approval 2 weeks prior to start of work. The plan shall be prepared in accordance with the manual on uniform traffic control devices and FDOT design standards (latest edition and revisions)

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner not less than 3 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Owner's written permission.

1.9 SPECIFICATION FORMATS AND CONVENTIONS

A. Specification Format: The Specifications are organized into Divisions and Sections using the 50-division format and CSI/CSC's "MasterFormat" numbering system.

1. Section Identification: The Specifications use Section numbers and titles to help cross-referencing in the Contract Documents. Sections in the Project Manual are in numeric sequence; however, the sequence is incomplete because all available Section numbers are not used. Consult the table of contents at the beginning of the Project Manual to determine numbers and names of Sections in the Contract Documents.
2. Division 01: Sections in Division 01 govern the execution of the Work of all Sections in the Specifications.

B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative mood and streamlined language are generally used in the Specifications. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.

    a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (See Drawings)

PART 3 - EXECUTION (See Drawings)

END OF SECTION 01 10 00

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

B. Related Sections include the following:
   1. Division 01 Section "Closeout Procedures" for submitting warranties.
   2. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
   3. Division 01 Section "Operation and Maintenance Data" for submitting operation and maintenance manuals.
   4. Division 01 Section "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of Owner's personnel.
   5. Divisions 02 through 49 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Owner’s responsive action.

B. Informational Submittals: Written information that does not require Engineer’s and Owner’s responsive action. Submittals may be rejected for not complying with requirements.

1.4 SUBMITTAL PROCEDURES

A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

   1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
   2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

      a. Owner and Engineer’s reserve the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

B. Submittals Schedule: All submittals shall be received by the Owner within 14 days of notice to proceed. Submittals shall be approved prior to commencement of work.

C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineers receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 15 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. The Owner will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 15 days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Architect's consultants, Owner, or other parties is indicated, allow 21 days for initial review of each submittal.

D. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 6 by 8 inches (150 by 200 mm) on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
3. Include the following information on label for processing and recording action taken:

    a. Project name.
    b. Date.
    c. Name and address of Engineer.
    d. Name and address of Contractor.
    e. Name and address of subcontractor.
    f. Name and address of supplier.
    g. Name of manufacturer.
    h. Submittal number or other unique identifier, including revision identifier.

        1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).

E. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.

F. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's written recommendations.
b. Manufacturer's product specifications.
c. Manufacturer's installation instructions.
d. Standard color charts.
e. Manufacturer's catalog cuts.
f. Wiring diagrams showing factory-installed wiring.
g. Printed performance curves.
h. Operational range diagrams.
i. Mill reports.
j. Standard product operation and maintenance manuals.
k. Compliance with specified referenced standards.
l. Testing by recognized testing agency.
m. Application of testing agency labels and seals.
n. Notation of coordination requirements.

4. Submit Product Data before or concurrent with Samples.
5. Number of Copies: Submit 7 copies of Product Data, unless otherwise indicated. Engineer will return 6 copies. Mark up and retain one returned copy as a Project Record Document.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Dimensions.
b. Identification of products.
c. Fabrication and installation drawings.
d. Roughing-in and setting diagrams.
e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
f. Shopwork manufacturing instructions.
g. Templates and patterns.
h. Schedules.
i. Design calculations.

j. Compliance with specified standards.
k. Notation of coordination requirements.
l. Notation of dimensions established by field measurement.
m. Relationship to adjoining construction clearly indicated.
n. Seal and signature of professional engineer if specified.
o. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. Approval Stamp: Stamp each submittal with a uniform, approval stamp.

3.2 ENGINEER'S ACTION

A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it.

C. Partial submittals are not acceptable, will be considered nonresponsive, and will be returned without review.

D. Submittals not required by the Contract Documents may not be reviewed and may be discarded.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and -control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and -control services required by Engineer or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections include the following:

1. Divisions 02 through 49 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Engineer.

C. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.

D. Source Quality-Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.

E. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

F. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

G. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.

1.4 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 SUBMITTALS

A. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

B. Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.

2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

C. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.6 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that are similar to those indicated for this Project in material, design, and extent.

F. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing the Work.

G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E 548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.

1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

H. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

1.7 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

    a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
2. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
3. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
4. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

G. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
   1. Operation manuals for systems, subsystems, and equipment.
   2. Maintenance manuals for the care and maintenance of products, materials, and finishes systems and equipment.

B. Related Sections include the following:
   1. Division 01 Section "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
   2. Divisions 02 through 49 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 SUBMITTALS

A. Initial Submittal: Submit 2 draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Engineer will return one copy of draft and mark when general scope and content of manual are acceptable.

B. Final Submittal: Submit 3 copies of each manual in final form.

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.

PART 2 - PRODUCTS

2.1 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Owner.
4. Date of submittal.
5. Name, address, and telephone number of Contractor.
6. Name and address of Architect.
7. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

   a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
   b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of

equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch (215-by-280-mm) white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.
    c. Provide 11x17 control drawings on each control panel corresponding to the controller in it.

2.2 OPERATION MANUALS

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions.
2. Performance and design criteria if Contractor is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following:

1. Product name and model number.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.

5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.3 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard printed maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training videotape, if available.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.

C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.

1. Do not use original Project Record Documents as part of operation and maintenance manuals.
2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Product Data.

B. Related Sections include the following:
1. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
2. Divisions 02 through 49 Sections for specific requirements for Project Record Documents of the Work in those Sections.

1.3 SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up Record Prints.
2. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal: Submit one set(s) of plots from corrected Record CAD Drawings and one set(s) of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plots and prints for organizing into sets, printing, binding, and final submittal.
b. Final Submittal: Submit one set(s) of marked-up Record Prints. Print each Drawing, whether or not changes and additional information were recorded.

B. Record Product Data: Submit one copy of each Product Data submittal.

1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an understandable drawing technique.
c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order.
k. Changes made following Engineer's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize Record Prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2.2 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2.3 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer’s reference during normal working hours.

END OF SECTION 01 78 39

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.
6. Commissioning requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 GENERAL REQUIREMENTS

A. Carefully examine General Conditions, other specification sections, and other drawings (in addition to DIVISION 26), in order to be fully acquainted with their effect on electrical work. Additions to the contract cost will not be allowed due to failure to inspect existing conditions.

B. Do all work in compliance with 2017 Florida Building Code 6th Edition, and the Codes adopted therein, including NFPA 70 (2014 NEC), 2017 Florida Fire Prevention Code 6th Edition and the regulations of the local power utility, cable television and telephone companies. Obtain and pay for any and all required permits, inspections, certificates of inspections and approval, and the like, and deliver such certificates to the Architect/Engineer.

C. Cooperate and coordinate with all other trades. Perform work in such manner and at such times as not to delay work of other trades. Complete all work as soon as the condition of the structure and installations of equipment will permit. Patch, in a satisfactory manner and by the proper craft, any work damaged by electrical workmen.

D. Furnish, perform, or otherwise provide all labor (including, but not limited to, all planning, purchasing, transporting, rigging, hoisting, storing, installing, testing, chasing, channeling, cutting, trenching, excavating and backfilling), coordination, field verification, equipment installation, support, and safety, supplies, and materials necessary for the correct installation of

complete and functional electrical systems (as described or implied by these specifications and the applicable drawings).

E. Coordinate and verify power and telephone company service requirements prior to bid. Bid to include all work required.

F. Circuiting and connection of all items using electric power shall be included under this division of the specifications, including necessary wire, conduit, circuit protection, disconnects and accessories. Secure rough-in drawings and connection information for equipment involved to determine the exact requirements. See all divisions of drawings or specifications for electrically operated equipment. If the connection of an item is not shown on the electrical drawings and it is unclear how to provide for the circuiting and connection, notify the engineer of record in writing prior to bidding project. Submission of a bid indicates that the bidder has included these requirements as part of the scope of work.

1.5 DRAWINGS:

A. Indicate only diagrammatically the extent, general character, and approximate location of work. Where work is indicated, but with minor details omitted, furnish and install it complete and so as to perform its intended functions.

B. DIVISION 26 work called for under any section of the project specifications, shall be considered as included in this work unless specifically excluded by inclusion in some other branch of the work. This shall include roughing-in for connections and equipment as called for or inferred. Check all drawings and specifications for the project and shall be responsible for the installation of all DIVISION 26 work.

C. Take finish dimensions at the job site in preference to scale dimensions. Do not scale drawings where specific details and dimensions for DIVISION 26 work are not shown on the drawings, take measurements and make layouts as required for the proper installation of the work and coordination with all drawings and coordination with all other work on the project. In case of any discrepancies between the drawings and the specifications that have not been clarified by addendum prior to bidding, it shall be assumed by the signing of the contract that the higher cost (if any difference in costs) is included in the contract price, and perform the work in accordance with the drawings or with the specifications, as determined and approved by the Architect/ Engineer, and no additional costs shall be allowed to the base contract price.

D. Carefully check the drawings and specifications of all trades and divisions before installing any of his work. He shall in all cases consider the work of all other trades, and shall coordinate his work with them so that the best arrangements of all equipment, piping, conduit, ducts, rough-in, etc., can be obtained.

E. Review the specific equipment (such as mechanical, plumbing, kitchen, FFE, etc) minimum circuit ampacity and maximum over current protection requirements of equipment provided by others to confirm it is properly coordinated with the devices being purchased. Notify the AE team immediately upon discovery of discrepancies. This shall be done at the submittal stage prior to purchasing over current protection or installation of conduit, wire, disconnects, breakers, etc. No cost will be allowed for changes to coordinate.

F. Locations designated for outlets, switches, equipment, etc., are approximate and shall be verified by instruction in these specifications and/or notes on the drawings. Where instructions or notes are insufficient to convey the intent of the design, consult the Architect/Engineer prior to installation.

G. Obtain manufacturer's data on all equipment, the dimensions of which may affect electrical work. Use this data to coordinate proper service characteristics, entry locations, etc., and to ensure minimum clearances are maintained.

1.6 QUALIFICATIONS OF CONTRACTOR:

A. DIVISION 26 Contractor shall have had experience of at least the same size and scope as this project, on at least two other projects within the last fifteen years.

B. Contractor performing any part of this scope of work shall be a State Certified (Type E.C. License) electrical contractor

C. Provide field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable size and complexity. Superintendent shall be on the site at all times during construction and must have an active Journeyman's Electrical License.

1.7 SITE VISIT/CONDITIONS

A. Visit the site of this contract and thoroughly familiarize with all existing field conditions and the proposed work as described or implied by the contract documents. During the course of his site visit, verify every aspect of the proposed work and the existing field conditions in the areas of construction which might affect his work. No compensation or reimbursement for additional expenses incurred due to failure or neglect to make a thorough investigation of the contract documents and the existing site conditions will be permitted.

B. Install all equipment so that all Code required and Manufacturer recommended servicing clearances are maintained. Coordinate the proper arrangement and installation of all equipment within any designated space. If it is determined that a departure from the Contract Documents is necessary, submit to the A/E, for approval, detailed drawings of the proposed changes with written reasons for the changes. No changes shall be implemented without the issuance of the required drawings, clarifications, and/or change orders.

C. Submission of a proposal will be construed as evidence that such examination has been made and later claims for labor, equipment or materials required because of difficulties encountered will not be recognized.

D. Existing conditions and utilities indicated are taken from existing construction documents, surveys, and field investigations. Unforeseen conditions probably exist and existing conditions shown on drawings may differ from the actual existing installation with the result being that new work may not be field located exactly as shown on the drawings. Field verify dimensions of all site utilities, conduit routing, boxes, etc., prior to bidding and include any deviations in the contract. Notify A/E if deviations are found.

E. All existing electrical is not shown. Become familiar with all existing conditions prior to bidding, and include in the bid the removal of all electrical equipment, wire, conduit, devices, fixtures, etc. that is not being reused, back to it's originating point.

F. Locate all existing utilities and protect them from damage. Pay for repair or replacement of utilities or other property damaged by operations in conjunction with the completion of this work.

G. Investigate site thoroughly and reroute all conduit and wiring in area of construction in order to maintain continuity of existing circuitry. Existing conduits indicated in Contract Documents indicate approximate locations. Verify and coordinate existing site conduits and pipes prior to any excavation on site. Bids shall include hand digging and all required rerouting in areas of existing conduits or pipes.

H. Work is in connection with existing buildings which must remain in operation while work is being performed. Work shall be in accord with the schedule required by the Contract. Schedule work for a minimum outage to Owner. Notify Owner 72 hours in advance of any shut-down of existing systems. Perform work during non-school operating hours unless otherwise accepted by Owner. Protect existing buildings and equipment during construction.

1.8 COMMISSIONING RESPONSIBILITIES

A. Attend commissioning meetings scheduled by the General Contractor.

B. Schedule work so that required electrical installations are completed, and system verification checks and functional performance test can be carried out on schedule.

C. Inspect, check and confirm in writing the proper installation and performance of all electrical services as required by the system verification and functional performance testing requirements of electrical equipment in the commissioning specifications.

D. Provide qualified personnel to assist and operate electrical system during system verification checks and functional performance testing of HVAC systems as required by the commissioning specifications.

E. Provide instruction and demonstrations for the Owner’s designated operating staff in accordance with the requirements of the commissioning specifications.

1.9 TEMPORARY POWER:

A. Provide temporary power distribution for the connection of all single phase 120V 20A tools, OSHA work lighting, and testing as required for performance of the project. Provide OSHA required work lighting and task lighting for the project.

B. Coordinate requirements with the local Utility Company for availability of adequate power. Include all cost associated with any Utility Company charges for connection or upgrades in this bid price.

C. If power to any of the existing facilities will be interrupted, coordinate the outage with the Owner atleast 72 hours in advance. All power outages will occur outside operational hours as determined by the Owner.

D. Provide temporary power to any buildings, parking lot lighting, canopy lighting, lift stations, etc that will have power removed during the course of construction temporarily. Additionally, if any new buildings, parking lots, lift stations, etc will need power until the permanent power becomes available, provide temporary power until the permanent power is available.

E. Provide temporary lighting for all areas that will require lighting for school use as well as construction use during the course of construction. Temporary lighting must comply with all FBC requirements as though it was being installed for permanent use. This includes but is not limited to any temporary canopies, parking lots, walkways or roads. If you are unsure of how to connect or provide this lighting, notify the engineer of record in writing prior to bidding project. Submission of a bid indicates that the bidder has included these requirements as part of the scope of work.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Engineer shall have no responsibility for job site safety and the Contractor shall have full and sole authority for all safety programs and precautions in connection with the Work. Nothing herein shall be interpreted to confer upon the Engineer any duty regarding safety or the prevention of accidents at the jobsite.

B. Comply with NECA 1.

C. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

D. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Right of Way: Give to piping systems installed at a required slope.

G. All work shall be executed in a workmanship manner and shall present a neat mechanical appearance upon completion.

H. Care shall be exercised that all items are plumb, straight, level.

I. Care shall be exercised so that Code clearance is allowed for all panels, controls. etc., requiring it. Do not allow other trades to infringe on this clearance.

J. Balance load as equally as practicable on all feeders, circuits and panel buses.

K. The electrical circuits, components and controls for all equipment are selected and sized based on the equipment specified. If substitutions are proposed, furnish all materials and data required to prove equivalence. No additional charges shall be allowed if additional materials, labor, connections or equipment are needed for substituted products.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Coordinate with roofing scope of work for the installation of electrical items which pierce roof. Roof penetrations shall not void warranty. Pitch pockets are not acceptable.

D. Where work pierces waterproofing, it shall maintain the integrity of the waterproofing. Coordinate roofing materials which pierce roof for compatibility with membrane or other roof types.

E. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

F. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors **2 inches** above finished floor level.

I. Size pipe sleeves to provide **1/4-inch** annular clear space between sleeve and raceway or cable, unless indicated otherwise.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry

K. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

L. Fire-Rated-Assembly Penetrations: Firestop penetrations of walls, partitions, ceilings, and floors under Division 07 Section "Firestopping."

M. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work. The use of pitch pockets is not acceptable.

3.3 CONCRETE PADS

A. Furnish and install reinforced concrete housekeeping pads for transformers, switchgear, motor control centers, and other free-standing equipment. Unless otherwise noted, pads shall be four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by three (3) inches each side, except when equipment is flush against a wall where the side against the wall shall be flush with the equipment.

B. Provide concrete pad for exterior pad mount transformers as required by power company.

C. Provide concrete pad for exterior generators as recommended by generator manufacturer and structural engineer (8" minimum).

END OF SECTION 260500

SECTION 26 05 01 - INVESTIGATION OF EXISTING ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Contractual conditions and Division 1 Specification sections apply to this section.

1.2 SUMMARY

A. This section includes the requirements for investigation and reporting on conditions of existing electrical systems.

1.3 DESCRIPTION

A. Test the essential features of existing electrical power, lighting and systems.

B. Each system shall be tested once only, and after completion of testing, results given to the Owner. Point out any non-operational function noticed during testing.

C. Document the existing conditions and operation of the existing electrical systems prior to any work.

D. Contractor shall be responsible for all non-working systems and their components unless non-working status is verified prior to work on system.

1.4 COORDINATION

A. The testing shall be held at a date to be agreed upon in writing by the Owner.

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION

3.1 PERFORMANCE VERIFICATION

A. The contractor shall investigate all existing systems prior to the beginning any work on site. Test the functionality of each system and report only those items that are non-functional to the Owner.

B. Demonstrate to the Owner the non-functional items to verify the issue. Owner will at its option correct the deficiency immediately or defer to correct until the construction is completed. Provide a written report to clarify the items and the Owners decisions on correction,

C. Each system shall be retested after completion of renovation to ensure proper operation.

D. At the completion of construction, the Owner will expect all power, lighting and systems to function for their intended purpose whether new or existing. The contractor will remain responsible for this unless noted otherwise during the initial investigation and documented and demonstrated as such.

3.2 MEMO OF INVESTIGATION (TESTING)

A. Submit Existing Facilities Investigation Memo and advise Owner of all deficiencies in system(s) prior to Work. All systems will be assumed to be fully operational if Memo is not received by Owner prior to work on system.

END OF SECTION 26 05 01

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.
4. Metal Clad cable, Type MC

B. Related Sections include the following:

1. Division 27 Section "Data Communications Integration" for cabling used for voice and data circuits.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Provide type and UL listing of each type of conductor, cable, connector and termination to be utilized for the DIVISION 26 scope of work.

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled as defined in NFPA 70, Article 100.

B. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. BUILDING WIRES AND CABLES

1. CONDUCTOR INSULATION

a. Comply with NEMA WC 70 for Types THHN-THWN
b. Service Entrance: Type THHN-THWN CU or XHHW-2 Al, single conductors in raceway.
c. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.
d. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.
e. Feeders Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway.
f. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.
g. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Metal-clad cable, Type MC (MC may only be utilized in certain specific installations as described elsewhere in this section).
h. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway. Minimum #12.
i. Branch Circuits Installed below Raised Flooring: Type THHN-THWN, single conductors in raceway. Minimum #12.
j. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
k. Class 1 Control Circuits: Type THHN-THWN, in raceway.
l. Class 2 Control Circuits: Type THHN-THWN, in raceway.

2. CONDUCTOR MATERIAL:

a. Copper Conductors: Comply with NEMA WC 70.
b. All #10 and smaller conductors shall be solid CU. No stranded conductors are permitted for #10 and smaller.
c. Aluminum conductors may be used for 1/0 and larger panel board feeders if identified as aluminum on the electrical feeder schedule. Aluminum conductors shall be compact stranded aluminum alloy with XHHW-2 insulation, made of an AA-8000 series electrical grade aluminum alloy conductor material.

2.2 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. AMP Incorporated
3. Anderson
4. O-Z/Gedney; EGS Electrical Group LLC.
5. 3M; Electrical Products Division.
6. Burndy

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

C. Aluminum connections shall be made with compression type wire barrels factory prefilled with oxide inhibiting compound. Set screw connectors are not acceptable.

2.3 FLEXIBLE METAL CLAD CABLE

A. Comply with:

1. NFPA 70
2. ANSI/UL 4/UL 83/UL 1479
3. Fed. Specification J-C-30B

B. Cable material:

1. Jacket material:

a. Galvanized Steel or aluminum , interlocked.

2. Conductor covering: Paper wrap.
3. Conductor Material:

a. Copper, Solid, THHN
b. Minimum #12 gauge
c. Maximum #10 gauge
d. 90 degree C, 600 volt.
e. Full size insulted grounding conductor, green.
f. Conductor color coding to match system voltage. Comply with Division 26 Section “Identification”.

C. Fittings:

1. ANSI/NEMA FB 1
2. ANSI/UL 514B
3. Zinc plated Malleable iron, or steel.

a. Direct flexible conduit bearing set screw type not acceptable.
b. Install insulated bushings or equivalent protection (i.e. Anti-short) between core conductors and outer jacket.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES IN RACEWAY

A. No cables shall be installed in raceways until the raceway system is complete from end to end.

B. Examine raceways and building finishes to confirm compliance with contract requirements for installation tolerances and other conditions affecting installation of wires and cables. Do not proceed with installation until area is ready and any unsatisfactory conditions have been corrected.

C. Verify that interior of building has been protected from weather.

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

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

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

G. All branch circuit wire shall be sized for a maximum voltage drop of 3%. The contractor shall size all cables to comply with this requirement. Below are some guidelines that may be followed to achieve the correct voltage drop in lieu of providing custom calculations for each case.

1. Use conductor not smaller than #12 AWG for all 120V 20A branch circuits less than 60’ in length from the source breaker to any device.
2. All 120V branch circuit conductors where the length is 61’ to 120’ from the source breaker to any device shall utilize #10 minimum throughout the circuit, unless otherwise noted.
3. All 120V branch circuit conductors where the length is 121’ to 240’ from the source breaker to any device shall utilize # 8 minimum throughout the circuit, unless otherwise noted.
4. All 120V branch circuit conductors where the length is greater than 241’ from the source breaker to any device shall utilize # 6 minimum throughout the circuit, unless otherwise noted.
5. Use conductor not smaller than #12 AWG for all 277V 20A branch circuits less than 140’ in length from the source breaker to any device.
6. All 277V branch circuit conductors where the length is 141’ to 220’ from the source breaker to any device shall utilize #10 minimum throughout the circuit, unless otherwise noted.
7. All 277V branch circuit conductors where the length is 221’ to 340’ from the source breaker to any device shall utilize # 8 minimum throughout the circuit, unless otherwise noted.
8. All 277V 20A branch circuit conductors where the length is greater than 341’ from the source breaker to any device shall utilize # 6 minimum throughout the circuit, unless otherwise noted.

H. Provide a dedicated neutral conductor for all dimmer circuits from the load back to the dimmer module or switch.

I. Provide a dedicated neutral conductor for all computer receptacle circuits from the load back to the branch circuit panel board.

J. Neatly train and lace wiring inside boxes, equipment, and panelboards.

K. Conductor sizes indicated on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or in these specifications.

L. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final submittal on equipment to assure proper number and AWG of conductors. (As for multiple speed motors, different motor starter arrangements, etc.).

M. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide/install lugs as required to match wire size.

3.2 INSTALLATION REQUIREMENTS FOR METAL CLAD CABLES

A. Metal Clad Cables may be used only as specified, where permitted by NEC, and if approved by the Local Inspecting Authority having Jurisdiction.

B. MC Cable shall not be run to the panel board or electrical room. All final runs to the panelbpard shall be in conduit to a point at least 10’ outside the electrical room. No more than 6 current carrying conductors shall be run in any conduit to a junction box outside the electrical room. No junction box shall contain more than 6 current carrying conductors. Wireways are not permitted for the termination of MC cables.

C. MC cable shall not be used for any other building system wiring (except power and lighting).

D. MC cables shall not be used for switch legs.

E. MC cables shall not be used for feeder circuits or for systems.

F. Utilize the same sizing requirements for 20A branch circuit conductors as listed for conductors in raceways.

G. Connectors and supporting components shall be UL Listed for such use. Tie wire is not acceptable for supporting MC cable.

H. Cut cables with UL listed tools intended for such use. Ream smooth and free of sharp and abrasive areas. Install bushing between conductors and outer jacket. The use of slide cutters or dikes to cut cables is not acceptable.

I. Maintain minimum 1/2 inch separation between each cable and support per NEC. The practice of bundling cables is not acceptable.

J. Install cables minimum of 1’-0” from communications cables.

K. Attachment of cables to ceiling system is prohibited.

L. Attachment of cables to, on, or from mechanical (HVAC) equipment, supports, etc., is not permitted.

M. Install cables parallel and perpendicular to building structure.

N. Zigzagging cables through building elements, as method of support is not acceptable.

O. Cable with outer metal sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to owner.

3.3 CONNECTIONS

A. Where oversized conductors are called for (due to voltage drop, etc.) provide/install lugs as required to match conductors, or provide/install splice box, and splice to reduce conductor size to match lug size.

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

C. All aluminum connections shall be made with approved compression connectors before being connected to lugs. Conductors shall be cleaned with a wire brush immediately prior to connecting.

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

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

F. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes, or equipment enclosures where sufficient additional room is provided for all splices. No splices shall be made in in-ground pull boxes (without written acceptance of engineer).

G. Splices in lighting and power outlet boxes, wireway, and troughs shall be kept to a minimum, pull conductors through to equipment, terminal cabinets, and devices.

H. No splices shall be made in junction box, and outlet boxes (wire No. 8 and larger) without written acceptance of Engineer.

I. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B. A calibrated torque wrench shall be used for all bolt tightening.

J. All interior power and lighting taps and splices in No. 8 or smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than No. 8 shall be made with compression type connectors and taped to provide insulation equal to wire. Utilize weatherproof connectors for all splices in exterior boxes.

K. No splices are permitted in exterior below grade handhole or pull boxes.

3.4 FIELD QUALITY CONTROL

A. After feeders are in place, but before being connected to devices and equipment, test for shorts, opens, and for intentional and unintentional grounds.

B. Cables 600 volts or less in size #1/0 and larger shall be meggered using an industry approved “megger” with 1000 V internal generating voltage. Readings shall be recorded and submitted to

the Engineer for acceptance prior to energizing same. If values are less than recommended NETA values notify Engineer. Submit five copies of tabulated megger test values for all cables.

C. Cables 250 volts or less in size #1/0 and larger shall be meggered using an industry approved “megger” with 500 V internal generating voltage. Readings shall be recorded and submitted to the Engineer, for acceptance prior to energizing same. Submit five copies of tabulated megger test values for all cables.

D. Perform Insulation resistance test and turns ratio test. Submit five copies to engineer at substantial completion.

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

END OF SECTION 26 05 19

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems, equipment and common ground bonding with lightning protection system.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with UL 467 for grounding and bonding materials and equipment.

B. Test all ground rod locations as described to confirm quality standard intent is attained.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches in cross section, unless otherwise indicated; with insulators.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Lugs: Compression of substantial construction, cast copper or cast bronze, with "ground" (micro-flat) surfaces, compression type, two-hole tongue, equal to Burndy or equal by T&B or OZ Gedney. Lightweight and "competitive" devices shall be rejected.

E. Grounding and Bonding Bushings: Malleable iron, Thomas and Betts (T&B), or equal.

F. Grounding Screw and Pigtail: Raco No. 983 or equal.

G. Building Structural Steel, Existing: Thompson 701 Series heavy duty bronze "C" clamp with two-bolt vise-grip cable clamp or equal.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type; 5/8 inch by 10 feet in diameter.

2.4 GROUNDING WELL COMPONENTS

A. All Areas:

1. Well: Minimum 12 inch long by 12 inch wide by 18 inches deep with open bottom.
2. Well Cover: Traffic rated for use with "GROUND" embossed on cover.
3. Material: Composolite.
4. Manufacturer: Quazite.
5. Increase depth, diameter or size as required to provide proper access at installed location.

2.5 GROUNDING BARS/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BARS AND GROUND BUS BARS)

A. Ground bars shall be copper of the size and description as shown on the drawings. If not sized on drawings, bus bar shall be minimum 1/4" x 4" bus grade copper, spaced from wall on insulating 2" polyester molded insulator standoff/supports, and be 12" or greater minimum overall length, allowing 2" length per lug connected thereto. Increase overall length as required to facilitate all lugs required while maintaining 2" spacing. Size of bus bar used in main electrical room shall be similar except minimum of 4" high and 24" long.

B. Provide bolt-tapping lug with two hex head mounting bolts for each terminating ground conductor, sized to match conductors. Mount on bus bar at 2 inches on center spacing. Lugs to be manufactured by Burndy or T&B.

C. Standoff supports to be 2" polyester as manufactured by Glastic #2015-4C.

PART 3 - EXECUTION

3.1 GROUNDING ELECTRODES

A. All connections shall be exothermic welded unless otherwise noted herein. All connections above grade and in accessible locations may be by exothermic welding or by braising or clamping with devices UL listed as suitable for use except in locations where exothermic welding is specifically specified in these specifications or called for on drawings.

B. Each rod shall be die stamped with identification of manufacturer and rod length.

C. Install rod electrodes at locations indicated and/or as called for in these specifications.

D. Ground Resistance:

1. Main Electrical Service (to each building) and Generator Locations:

    a. Grounding resistance measured at each main service electrode system and at each generator electrode system shall not exceed 5 ohms.

2. Other Locations:

    a. Resistance to ground of all non-current carrying metal parts shall not exceed 5 ohms measured at motors, panels, busses, cabinets, equipment racks, light poles, transformers, and other equipment.

3. Lightning Protection system ground locations shall not exceed 5 ohms for the Franklin system measured at ground electrode.
4. Resistance called for above shall be maximum resistance of each ground electrode prior to connection to grounding electrode conductor. Where ground electrode system being measured consists of two (2) or more ground rod electrodes then the resistance specified above shall be the maximum resistance with two (2) or more rods connected together but not connected to the grounding electrode conductor.

E. Install additional rod electrodes as required to achieve specified resistance to ground (specified ground resistance is for each ground rod location prior to connection to ground electrode conductor). Depending on soil condition, etc. of ground rod locations it has been found that the ground rod lengths required to achieve the specified resistance may range from the minimum specified length to up to 80 feet or more in length.

F. Verify that final backfill and compaction has been completed before driving rod electrodes.

G. Install ground rods not less than 1 foot below grade level and not less than 2 feet from structure foundation.

3.2 EQUIPMENT GROUNDING CONDUCTOR

A. Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.

B. Provide green insulated ground wire for all grounding type receptacles and for equipment of all voltages. In addition to grounding strap connection to metallic outlet boxes, a supplemental grounding wire and screw equal to Raco No. 983 shall be provided to connect receptacle ground terminal to the box.

C. All plugstrips and metallic surface raceway shall contain a green insulation ground conductor from supply panel ground bus connected to grounding screw on each receptacle in strip and to strip channel. Conductor shall be continuous.

D. All motors, all heating coil assemblies, and all building equipment requiring flexible connections shall have a green grounding conductor properly connected to the frames and extending continuously inside conduit with circuit conductors to the supply source bus with accepted connectors regardless of conduit size or type. This shall include Food Service equipment, Laundry equipment, and all other "Equipment By Owner" to which an electric conduit is provided under this Division.

3.3 MAIN ELECTRICAL SERVICE

A. Existing Buildings:

1. Verify that each building's electrical service is properly grounded as required by the NEC.
2. Provide and install electrical service grounding at each building as called for herein for all existing services that do not comply with the grounding specified above.
3. Supplement existing electrical service grounding at each building as required to comply with all requirements in these specifications.
4. If exterior ground rod electrode does not exist at each buildings main electrical service, provide and install these ground rods as called for main electrical service, exterior of building. Connect all counterpoise conductors required elsewhere thereto.

B. Ground electrodes shall be provided for the main service in sufficient number and configuration to secure resistance specified.

C. Bond to all of the following when available on site:

1. Ground Rods
2. Metal Water Pipe (Interior and Exterior to Building)
3. Building Metal Frame, Structural Steel and/or Reinforced Structural Concrete
4. All Piping Entering or Leaving All Buildings (Including Chilled Water Piping)
5. Encasing Electrodes
6. Ground Ring
7. Site Distribution Counterpoise Ground System
8. Lightning Protection System

D. A main ground, bare copper conductor, sized per applicable table in NEC, but in no case less than #2/0, shall be run in conduit from the main switchgear of each building to the building steel in respective building. This ground conductor shall also be run individually from the main switchgear and be bonded to the main water service ahead of any union in pipe and must be metal pipe of length as acceptable by authorities having jurisdiction. Provide properly sized

bonding shunt around water meter and/or dielectric unions in the water pipe. Also required is the same size ground wire to ground rod electrode as called for below:

1. Three 30 ft. ground rods in a delta configuration at no less than 30 ft. spacing driven to a minimum depth of 30 ft. plus 1 below grade.
2. Bond ground rod electrodes together with a bare copper ground conductor that matches size required by applicable table in NEC 250, but in no case less than #2/0.
3. Provide additional rod electrodes as required to achieve specified ground resistance.

E. Ground/bond neutral per NEC.

F. Bond grounding electrodes to site counterpoise grounding system and lightning protection system where provided.

G. Provide and install ground bus bar on wall near main service disconnect/switchboard. Connect to ground bar in disconnect/switchboard bonded to switchboard/disconnect enclosure/neutral with copper grounding conductor sized per applicable table in NEC.

3.4 TRANSFORMER GROUNDING

A. Ground all transformers and enclosures of 120/208V and 277/480V "separately derived systems" as specified herein.

1. Ground per NEC 250 and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC.
3. Connect transformer neutral/ground to grounding electrode per NEC with grounding electrode conductor sized per applicable table in NEC.
4. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
6. Where transformer is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system (wherever counterpoise system is available).
7. Ground to water system service pipe as required by NEC.

B. Provide additional ground electrodes as required to achieve specified ground resistance.

C. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet applicable table in NEC, but in no case less than #2/0.

D. Provide and install ground bus bar on wall near transformer (or in associated electrical room for exterior mounted transformers). Connect to ground lug in transformer bonded to transformer enclosure/neutral with copper ground conductor sized per applicable table in NEC.

3.5 GENERATOR GROUNDING

A. Separately derived systems (i.e. systems where generator neutral is not solidly interconnected to service supplied system neutral such as 4 pole switched neutral transfer switch systems).

1. Ground per NEC and these specifications.
2. Bond neutral to transformer frame/enclosure and the equipment grounding conductors of the derived system with copper ground conductor sized per applicable table in NEC.
3. Connect generator neutral/ground to grounding electrodes per NEC with grounding electrode conductor sized per applicable table in NEC.
4. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.
    b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection with connection to other electrodes specified in NEC.
    c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or mote 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

5. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
6. Where generator is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.

B. Non separately derived systems (i.e. systems where generator neutral is solidly interconnected to service supplied system neutral such as 3 pole non-switched neutral transfer switch systems).

1. Do not bond neutral to transformer frame/enclosure or the equipment grounding conductors of the derived system.
2. Connect generator frame/enclosures ground to grounding electrode per NEC with grounding electrode conductor sized per applicable table in NEC .
3. In addition to connection to grounding electrode conductor called for above (i.e. per NEC) provide, install and connect supplemental grounding electrode as follows:

    a. Where grounding required per NEC is to building steel/structure, supplement this grounding with connection to nearest available effectively grounded metal water pipe.

b. Where grounding connection required per NEC is to grounded metal water pipe, supplement this grounding with connection to other electrodes specified in NEC.
c. Where supplemental grounding electrodes required above is a ground rod electrode, provide, install and connect two or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.

4. Where neither building steel nor water pipe grounding electrodes are available (i.e. exterior locations with no available water pipe electrode) provide two (2) ground connections: each to two (2) or more 30 ft. ground rod electrodes at no less than 30 ft. spacing, driven vertical to a minimum depth of 30 ft. plus 1 below grade.
5. Where generator is mounted exterior to building one (1) of the two (2) ground electrodes required shall be ground rod electrode as called for in 5. above. This ground rod electrode shall also be connected to counterpoise system.

C. Provide additional ground electrodes as required to achieve specified ground resistance.

D. Where two or more ground electrodes are used at any one required ground location, they shall be bonded together with a copper ground conductor, sized to meet applicable table in NEC, but in no case less than #2/0.

3.6 LIGHTNING PROTECTION SYSTEMS

A. Ground per applicable section on lightning protection system, NFPA 780, and as specified herein. The most stringent requirements shall govern.

B. Bond lightning protection system grounds to electrical service system ground, all piping entering or leaving all buildings, and counterpoise system ground where provided.

C. Lightning protection ground rods shall be 20’ in length and should not be driven deeper. If additional rods are required to achieve the required resistance to ground, they should be added in parallel with the first at one rod length separation.

3.7 EXTERIOR GRADE (OR FREE STANDING ABOVE GROUND) MOUNTED EQUIPMENT

A. General:

1. All equipment (including chillers, pumps, disconnects, starters, control panels, panels, etc) mounted exterior to building shall have their enclosures grounded directly to a grounding electrode at the equipment location in addition to the building equipment ground connection.
2. Bond each equipment enclosure, metal rack support, mounting channels, etc. to ground electrode system at each rack with an insulated copper ground conductor sized to match the grounding electrode conductor required by applicable table in NEC based on equipment feeder size, but in no case shall conductor be smaller than #6 copper or larger than #2 copper. This connection is in addition to grounding electrode connections required for services.

B. Main electrical service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE".
2. Bond all metal parts as noted above.

C. Electrical sub service rack mounted equipment.

1. Ground per "MAIN ELECTRICAL SERVICE", except do not bond neutral to ground.
2. Bond all metal parts as noted above.

D. Electrical equipment connection rack mounted equipment.

1. Bond all metal parts as noted above.

E. Grounding electrodes (ground electrodes system) shall be:

1. Located at each rack location.
2. For service equipment: Ground electrode required per "MAIN ELECTRICAL SERVICE".
3. For equipment connection equipment: Two or more 30 ft. ground rods at no less than 30 ft. spacing, driven vertical to a minimum depth of 1 ft below grade. Bond the two or more ground rods together with a size to meet applicable table in NEC , but no less than a #2 copper ground conductor. Provide additional rod electrodes as required to achieve specified ground resistance.

3.8 LIGHTING FIXTURES

A. All new and removed/reinstalled fixtures in building interior, and exterior fixtures shall be provided with green grounding conductor, solidly connected to unit. Individual fixture grounds shall be with lug to fixture body, generally located at point of electrical connection to the fixture unit.

B. All suspended fixtures and those supplied through flexible metallic conduit shall have green ground conductor from outlet box to fixture. Cord connected fixtures shall contain a separate green ground conductor.

C. Pole Light Fixtures:

1. Metal Pole Light Fixtures:

a. Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
b. Conductor shall be bonded to metal pole via UL Listed ground clamp suitable for use. Locate ground lug opposite to handhole (or adjacent if visible through handhole).

2. Concrete or Non-Metallic Pole:

a. Freestanding pole mounted lighting fixtures shall each have a Class I or Class II lightning protection main copper down conductor connected to grounding electrodes at base of pole.
b. Conductor shall be extended from grounding electrode to top of pole and terminate at the top of pole in a Class I or Class II copper lightning protection air terminal.
c. Each metal part of light fixture assembly, bracket, ballast cabinet, disconnect, transformer, etc. that is mounted to pole shall be bonded to down conductor.

3. Fixtures located on elevated roadway ramps shall be specially provided with a connection to lightning counterpoise grounding system, properly installed.

4. Grounding electrode(s) at each pole shall be connected (bonded) to site distribution counterpoise system.
5. Grounding Electrodes:

    a. Two or more 10 ft. ground rods at no less than 10 ft. spacing shall be driven vertically to a minimum depth of 10 ft. plus 1 below grade.
    b. Bond the two or more ground rod electrodes together with a Class I or Class II lightning protection main copper conductor.
    c. Provide additional rod electrodes as required to achieve specified ground resistance.
    d. The two (2) or more grounding rod electrodes shall be installed at each light pole.

6. Installation shall exceed minimum requirements of NFPA 780.

3.9 PULLBOX, MANHOLE, HANDHOLE GROUNDING.

A. One 30 ft. ground rod electrode shall be driven vertically to a minimum depth of 30 ft. plus 1 ft. below grade in each manhole, handhole or pullbox (in ground).

B. Bond to counterpoise system (whenever counterpoise system is provided.)

C. Bond grounding electrode to all exposed metal parts of manhole, handhole, and pullbox (including metal cover) with #6 copper ground conductor. Connect to ground rod electrode with exothermic weld. Connect to metal cover with exothermic weld. Connect to other metal parts with exothermic weld or UL accepted grounding clamp. Provide 3 ft. or more slack ground cable on cover connection as required to facilitate removal of cover.

3.10 GROUND RING

A. Provide complete underground building perimeter ground ring system, completely encircling each building.

B. Conductor shall be minimum of Class II lightning protection copper conductor (bare).

C. Install at not less than 2-1/2 feet depth into earth.

D. Install ground rods 20 ft. long every 150 feet section of ground ring conductor.

E. Bond ground ring to building steel every 150 feet of building perimeter, bond to any and all electrical and piping systems that cross the ground ring system, bond to lightning protection down conductors and to any lightning or other earth grounding electrodes that may be present on the premises.

F. Bond to building service and counterpoise ground systems.

3.11 MISCELLANEOUS GROUNDING CONNECTIONS

A. Provide bonding to meet regulatory requirements.

B. Required connections to building steel shall be with UL accepted non-reversible crimp type ground lugs exothermically welded to bus bar that is either exothermically welded to steel or bolted to steel in locations where weld will not affect the structural properties of the steel.

Required connections to existing building structural steel purlins/I beams shall be with heavy duty bronze "C" clamp with two bolt vise-grip cable clamp.

C. Grounding conductors shall: be so installed as to permit shortest and most direct path from equipment to ground; be installed in conduit; be bonded to conduit at both ends when conduit is metal; have connections accessible for inspection; and made with accepted solderless connectors brazed (or bolted) to the equipment or to be grounded; in NO case be a current carrying conductor; have a green jacket unless it is bare copper; be run in conduit with power and branch circuit conductors. The main grounding electrode conductor shall be exothermically welded to ground rods, water pipe, and building steel.

D. All surfaces to which grounding connections are made shall be thoroughly cleaned to maximum conductive condition immediately before connections are made thereto. Metal rustproofing shall be removed at grounding contact surfaces, for 0 ohms by digital Vm. Exposed bare metal at the termination point shall be painted.

E. All ground connections that are buried or in otherwise inaccessible locations, shall be welded exothermically. The weld shall provide a connection which shall not corrode or loosen and which shall be equal or larger in size than the conductors joined together. The connection shall have the same current carrying capacity as the largest conductor.

F. Install ground bushings on all metal conduits entering enclosures where the continuity of grounding is broken between the conduit and enclosure (i.e. metal conduit stub-up into a motor control center enclosure or at ground bus bar). Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

G. Install ground bushings on all metal conduits where the continuity of grounding is broken between the conduit and the electrical distribution system (i.e. metal conduit stub-up from wall outlet box to ceiling space. Provide an appropriately sized bond jumper from the ground bushing to the respective equipment ground bus or ground bus bar.

H. Each feeder metallic conduit shall be bonded at all discontinuities, including at switchboards and all subdistribution and branch circuit panels with conductors in accordance with applicable table in NEC 250 for parallel return with respective interior grounding conductor.

I. Grounding provisions shall include double locknuts on all heavywall conduits.

J. Bond all metal parts of pole light fixtures to ground rod at base.

K. Install grounding bus in all existing panelboards of remodeled areas, for connection of new grounding conductors, connected to an accepted ground point.

L. Bond together reinforcing steel and metal accessories in pool and fountain structures.

M. Where reinforced concrete is utilized for building grounding system, proper reinforced bonding shall be provided to secure low resistance to earth with "thermite" type devices, and #10AWG wire ties shall be provided to not less than ten (10) full length rebars which contact the connected rebar .

3.12 GROUNDING BAR/GROUND BUS (INCLUDING 'SYSTEMS' GROUND BUS/BAR ON GROUND BUS/BAR) INSTALLATION

A. Where indicated on the drawings, provide and install grounding bar/ground bus (bus bar). These bus installations are intended to provide a low-impedance "earthing" path for surge

voltages, which are electrically "clamped" and shunted to earth by variable-impedance surge protective devices. Metal sheaths of underground cables are also to be grounded thereto at points of building entrance.

B. Mount bolt tapping lugs with hex head bolts to bus bar at 2" o.c. spacing, one for each ground conductor.

C. Mount bus bar to wall using 2" polyester molded insulator stand-off.

D. Extend a #2/0 (minimum size) or larger THWN insulated copper ground conductor (if larger size is called for on drawings or required by N.E.C. for service ground, etc.) in PVC conduit to accepted service ground installation or ground bus/bar in main service equipment enclosure.

E. Extend #6 insulated copper ground wire from respective bus/bar to each 'local' ground bus/bar in each cabinet for Section 27 systems.

F. 'SYSTEMS' grounding bus/bar must be connected with #2/0 insulated copper conductor to grounding electrodes system as defined in NEC "Article 800.

3.13 COMMUNICATIONS SYSTEMS

A. Provide and install all grounding as required by NEC Article 800 and where available on project: Articles 810 (Radio and Television Equipment); 820 (Community Antenna Television and Radio Distribution Systems); and 830 (Network-Powered Broadband Communications Systems.

B. Provide and install grounding electrode at point of entry of communication cables and bond to service entrance grounding electrodes per NEC 800. Install ground bus bar at point of entry of communications cable and connect electrode to ground bus. Connect communications cable metal sheath and surge protection devices to ground bar.

3.14 TESTING AND REPORTS

A. Ground resistance measurements shall be made on each system utilized in the project. The ground resistance measurements shall include building structural steel, driven grounding system, water pipe grounding system and other accepted systems as may be applicable. Ground resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground under test isolated from other grounds and equipment. Resistances measured shall not exceed specified limits.

B. Test existing building ground electrode system to confirm compliance with these specifications (5 ohm to ground). Notify the engineer in writing if the existing ground electrode does not comply with the requirements.

C. Upon completion of testing, the testing conditions and results shall be certified and submitted to the Architect/Engineer.

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END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Unistrut
2. Straps
3. Clamps
4. Rods
5. Hangers

6. Anchors
7. Attachment Devices

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

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

a. Cooper B-Line, Inc.; a division of Cooper Industries.
b. ERICO International Corporation.
c. Thomas & Betts Corporation.
d. Unistrut; Tyco International, Ltd.
e. Wesanco, Inc.

2. Metallic Coatings: Exterior of the building utilize stainless steel or hot-dip galvanized after fabrication and applied according to MFMA-4. Interior utilize electro-galvanized steel products.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper B-Line, Inc.; a division of Cooper Industries.
    b. Fabco Plastics Wholesale Limited.
    c. T & B/Carlon
    d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.

4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25percent in future without exceeding specified design load limits.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

F. Do not support conduit or raceway with wire, metal banding material, or perforated pipe straps. Remove wire used for temporary supports

G. Do not attach conduit or raceway to ceiling support wires.

H. Conduits or raceways shall not be supported from ceiling grid supports, plumbing pipes, duct systems, heating or air conditioning pipes, or other building systems.

I. Non-bolted conduit clamps, spring type conduit clamps, and tie wire are not acceptable for supports. All conduits must be supported with bolted hangers listed for the specific installed application.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION 26 05 29

SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. ENT: Electrical nonmetallic tubing.

C. EPDM: Ethylene-propylene-diene terpolymer rubber.

D. FMC: Flexible metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. LFNC: Liquidtight flexible nonmetallic conduit.

G. NBR: Acrylonitrile-butadiene rubber.

H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. Custom enclosures and cabinets.
2. For handholes and boxes for underground wiring, including the following:

a. Duct entry provisions, including locations and duct sizes.
b. Frame and cover design.

c. Grounding details.
d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

1.5 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit - Zinc Coated

B. ANSI C80.3 - Electrical Metallic Tubing - Zinc Coated

C. ANSI C80.5 - Aluminum Rigid Conduit (ARC)

D. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

E. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

G. ANSI/NFPA 70 - National Electrical Code

H. NECA Standard Practices for Good Workmanship in Electrical Contracting

I. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

J. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit (EPC 40, EPC 80)

K. NEMA TC 3 -Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

1.6 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Minimum Trade Size

1. All Conduit (except switch legs) - 3/4"c.

2. Switch legs - 1/2"c.

B. RIGID METALLIC CONDUIT

1. Comply with:

   a. ANSI C80.1
   b. UL Spec - No. 6
   c. NEC 344

2. Conduit material:

   a. Zinc coated or hot dipped galvanized steel.

3. Fittings:

   a. Threaded.
   b. Insulated bushings shall be used on all rigid steel conduits terminating in panels, boxes, wire gutters, or cabinets, and shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.
   c. Zinc plated or hot dipped galvanized malleable iron or steel.

4. Conduit Bodies:

   a. Comply with ANSI/NEMA FB 1.
   b. Threaded hubs.
   c. Zinc plated or hot-dipped galvanized malleable iron.

C. RIGID ALUMINUM CONDUIT

1. Comply with:

   a. ANSI C80.5
   b. UL 6
   c. NEC 344

2. Conduit material: Aluminum.
3. Fittings:

   a. Threaded.
   b. Aluminum.
   c. Insulated bushings on terminations.

4. Conduit bodies:

   a. Comply with ANSI/NEMA FB 1.
   b. Threaded hubs.
   c. Aluminum.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with:

   a. UL 6

b. ANSI C80.1
c. NEC. 344
d. NEMA RN1

2. Conduit material: Hot-dipped galvanized rigid steel with external PVC coating, 20 mil. thick.
3. Fittings:

a. Threaded.
b. Insulated bushings on terminations.
c. Zinc plated or hot-dipped galvanized malleable iron or steel with external PVC coating, 20 mil. thick.

4. Conduit bodies:

a. Comply with:
b. ANSI/NEMA FB 1
c. Threaded hubs
d. Zinc plated or hot-dipped galvanized malleable iron with external PVC coating 20 mil thick.

E. EMT: ANSI C80.3.

1. Comply with:

a. UL 797
b. ANSI C80.3
c. NEC 358
d. ANSI/UL797

2. Conduit material: Galvanized steel tubing.
3. Fittings:

a. ANSI/NEMA FB 1
b. Set screw, Die Cast for Interior Dry locations
c. Compression, Steel for all damp locations

F. FMC: Zinc-coated steel or aluminum.

1. Comply with:

a. NEC 348
b. ANSI/UL 1

2. Conduit material: Steel or aluminum, interlocked.
3. Fittings:

a. ANSI/NEMA FB 1
b. ANSI/UL 514B
c. Die Cast
d. Threaded rigid conduit to flexible conduit coupling.
e. Direct flexible conduit bearing set screw type not acceptable.

G. LFMC: Flexible steel conduit with PVC jacket.

1. Comply with:

    a. NEC 350
    b. ANSI/UL 360

2. Conduit material:

    a. Flexible hot-dipped galvanized steel core, interlocked.
    b. Continuous copper ground built into core up to 1-1/4" size.
    c. Extruded polyvinyl gray jacket.

3. Fittings:

    a. Threaded for rigid conduit connections.
    b. Accepted for hazardous locations where so installed.
    c. Provide sealing washer in wet/damp locations.
    d. Compression type.
    e. ANSI/NEMA FB 1.
    f. ANSI/UL 5148.
    g. Zinc plated malleable iron or steel.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Minimum Trade Size – ¾”

B. RNC: NEMA TC 2, Schedule-40-PVC, unless otherwise indicated.

1. Comply with:

    a. NEMA TC-2
    b. UL 651
    c. NEC 352

2. Conduit material:

    a. Shall be high impact PVC - tensile strength 55 PSI, flexural strength 11000 PSI.

3. Fittings:

    a. Comply with: NEMA TC-3 and UL 514.

2.3 EXPANSION FITTINGS

A. Expansion fittings shall be:

1. UL Listed, hot dipped galvanized inside and outside providing a 4" expansion chamber - when used with rigid conduit and electrical metallic conduit, or:
2. Be polyvinyl chloride and shall meet the requirements of and as specified elsewhere for non-metallic conduit and shall provide a 6" expansion chamber.
3. Hot dipped galvanized expansion fitting shall be provided with an external braided grounding and bonding jumper with accepted clamps, UL Listed for the application.

4. Expansion fitting, UL Listed for the application and in compliance with the National Electrical Code without the necessity of an external bonding jumper may be considered. Submit fitting with manufacturer's data and UL Listing for acceptance prior to installation.

2.4 METAL WIREWAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type.

E. Finish: Manufacturer's standard enamel finish.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Thomas & Betts Corporation.
b. Walker Systems, Inc.; Wiremold Company (The).
c. Wiremold Company (The); Electrical Sales Division.
d. Mono-Systems, Inc.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.

10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch (13 mm) male fixture studs where required.
2. Concrete Ceiling Boxes: Concrete type.
3. Interior flush outlet boxes shall be one piece drawn galvanized steel constructed with stamped knockouts in back and sides, and threaded holes with screws for securing box coverplates or wiring devices.
4. Ceiling outlet boxes shall be 4" octagonal or 4" square X 1 1/2" deep or larger as required for number and size of conductors and arrangement, size and number of conduits terminating at them.
5. Switch, wall receptacle, telephone and other recessed wall outlet boxes in drywall shall be a minimum of 4" square X 1 1/2" deep. For recessing in exposed masonry, provide one piece drawn 4" square x 1 1/2" deep wall boxes with appropriate 4" square cut tile wall covers. For recessing in furred-out block walls, provide 4" square box with required extension for block depth and required extension for drywall depth.
6. Boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.
7. Handy boxes shall not be used for any purpose.
8. Where a box is used as the sole support for a ceiling paddle fan, the box must be listed for this purpose and the weight of the fan.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.

1. Interior surface outlet boxes and conduit bodies installed from 0" AFF to 90" AFF (including fire alarm device backbox) shall be the heavy cast aluminum or iron with external threaded hubs for power devices and threaded parts for low voltage devices. Trim rings shall also be of one-piece construction.
2. Weatherproof outlet boxes shall be constructed of corrosion-resistant cast iron suited to each application and having threaded conduit hubs, cast metal faceplate with spring-hinged waterproof cap suitable configured, gasket, and corrosion-proof fasteners.
3. Freestanding malleable iron cast boxes are to be type FSY (with flange). Cast aluminum/zinc boxes are not acceptable (Bell Boxes).

D. Floor Boxes:
1. For all slab on grade areas except wet locations and wooden floors: Cast iron or steel with epoxy paint, fully adjustable before and after the concrete pour. The cover shall provide protection from water, dirt and debris. The cover will be flanged die cast aluminum with brushed aluminum finish that will accept carpet or tile cutouts to match flooring. The box shall be capable of adapting to most power and communications needs. Provide all activations, barriers and brackets required for the particular installation. Design Selection is Wiremold RFB 4 (based on required outlets) or equal.
2. Wood Floors: Cast iron or steel fully adjustable, rectangular, multi-gang box. The cover shall provide protection from water, dirt and debris. The cover will be brass flip lids with appropriate multi gang ring to set flush with wood flooring. The box shall be capable of adapting to most power and communications needs.
3. Poke Thru's for all floor boxes in elevated slabs: Flush style round poke thru with combination power (2 duplex) and data (6 Cat6 outlets). Poke Thru shall be UL scrub water exclusion for tile and carpeted floors. Poke thru shall be maintains UL fire rated for up to 2 hour rated floors. Poke thru shall meet FBC and ADA accessibility guidelines.

E. Sheet Metal Pull and Junction Boxes: NEMA OS 1.

1. Pull and junction boxes (not in-ground type) larger than 25 square inches shall be hinged cover type with flush latches operated with screwdriver.
2. Large Pull Boxes: Boxes larger than 400 cubic inches in volume or 20 inches in any dimension:

   a. Use continuous hinged enclosures with locking handle.

3. Exterior, damp location and wet location pull and junction boxes shall be Nema 4x stainless steel.

F. Cabinets (Control and Systems):

1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Metal barriers to separate wiring of different systems and voltage.
4. Accessory feet where required for freestanding equipment.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Concrete ring with Nema 6P box inside (All Areas)

1. Color of Frame and Cover: Gray.
2. Configuration: Concrete ring shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural traffic load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC.", "TELEPHONE." or as indicated for each service.
6. Nema 6P box rated for direct burial enclosure shall be located inside the concrete ring for termination of conduits.
7. Handholes 36 inches wide by 36 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

PART 3 - EXECUTION

3.1 RACEWAY LOCATION INSTALLATION REQUIREMENTS

A. Underground Installations:

1. Use rigid non-metallic conduit (PVC) only unless local authority having jurisdiction or applicable codes/utility requirements, etc. require rigid steel conduit.
2. All conduits or elbows entering, or leaving the ground shall be rigid steel conduit coated with asphaltic paint.
3. All underground raceways shall be installed in accordance with the NEC except that the minimum cover for any conduit outside the building slab shall be two feet. Included under this Section shall be the responsibility for verifying finished lines in areas where raceways will be installed underground before the grading is complete.

4. Where rigid metallic conduit is installed underground as noted above it shall be coated with waterproofing black mastic before installation, and all joints shall be re-coated after installation.
5. Utilize rigid steel 90° elbows at each riser and at each change in direction. Elbows shall be coated with black mastic or PVC coating. Bond all metal elbows per NEC.
6. All underground service lateral raceways shall be protected as required by the NEC including requirements for installation of warning tape.

B. In Slab Above or on Grade:

1. Use coated rigid steel conduit or rigid non-metallic conduit.
2. Coating of metallic conduit to be black asphaltic or PVC.

C. Penetration of Slab:

1. Exposed Location subject to damage:

a. Where penetrating a floor in an exposed location subject to damage from underground or in slab, a black mastic coated or PVC coated galvanized rigid steel conduit shall be used.

2. Interior Location not subject to damage:

a. Where penetrating a floor in a location concealed in block wall and acceptable by applicable codes, rigid non-metallic conduit may be used up to first outlet box, provided outlet box is at a maximum height of 40" above finished floor.
b. Where penetrating a floor in location other than that above, transition to metallic conduit at the floor.

D. Outdoor Location:

1. Above Grade:

a. Where penetrating the finished grade, black mastic coated or PVC coated galvanized rigid steel conduit shall be used.
b. In general all exterior conduit runs shall be rigid steel conduit and threaded connectors as specified elsewhere.
c. Electrical metallic tubing (thin wall) is permitted under roof, overhangs, etc. provided it is not subjected to physical damage and is not in direct contact or directly subject to exterior elements including sunlight.

2. Metal Canopies:

a. Conduit runs except for canopy lighting raceways are not to be run on (top or bottom) of metal canopies roof systems. All new conduit shown on or at these areas is to be run underground. Clamp back spacers shall be used on all canopies to prevent galvanic action from dissimilar metals. Conduits installed exposed from Building structure to Metal Canopies will not be permitted.

3. Roofs:

a. Conduit is not to be installed on roofs, without written authorization by A/E and the Owner for specific conditions.
b. When accepted by written authorization conduit shall comply with the following:

1) Be PVC coated rigid galvanized metal conduit.
2) All fittings, etc. are to be PVC coated.
3) Conduit shall be supported above roof at least 6 inches using accepted conduit supporting devices. Refer to applicable sections of specifications on roofing, etc.
4) Supports to be fastened to roof using roofing adhesive or means compatible with roofing. Confirm the method used will not void the roofing warranty. The use of pitch pockets is not acceptable.

E. Interior Dry Locations:

1. Concealed: Use rigid galvanized steel conduit and electrical metallic tubing. Rigid non-metallic conduit may be used inside block walls up to first outlet to a maximum of 40" A.F.F. except where prohibited by the NEC (places of assembly, etc.).
2. Exposed: Use rigid galvanized steel or electrical metallic tubing. EMT may only be used where not subject to damage, which is interpreted by this specification to be above 90" AFF.
3. Concealed or exposed flexible conduit:

a. Concealed flexible steel conduit or seal tight flexible steel conduit in lengths not longer than six (6) feet in length with a ground conductor installed in the conduit or an equipment ground conductor firmly attached to the terminating fitting at the extreme end of the flex. Exposed flexible steel conduit or seal tight flexible steel conduit shall not exceed two (2) feet in length, unless written authorization by A/E for specific conditions is granted.

F. Interior Wet and Damp Locations:

1. Use rigid galvanized steel conduit.

G. Concrete Columns or Poured in-place Concrete Wall Locations:

1. Use rigid non-metallic conduit. Penetration shall be by accepted metal raceway (i.e. metal conduit as required elsewhere in these specifications).

3.2 RACEWAY INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. All bending, cutting, and reaming shall be completed with tools specifically designed for the specific use.

C. Expansion fittings shall be installed in the following cases:

1. In each conduit run wherever it crosses an expansion joint in the concrete structure; on one side of joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
2. In each conduit run which mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
3. In straight conduit run above ground which is more than one hundred feet long and interval between expansion fittings in such runs shall not be greater than 100 feet.

D. Arrange conduit to maintain headroom and present neat appearance.

E. Provide rigid steel long radius 90 degree sweeps (bend radius of 10 times the conduit trade size diameter) for all changes in direction (vertical and horizontal) for utility conduits. Comply with all installation requirements of the utility to utilize the conduits.

F. Utility conduits shall be buried a minimum of 36” deep to the top of the conduit.

G. Route conduit installed above accessible ceilings or exposed to view parallel or perpendicular to walls. Do not run from point to point.

H. Do not cross conduits in slab.

I. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

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

K. Complete raceway installation before starting conductor installation.

L. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

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

N. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch (50 mm) size.

O. Provide continuous fiber polyline 1000 lb. minimum tensile strength pull string in each empty conduit except sleeves and nipples. This includes all raceways which do not have conductors furnished under this Division of the specifications. Pull cord must be fastened to prevent accidental removal.

P. Use suitable caps to protect installed conduit against entrance of dirt and moisture.

Q. Rigid steel box connections shall be made with double locknuts and bushings.

R. Spare conduit stubs shall be capped and location and use marked with concrete marker set flush with finish grade. Marker shall be 6" round x 6" deep with appropriate symbol embedded into top to indicate use. Also, tag conduits in panels where originating.

S. Spare conduit stubs shall be capped with a UL listed and accepted cap or plug for the specific intended use and identified with ink markers as to source and labeled "Spare."

T. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

U. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

V. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

W. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

X. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Z. All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.

AA. Raceways shall not be routed through stairwells, elevator shafts, elevator machine rooms or fire pump rooms unless the conduit is for use within that space.

BB. Raceways installed in hazardous locations shall be installed in accordance with the appropriate provisions of NEC chapter 5 for that location. Confirm the appropriate space rating with life safety plans.

CC. All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction and until wires are pulled in, and covers are in place. No conductors shall be pulled into raceways until construction work which might damage the raceways has been completed.

DD. Electrical raceways shall be supported independently of all other systems and supports, and shall in every case avoid proximity to other systems which might cause confusion with such systems or might provide a chance of electrolytic actions, contact with live parts or excessive induced heat.

EE. Excavate trench bottom to provide firm and uniform support for conduit installed underground. Prepare trench bottom as specified in Division 31 Section "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter. Install backfill as specified in Division 31 Section "Earth Moving."

FF. After installing underground conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."

3.3 BOX INSTALLATION

A. Set metal floor boxes level and flush with finished floor surface.

B. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

C. Install electrical boxes as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.

D. Install electrical boxes to maintain headroom and to present neat mechanical appearance.

E. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches (150 mm) from ceiling access panel or from removable recessed luminaire.

F. Install boxes to preserve fire resistance rating of partitions and other elements.

G. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices with each other.

H. Outlets for 120V clocks shall be recessed so that the clock will hang flush with the finished surface of the wall.

I. Use flush mounting outlet boxes in finished areas.

J. Do not install flush mounting boxes back-to-back in walls; provide minimum 6 inch (150 mm) separation. Provide minimum 24 inches (600 mm) separation in acoustic and fire rated walls.

K. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

L. Use stamped steel bridges to fasten flush mounting outlet box between studs.

M. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

N. Support all outlet boxes from structure with minimum of one (1) 3/8" all-thread rod hangers. Boxes larger than 25 square inches shall be supported with two (2) all-thread rod hangers, minimum.

O. Do not fasten boxes to ceiling support wires.

P. Use multi-gang box where more than one device is mounted together. Do not use sectional box.

Q. Boxes in exterior walls shall be flush mounted. Use cast outlet box in exterior locations and wet locations where flush mounting is not possible.

R. Install outlets in the locations shown on the drawings; however, the Owner shall have the right to make, prior to rough-in, slight changes in locations to reflect room furniture layouts.

S. Coordinate work with all divisions so that each electrical box is the type suitable for the wall or ceiling construction provided and suitable fireproofing is inbuilt into fire rated walls.

T. All boxes shall be installed in a flush rigid manner with box lines at perpendicular and parallel angles to finished surfaces. Boxes shall be supported by appropriate hardware selected for the type of surface from which the box shall be supported. For example, provide metal screws for metal, wood screws for wood, and expansion devices for masonry or concrete.

U. For locations exposed to weather or moisture (interior or exterior), provide weatherproof boxes and accessories.

V. As a minimum, provide pull boxes in all raceways over 150 feet long. The pull box shall be located near the midpoint of the raceway length.

W. Provide knockout closures to cap unused knockout holes where blanks have been removed, and plugs for unused threaded hubs.

X. Provide conduit locknuts and bushings of the type and size to suit each respective use and installation.

Y. Boxes and conduit bodies shall be located so that all electrical wiring is accessible.

Z. Avoid using round boxes where conduit must enter box through side of box, which would result in a difficult and insecure connection with a locknut or bushing on the rounded surface.

AA. All flush outlets shall be mounted so that covers and plates will finish flush with finished surfaces without the use of shims, mats or other devices not submitted or accepted for the purpose. Add-a-Depth rings or switch box extension rings are not acceptable. Plates shall not support wiring devices. Gang switches with common plate where two or more are indicated in the same location. Wall-mounted devices of different systems (switches, thermostats, etc.) shall be coordinated for symmetry when located near each other on the same wall. Outlets on each side of walls shall have separate boxes. Through-wall type boxes shall not be permitted. Back-to-back mounting shall not be permitted. Trim rings shall be extended to within 1/8" of finish wall surface.

BB. Outlet boxes mounted in metal stud walls, are to be supported to studs with two (2) screws inside of outlet box to a horizontal stud brace between vertical studs or one side of outlet box supported to stud with opposite side mounted to section of stud or device to prevent movement of outlet box after wall finished.

CC. All outlet boxes that do not receive devices in this contract are to have blank plates installed matching wiring device plates.

DD. Height of wall outlets to bottom above finished floors shall be as follows, unless specifically noted otherwise, or unless otherwise required by applicable codes including ADA. Verify with the Architectural plans and shop drawings for installing.

1.	Switches	4'-0" AFF to top
2.	Receptacles	1'-4" AFF to bottom
3.	Lighting Panels	6'-6" AFF to centerline of highest breaker/fuse
4.	Phone outlets	1'-4" AFF to bottom
5.	Intercom Call-in	4'-0"AFF to top
6.	Fire Alarm Pull Stations	4'-0" AFF to top
7.	Fire Alarm Strobe Lights	Lens is not less than 80" AFF and not more than 96” AFF
8.	Fire Alarm Audible Only	Not less than 90” and not less than 6” below ceiling.

.

EE. Bottoms of outlets above counter tops or base cabinets shall be minimum 2" above counter top or backsplash, whichever is highest. Outlets may be raised so that bottom rests on top of concrete block course, but all outlets above counters in same area shall be at same height. It is the responsibility of this Division to secure cabinet drawings and coordinate outlet locations in relation to all cabinets as shown on Architectural plans, prior to rough-in, regardless of height shown on Division 26 drawings.

FF. Height of wall-mounted fixtures shall be as shown on the drawings or as required by Architectural plans and conditions. Fixture outlet boxes shall be equipped with fixture studs when supporting fixtures.

GG. Locate special purpose outlets as indicated on the drawings for the equipment served. Location and type of outlets shall be coordinated with appropriate trades involved. The securing of complete information for proper electrical roughing-in shall be included as work required under this section of specifications. Provide plug for each outlet.

HH. Electrical outlet boxes may be installed in vertical fire resistive assemblies classified as fire/smoke and smoke partitions without affecting the fire classification, provided such openings occur on one side only within a 24" wall space and that openings do not exceed 16 sq. inches. All clearances between such outlet boxes and the gypsum board must be completely filled with joint compound.

II. Fire-Barrier Penetrations: Firestop penetrations under division 07 Section "Firestopping".

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In all areas, set so cover surface will be flush with finished grade.

3.5 INSTALLATION OF WIREWAYS

A. Do not install wireways as a substitute for proper coordination and layout of conduit stub ups to panels. Prior authorization from the engineer is required prior to installation of any wireways.

B. Do not make splices in wireways. All wires must be pulled through without splice or termination.

C. Install wireway to maintain headroom and to present neat mechanical appearance.

D. Support wireway independently of conduit.

E. Wireway shall be located so that all electrical wiring is accessible.

END OF SECTION 26 05 33

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

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

1.3 SUBMITTALS

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

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

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

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY, BOX AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

B. Primed and Painted band 4” in length.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

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

2.3 UNDERGROUND-LINE WARNING TAPE

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

1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

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

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

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Safety Signs: Comply with 29 CFR, 1910.145.

B. Nameplates shall be laminated phenolic plastic, chamfer edges, punched or drilled for rivets.

1. For 120/208 Volt System:

a. Black front and back with white core, with lettering etched through the outer covering. White engraved letters on Black background.

2. For 277/480 Volt System:

a. Orange front and back with white core with lettering etched through the outer covering. White engraved letters on Orange background.

3. For Emergency System:

a. Red front and back with white core with lettering etched through the outer covering. White engraved letters on red background.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

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

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

F. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

G. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

I. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system.

1. Color-code 208/120-V system as follows:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Neutral: White.
e. Ground: Green.
f. Switchlegs(load side of contactor or relay is not considered a switchleg): Purple

2. Color-code 480/277-V system as follows:

a. Phase A: Brown
b. Phase B: Orange
c. Phase C: Yellow
d. Neutral: White with a colored stripe or gray.
e. Ground: Green.
f. Switchleg(load side of contactor or relay is not considered a switchleg): Pink

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 6 AWG:

a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

J. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

K. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

L. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

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

N. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction

signs with approved legend where instructions are needed for system or equipment operation.

2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

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

1. Labeling Instructions:

   a. Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) high.
   b. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: Include as a minimum the equipment identification (first line ½"): voltage rating and amperage rating (second line 3/8"): where it is fed from (third line 3/8"). (Example :Panel CP1 (Line 1), 208/120V 3ph, 4w, 225A(line 2), fed from swbd MDP-1 (Line 3))

   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchgear and switchboards.
   d. Transformers.
   e. Electrical substations.
   f. Emergency system boxes and enclosures.
   g. Motor-control centers.
   h. Disconnect switches.
   i. Enclosed circuit breakers.
   j. Motor starters.
   k. Push-button stations.
   l. Power transfer equipment.
   m. Contactors.
   n. Remote-controlled switches, dimmer modules, and control devices.
   o. Emergency Relay locations on grid below relay location
   p. Battery inverter units.
   q. Battery racks.
   r. Power-generating units.
   s. Voice and data cable terminal equipment.
   t. Master clock and program equipment.
   u. Intercommunication and call system master and staff stations.
   v. Television/audio components, racks, and controls.
   w. Fire-alarm control panel and annunciators.
   x. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   y. Monitoring and control equipment.
   z. Uninterruptible power supply equipment.
   aa. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 SWITCHGEAR BREAKERS

A. Provide labels for each breaker to identify the load served.

3.3 CONDUIT/JUNCTION BOX COLOR CODE

A. All conduit system junction boxes (except those subject to view in public areas) shall be color coded as listed below:

B. Color Code for Junction Boxes

1.	System Emergency 277/480 volt	Orange/Brown
2.	System Emergency 120/208 volt	Orange/Black
3.	Fire Alarm	Red
4.	Normal Power 277/480 volt	Brown
5.	Normal Power 120/208 volt	Black
6.	Fiber Optics	Purple
7.	Sound System	Yellow
8.	Clock	Light Blue
9.	Intercom	Blue
10.	Computer/Data	Gold
11.	TV	White
12.	Security/CCTV	Beige
13.	Ground	Fluorescent Green
14.	Telephone	Clover Green

C. Conduits (not subject to public view) longer than 20 feet shall be painted with above color paint band 20 ft. on center. Paint band shall be 4” in length, applied around the entire conduit. Where conduits are parallel and on conduit racking, the paint bands shall be evenly aligned. Paint shall be neatly applied and uniform. Paint boxes and raceways prior to installation or tape conduits and surrounding surfaces to avoid overspray. Paint overspray shall be removed.

D. All new and existing junction boxes/cover plates for power, lighting and systems (except those installed in public areas) shall adequately describe it’s associated panel and circuit reference number(s) within, (i.e. ELRW-2, 4, 6) or systems within (i.e. fire alarm, intercom. Etc.). Identification shall be by means of black permanent marker. (Paint ½ cover plate with appropriate color as noted in 2.3 above, and mark other ½ with associated panel/circuit or system description as described).

END OF SECTION 26 05 53

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SECTION 26 08 16 – DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Purpose:

1. This section includes the requirements for demonstration of completed electrical systems; requirements of this section are in addition to any other related section.

B. Demonstrate to the Owner the essential features of the following electrical systems:

1. Communications Systems

   a. All systems included in DC Sections 27 and 28.

2. Electrical Entrance Equipment

   a. Circuit Breakers
   b. Fuse and fuseholders
   c. Meters (where applicable)

3. Miscellaneous Electrical Equipment

   a. Kitchen exhaust hood shut down
   b. Electrical systems controls and equipment
   c. Electrical power equipment
   d. Motor control devices
   e. Relays
   f. Special transformers
   g. Starting devices
   h. Surge suppression equipment

4. Lighting Fixtures (including relamping and replacing lenses)

   a. Exit and safety fixtures
   b. Fixtures, indoor and outdoor

5. Distribution Equipment

   a. Lighting and appliance panelboards
   b. Distribution panels
   c. Switchboards

6. Stand-by Electrical Equipment

   a. Batteries
   b. Battery chargers
   c. Controls and alarms
   d. Emergency generators, transfer switches

7. Wiring Devices

    a. Low-voltage controls
    b. Switches: regular, time
    c. Upon completion of testing, each system is to be demonstrated only once.
    d. The demonstration is to be held upon completion of all systems at a date to be agreed upon in writing by the Owner or his representative.
    e. The demonstration is to be scheduled and performed by this Contractor in the presence of the Owner, and the manufacturer's representative.

1.2 DEMONSTRATION

A. Demonstrate the function and location (in the structure) of each system, and indicate its relationship to the riser diagrams and drawings.

B. Demonstrate by "start-stop operation" how to work the controls, how to reset protective devices, how to replace fuses, and what to do in case of emergency.

1.3 COORDINATION / EXHIBITS

A. Specification Items:

    a. Exhibit 1 – Check Out Memo Form

END OF SECTION 26 08 16

CHECK OUT MEMO FORM

This form shall be completed and a copy provided to the Owner at the Owner's Performance Verification and Demonstration Meeting. A copy shall also be included in the specification section of each O & M Manual for the equipment checked.

Project Name: _____

Type of Equipment Checked: _____

Equipment Number: _____

Name of manufacturer of equipment: _____

Signature below by the manufacturer's authorized representative signifies that the equipment has been satisfactorily tested and checked out on the job by the manufacturer.

1. The attached Test and Data and Performance Verification information was used to evaluate the equipment installation and operation.

2. The equipment is properly installed, has been tested by the manufacturer's authorized representative, and is operating satisfactorily in accordance with all requirements, except for items listed below.*

3. Written operating and maintenance information has been presented to the Contractor, and gone over with him in detail.

4. Sufficient copies of all applicable operating and maintenance information, parts lists, lubrication checklists, and warranties have been furnished to the contractor for insertion in the Operation and Maintenance Manuals.

Checked By: _____
(Print or Type Nam of Manufacturer's Representative)

Address: _____
(Address and Phone No. of Representative)

Signature: _____
(Title of Representative)

Date Checked: _____

Witnessed By: _____
(Signature and Title of Contractor Representative)

*Exceptions Noted at Time of Check-Out (use additional page if necessary):

EXHIBIT 1

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SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

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

1. Distribution transformers.
2. Buck-boost transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

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

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

C. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

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

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

1.7 WARRANTY

A. Ten (10) years, minimum, unlimited repair or replacement.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Energy & Automation, Inc.
4. Square D; Schneider Electric.

2.2 DISTRIBUTION TRANSFORMERS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores:
1. Grain-oriented, non-aging silicon steel.
2. One leg per phase.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper

D. Low-Sound-Level Units: Minimum of NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

E. Enclosure: Ventilated, NEMA 250, Type 1. Provide N3R rainshield for exterior transformers.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

F. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

K. Energy Efficiency for Transformers Rated 15 kVA and Larger:

1. Complying with TSL 2 standards effective by the DOE on January 1, 2016.

L. K-Factor Rating: Transformers feeding clean power or computer power panels (Panels with LC in name) shall comply with UL 1561 requirements for K-13 load current-handling capability, whether indicated on single line diagram or not.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to K-13 factor.
2. Indicate value of K-factor on transformer nameplate.

M. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize inter-winding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

N. Wall Brackets: Manufacturer's standard brackets for transformers up to 75KVA.

O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

2.3 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: Gray.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project if specified levels are below standard ratings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

B. Install pad mount transformers on a concrete pad with dimensions 3” larger than the transformer footprint.

C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

F. Identify transformers and install warning signs according to Division 26 Section "Identification of Electrical Systems"

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

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection test stated in NETA Acceptance Testing Specification prior to energizing.

B. Check for damage and tight connections prior to energizing transformer.

C. Measure primary and secondary voltages and make appropriate tap adjustments.

D. Remove and replace units that do not pass tests or inspections and retest as specified above.

E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

F. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.5 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

END OF SECTION 26 22 00

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. RFI: Radio-frequency interference.

D. RMS: Root mean square.

E. SPDT: Single pole, double throw.

1.4 REFERENCES

A. NECA (National Electrical Contractors Association) "Standard of Installation."

B. NEMA AB 1 - Molded Case Circuit Breakers.

C. NEMA PB 1 - Panelboards.

D. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

E. NFPA 70 - National Electrical Code.

F. UL. 67 – Panelboards

G. UL 50 Enclosures for Electrical Equipment

H. UL 489 Molded Case Circuit Breakers and Circuit Breaker Enclosures

I. Federal Specification W-P-115C-Type I Class I

J. Federal Specification W-C-375B/GEN-Circuit Breakers, Molded Case, Branch Circuit and Service

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.
b. Bus configuration, current, and voltage ratings.
c. Short-circuit current rating of panelboards and overcurrent protective devices.
d. UL listing for series rating of installed devices.
e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

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

C. Operation and Maintenance Data: For panelboards and components to include in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
3. Panelboard Schedules: Submit final versions after load balancing.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

F. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum ten years experience.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the environmental conditions that it will be permanently located.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Construction Manager and Owner's written permission.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handle panelboards and enclosures carefully to prevent damage.

B. Store equipment indoors and protect from weather.

C. Deliver tubs and internal assemblies sufficiently in advance of installation period as necessary to prevent delay of work.

1.9 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. Eaton Corporation; Cutler-Hammer Products.
b. General Electric Co.; Electrical Distribution & Protection Div.

c. Siemens Energy & Automation, Inc.
d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Flush- and surface-mounted cabinets. NEMA PB 1, Type 1.

1. Rated for environmental conditions at installed location.

a. Outdoor Locations: NEMA 250, Type 3R.
b. Kitchen Areas: Flush Mount with stainless steel cover.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X stainless steel.
d. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Provide with flush lock all keyed alike.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover (“door in door”).
4. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
5. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
6. Enclosure shall not exceed 80” in height.

B. Phase and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
3. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads. For all panels serving computer loads or noted as 200% neutral.

C. MAINS

1. Provide main lug only (MLO) or main circuit breaker (MCB) as noted on drawings either by riser diagram or by schedule. Where conflict exists, provide MCB.
2. Regardless of what is shown on drawings provide the following minimum requirements.

a. Main circuit breaker on each panel serving building main if required by applicable codes.
b. Main circuit breaker on each panel fed directly from a transformer (unless disconnect with overcurrent devices is installed in feeder between transformer and panel).

3. Provide lugs as required for conductors being connected to panelboard lugs, circuit breakers, etc.
4. Main circuit breaker is not to be mounted as branch breaker or subfeed breaker.

D. Conductor Connectors: Suitable for use with conductor material.

1. Main and Neutral Lugs: Mechanical type.
2. Ground Lugs and Bus Configured Terminators: Compression type.
3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
4. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus. For all panels serving computer loads or noted as 200% neutral.

E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices. This includes all bussing and hardware less the breaker.

G. Provide lugs as required for conductors being connected to panelboard lugs, circuit breakers, etc.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. UL label indicating series-connected rating with integral or remote upstream overcurrent protective devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.

2.4 DISTRIBUTION PANELBOARDS

A. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch Overcurrent Protective Devices:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

C. Kitchen panel boards shall have surge protection integral to the panel. See SPD specification.

2.6 EQUIPMENT FOR ELECTRICITY METERING BY OWNER

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

1. E-Mon; a division of Hunt Power.

2. Osaki Meter Sales, Inc.
3. Square D; a brand of Schneider Electric.

B. General Requirements for Owner's Meters:

1. Comply with UL 1244.
2. Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
3. Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.
4. Building Automation System (BAS) Interface: Match signal to BAS input and arrange to convey the instantaneous, integrated, demand level measured by meter to provide data for processing.

C. Kilowatt-hour/Demand Meter: Electronic single- and three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kilowatt-hours, current time and date, current demand, and historic peak demand, and time and date of historic peak demand.

2.7 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable electronic trip setting for circuit-breaker frame sizes 250 A and larger.
2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip-unit circuit breakers shall have RMS sensing; field-replaceable rating plug; and with the following field-adjustable settings:

    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
6. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
4. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
6. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
7. Multipole units enclosed in a single housing or factory-assembled to operate as a single unit.

2.8 COORDINATION STUDY

A. Manufacturer shall provide a coordination study and Arc flash labeling in accordance with section 26 05 73 to coordinate the tripping of overcurrent protective devices for all new switchboards, distribution boards and panel boards supplied as part of this project. Provide settings of all adjustable trip breakers and confirm that non-adjustable trip breakers are properly coordinated to provide tripping of smaller breakers before the tripping of larger breakers. If non-adjustable trip breakers will not coordinate properly with the upstream breaker, an adjustable trip breaker will be provided to coordinate properly at no additional cost to the Owner. All breakers provided shall provide the correct interrupting capacity required or series protection required to protect the distribution system from faults.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Install all panelboards and panelboard enclosures in accordance with the manufacturer's written instructions, NECA's "Standard of Installation", the applicable requirements of the National Electrical Code, and recognized industry practices.

C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Install overcurrent protective devices and controllers.

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

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from flush panelboards into accessible ceiling space or space designated to be ceiling space in the future.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Provide typed circuit directory for each branch circuit panelboard. Mount a typewritten directory showing the actual circuit numbers, type of load and room names/numbers on inside of door. Room names/numbers shall be actual names or numbers used, not necessarily shown on the drawings. Any directory that does not facilitate determination of exactly what room(s) and what

load(s) are on a circuit shall be corrected prior to request for substantial completion. Progress Drawings shall show same arrangements as the Directory. Revise directory to reflect circuiting changes required to balance phase loads.

I. Proper working clearances shall be maintained at every panelboard location. The working space in front of a panelboard shall be as a minimum, 30 inches wide extending 3 feet, 3.5 feet, or 4 feet (per NEC) out perpendicular to the panelboard.

J. All enclosures shall be firmly anchored to walls and supporting structures (where used) using appropriate hardware. Provide supporting (unistrut type) channels on walls constructed of gypsum board or where otherwise necessary to provide a mechanically secure and permanent installation. Enclosures shall be installed so that the top is 6'-6" above finished floor. Where the size of the enclosure is such that the top cannot be installed at 6'-6", the top of the enclosure shall be kept as low as possible.

K. Sub-Metering shall be provide on the Kitchen Panelboards with capability of monitoring of the Panelboards entire load by OCPS EMS (whether shown on drawings or not). Coordinate interface with DG 23 09 23 Direct Digital Control for HVAC Systems. Metering devices will be flush mounted next to Panelboard being monitored. Metering devices shall be similar to Emon.

L. Sub-Metering shall be provided for Lighting Panelboards that serve the lighting in the Kitchen and Cafeteria areas (whether shown on drawings or not). Panelboards with capability of monitoring of the Panelboards individual circuits/loads by OCPS EMS. Coordinate interface with DG 23 09 23 Direct Digital Control for HVAC Systems. Metering devices will be surface mounted in electrical room next to Panelboard being monitored. Metering devices shall be similar to Emon.

M. Coordinate all raceways and conductors with their respective panelboards so that all connections and conductors routing present an orderly appearance. Conductors in the panelboards shall be laced and arranged in orderly manner.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

D. Nameplate shall state panel name, voltage and name of panel that feeds this respective panel, UL short-circuit rating.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

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

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Isolated-ground receptacles.
4. Snap switches and wall-box dimmers.
5. Solid-state fan speed controls.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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

C. Comply with NFPA 70.

D. Comply with NEMA WD 1.

1.6 COORDINATION

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

1. Cord and Plug Sets: Match equipment requirements.

1.7 ALLOWANCES

A. Provide for twenty additional receptacles as directed in field. Allowance includes purchase, delivery and installation of box, receptacle cover plate, wire and 100 feet of conduit for each receptacle.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
2. Leviton Mfg. Company Inc. (Leviton).
3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following for standard convenience outlets:

a. Hubbell; HBL5361 (single), HBL5352 (duplex).
b. Leviton; 5351 (single), 5352 (duplex).
c. Pass & Seymour; 5361 (single), 5352 (duplex).

2. Black Computer Power Duplex Receptacle:

a. Pass & Seymour Model PS5352-Black
b. Hubbell Model HBL5362-Black
c. Leviton Model 5362-Black

B. Convenience Controlled Duplex Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following for standard convenience outlets:
a. Hubbell; BR20C1I (Split wired), BR20C2I (Both controlled).
b. Leviton; TBR20-S1I (Split wired), TBR20-S2I (Both controlled).
c. Pass & Seymour; 5362CHI (Split wired), 5362CDI (Both controlled).

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and trip button to indicate when device is tripped. Face will not have power if reverse wired. Visual indication for device has lost capability to provide protection.

B. Outdoor locations provide weather resistant GFCI convenience receptacles, 125V, 20A - Black
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell #GFR5362WR
b. Pass & Seymour; 2095DSWRBK.
c. Leviton #W7899-E

C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell #GFR5362
b. Pass & Seymour; 2095.
c. Leviton #6898

2.4 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.

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

a. Cooper Crouse-Hinds.
b. EGS/Appleton Electric.
c. Killark; a division of Hubbell Inc.

2.5 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HBL2310.
b. Leviton; 2310.
c. Pass & Seymour; L520-R.

2.6 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector; NEMA WD 6 configurations L5-20P and L5-20R, heavy-duty grade.

1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.7 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards.

C. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HBL1221 (single pole), HBL1222 (two pole), HBL1223 (three way), HBL1224 (four way).
b. Leviton; 1221 (single pole), 1222 (two pole), 1223 (three way), 1224 (four way).
c. Pass & Seymour; PS20AC1 (single pole), PS20AC2 (two pole), PS20AC3 (three way), PS20AC4 (four way).

D. Pilot Light Switches, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HPL1221PL for 120 V and 277 V.
b. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.

c. Pass & Seymour; PS20AC1RPL for 120 V.

2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off." Provide red handle for switches connected to emergency power.

E. Key-Operated Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HBL1221L.
b. Leviton; 1221L.
c. Pass & Seymour; PS20AC1-L.

2. Description: Single pole, with factory-supplied key in lieu of switch handle. All key operated switches shall be keyed alike.

F. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HBL1557.
b. Leviton; 1257.
c. Pass & Seymour; 1251.

G. Key-Operated, Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle. All keyed switches shall be keyed alike.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; HBL1557L.
b. Leviton; 1257L.
c. Pass & Seymour; 1251L.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable toggle switch; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

1. 600 W; dimmers shall require no derating when ganged with other devices.

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 FAN SPEED CONTROLS

A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable toggle switch, 5 A.
2. Three-speed adjustable slider, 1.5 A.

2.11 WALL PLATES

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

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.
3. Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel, having a nominal thickness of .04", and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.
4. Cover plates for switches located in corrosive atmospheres (where vaporproof is not indicated) shall be equal to Hubbell #17CM81/#17CM82/#17CM83/#17CM84 one piece neoprene with matching presswitch.
5. Cover plate engraving, where required, shall be accomplished by cover plate manufacturer in accordance with instructions given on the drawings. Metallic plates shall be engraved with black fill. Red plates shall be engraved with white fill.
6. Material for Unfinished Spaces: Galvanized steel.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable “in use” cover. Cover plates for exterior receptacles shall be gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed..

2.12 MULTIOUTLET ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).
3. Mono-systems, Inc.

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Wire: No. 12 AWG.

2.13 SERVICE POLES

A. Description: Factory-assembled and -wired units to extend power and voice and data communication from distribution wiring concealed in ceiling to devices or outlets in pole near floor.

1. Poles: Nominal 2.5-inch- (65-mm-) square cross section, with height adequate to extend from floor to at least 6 inches (150 mm) above ceiling, and with separate channels for power wiring and voice and data communication cabling.
2. Mounting: Ceiling trim flange with concealed bracing arranged for positive connection to ceiling supports; with pole foot and carpet pad attachment.
3. Finishes: Manufacturer's standard painted finish and trim combination.
4. Wiring: Sized for minimum of five No. 12 AWG power and ground conductors and a minimum of four, 4-pair, Category 3 or 5 voice and data communication cables.
5. Power Receptacles: Two duplex, 20-A, heavy-duty, NEMA WD 6 configuration 5-20R units.
6. Voice and Data Communication Outlets: Four RJ-45 Category 6 jacks.

2.14 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Gray, unless otherwise indicated or required by NFPA 70 or device listing.
2. Receptacle devices for computer power shall be black color.
3. Wiring Devices Connected to Emergency Power System: Red.
4. Modify any given catalog numbers as required to procure devices and plates of the proper color.

2.15 TAMPER PROOF RECEPTACLES

A. All nonlocking 125V, 15 and 20A receptacles in elementary schools shall be listed tamper-resistant. Modify all part numbers to incorporate this requirement.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

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

C. Install devices plumb and level.

D. Install switches with OFF position down.

E. Provide device coverplates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch

F. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.

G. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.

H. All devices shall be installed so that only one wire is connected to each terminal.

I. Connect wiring devices by wrapping conductor around screw terminal.

J. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

K. Install local room area wall switches at door locations on the lock side of the door, approximately four inches from the jamb. Where locations shown on the drawings are in question, provide written request for information to A/E prior to roughin.

L. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

M. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

N. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

O. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

P. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on bottom. Group adjacent switches or receptacles under multigang wall plates. Provide proper NEC barriers in boxes which serve devices for both the Normal and Emergency Systems.

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

3.2 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

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

3.3 NEUTRAL CONDUCTOR CONNECTIONS

A. At each receptacle "in" and "out" phase and neutral conductors shall have an additional conductor for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable. (IE: The device shall not be used to complete the circuit. Pigtails shall be used from the device)

3.4 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles and Switches: Identify panelboard and circuit number from which served. Use permanent marker to identify on the back of plates or tags within outlet boxes.

B. Time or Occupancy controlled receptacles shall have engraved plate at top “Occupancy Sensor controlled Receptacle” or “Time Controlled Receptacle” as appropriate for each outlet. See drawing details for additional information. The receptacle shall also be permanently marked as required by NEC 406.3 (E).

3.5 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.

B. Operate each wall switch with circuit energized and verify proper operation.

C. Verify that each receptacle device is energized.

D. Test each receptacle device for proper polarity.

E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

A. Adjust devices and wall plates to be flush and level.

END OF SECTION 26 27 26

SECTION 26 43 13 – SURGE PROTECTION DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Surge Protection Devices (SPD) includes all electrical systems and devices specifically installed in facility electrical systems to protect all electrical circuits, electronic equipment and building mechanical systems from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

1.3 APPLICATION

A. Surge suppression, grounding and bonding shall effectively protect the systems to which they are applied against lightning, transients, internal spikes, and other surge transients throughout the useful life of the systems, and shall be designed and installed in such a manner that normal operation, performance ratings and listing of the system is not impaired by the installation of such devices, wiring or connections.

B. Surge suppression devices shall be installed on all service entrance equipment (to include distribution panels and panelboards in separate buildings that perform the function of service entrance equipment for that particular building), distribution panels, lighting and appliance panelboards that may feed any electronic equipment (to include personal computers, copiers, printers, fire alarm panels, building management systems, intercom systems, etc.) and any circuits leaving the building; e.g. outdoor lighting and all signal circuits (data, telephone, fire alarm, intercom, etc.) leaving or entering a building.

1.4 DEFINITIONS

A. ATS: Acceptance Testing Specifications.

B. VPR: Voltage protection rating.

C. SPD: Surge Protection Devices

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. General: SPD wiring, bonding and grounding connections shall be indicated on the wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.

C. Testing: The test data submitted shall be specific for the actual method on installation proposed. Submittals will not be reviewed unless they include proper project related data. Interpretation of standard manufacturer's published data will not be acceptable unless the data coincides with the actual installation procedure.

D. Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification, including 6kV/3kA Combination Wave impulse by a recognized independent lab testing.

E. List and detail all protection systems such as fuses, disconnecting means and protective materials.

F. Product Certificates: For SPD signed by product manufacturer certifying compliance with the following standards:

1. UL 1449 4th Edition

G. Operation and Maintenance Data: For SPD to include in operation, and maintenance manuals.

H. Warranties: Special warranties specified in this Section.

1.6 REFERENCE STANDARDS AND PUBLICATIONS

A. ANSI/IEEE C62.33 - Standard for Test Specifications for Varistor Surge Protection Devices

B. ANSI/IEEE C62.35 - Standard for Test Specification for Avalanche Junction Semiconductor Surge Protective Devices

C. ANSI/IEEE C62.36 IEEE Standard for Test Methods for Surge Protectors Used in Low-Voltage AC Power Circuits

D. ANSI/IEEE C62.41 2002 Guide for Surge Voltages in Low-Voltage AC Power Circuits Categories A, B, & C and Table 8, High Exposure 6kV/3kA Combination Wave impulse waveform testing

E. ANSI/IEEE C62.45 2002 Guide on Surge Testing for Equipment Connected Low Voltage AC Power Circuits

F. IEEE Standard 142 Recommended Practice for Grounding

G. IEEE Standard 518 Recommended Guide on Electrical Noise

H. IEEE Standard 1100 Recommended Practice for Powering and Grounding Electronic Equipment

I. UL 1449, 4th Edition, Standard for Surge Protective Devices

J. NFPA 70 National Electrical Code

K. NFPA 75 Standard for the Protection of Electronic Computer/Data Processing Equipment

L. NFPA 780 Standard for the Installation of Lightning Protection Systems

M. Military Standard 220A

N. Federal Information Processing Standards (FIPS) Publication 94

O. CCITT Rec. K-I 7 Waveform Specification for Electronic Systems

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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

D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

E. Comply with UL 1449 4th Edition, "Safety Standard for Surge Protection Devices"

1.8 MANUFACTURER QUALIFICATIONS

A. Manufacturer: Company specializing in surge suppression equipment of the type herein specified with a minimum ten years documented experience.

B. Repair: The surge protection device manufacturer shall offer factory repair service and/or replacement for all units. The manufacturer shall provide this service within four working days and provide replacement components shipped to the Owner for installation within the allocated response time.

C. Installation Certification: Submit in the close out documents a letter from the surge protection manufacturer stating that the installation has been inspected by the manufacturer or the manufacturer's representative. The certification letter must state that the installation has been done in accordance with the manufacturers requirements and the warranty is in effect. Submit five copies to the Engineer for review.

1.9 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F (0 to 50 deg C).
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet (6090 m) above sea level.

1.10 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

B. Coordinate layout of all switchgear and panels to allow for the proper installation of the SPD. The SPD shall be located directly beside the breaker that is protecting it to allow for the shortest and straightest connection of the wiring to the device.

1.11 SPARE PARTS

A. Provide 1 complete spare SPD for each type of suppressor installed for Owners use as spares.

1.12 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within ten years from date of Substantial Completion.

B. Replacement: Any suppressor which shows evidence of failure or incorrect operation during the warranty period shall be repaired or replaced at no expense to the Owner including labor and materials. Since "Acts of Nature" or similar statements include the lightning threat to which these suppression devices shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. The warranty shall cover the entire device.

C. Installation: Installation of SPDs on electrical distribution equipment shall in no way compromise or violate equipment listing, labeling, or warranty of the distribution equipment.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Modular design with the following features and accessories:

1. Fabrication using bolted compression lugs for internal wiring.
2. Redundant field-replaceable mode level modules.
3. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
4. LED indicator lights for power and protection status.
5. Audible alarm, with silencing switch, to indicate when protection has failed.
6. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

B. Peak Single-Impulse Surge Current Rating: (Equal or greater than 3000A main - 400kA per phase), (1600A-2999A main - 300 kA per phase), (400A to 1599A main - 240kA per phase)

C. SPD shall be type 2 rated 20KA or more nominal discharge current (In) and labeled for lightning protection installations.

D. Connection Means: Permanently wired.

E. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277: 800 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277: 800 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277: 800 V for 208Y/120.

F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 600 V.
2. Line to Ground: 600 V.
3. Neutral to Ground: 600 V.

G. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 600 V, 800 V from high leg.
2. Line to Ground: 600 V.
3. Neutral to Ground: 600 V.

H. Short Circuit Withstand Rating: The device shall have a short circuit withstand rating identical or higher than the equipment that it is connected. Rating shall be permanently marked on the device.

I. Power Interruption: During normal suppression operation, the unit shall not short circuit or crowbar the power flow that would result in an interruption to the load. Building power shall not require interruption for maintenance.

J. Approved manufacturers:

1. LEA International
2. Advanced Protection Technologies
3. Liebert
4. PQ Protection
5. Switchgear manufacturer

2.2 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:

1. LED indicator lights for power and protection status.

B. Peak Single-Impulse Surge Current Rating: 80 kA per phase.

C. Protection modes and UL 1449 VPR for grounded wye circuits with voltages of 480Y/277, 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277: 600 V for 208Y/120.
2. Line to Ground: 1200 V for 480Y/277: 600 V for 208Y/120.
3. Neutral to Ground: 1200 V for 480Y/277: 600 V for 208Y/120.

D. Protection modes and UL 1449 VPR for 240/120-V, single-phase, 3-wire circuits shall be as follows:

1. Line to Neutral: 600 V.
2. Line to Ground: 600 V.
3. Neutral to Ground: 600 V.

E. Protection modes and UL 1449 VPR for 240/120-V, 3-phase, 4-wire circuits with high leg shall be as follows:

1. Line to Neutral: 600 V, 800 V from high leg.
2. Line to Ground: 600 V.
3. Neutral to Ground: 600 V.

F. Connection Means: Permanently wired through a 3-P breaker (the size of the breaker shall be as recommended by the SPD manufacturer). The breaker shall be installed in the panelboard and shall be rated with the same electrical characteristics of the panel board.

G. Short Circuit Withstand Rating: The device shall have a short circuit withstand rating identical to the equipment that it is connected. Rating shall be permanently marked on the device.

H. SPD for Kitchen panels shall be installed integral to the panel board. No externally mounted surge is acceptable.

I. Approved manufacturers:

1. LEA International
2. Advanced Protection Technologies
3. Cooper Crouse-Hinds MTL, Inc
4. Liebert
5. PQ Protection
6. Panel board manufacturer.

2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

2.4 COMMUNICATIONS

A. Entrance SPD shall be type 2 rated 20KA or more nominal discharge current (In) and labeled for lightning protection installations.

B. Communication Lines: The following standard for separately mounted telephone and signal line suppressors shall apply. All protectors shall be securely mounted at protected equipment location. All suppressors shall provide common (L-G) and normal (L-L) protection. Suppressors shall be tested in accordance with IEEE C62.45 2002 as a minimum. Protective interfacing with the telephone wire pairs shall be listed to UL 497A.

C. Data Line Protection: Solid state, silicon avalanche diode circuitry for protection from over voltages on long cable runs employing standard RS-232, 9, 15, or 25-pin "D" connectors utilized to interface a remote station with a host CPU. Unit shall have 2 built-in or ribbon cable attached connectors (in and out) and an external ground lug or cable. Connect ground lug or cable to CPU or terminal grounding system with a No. 12 copper green insulated stranded ground wire

as short as possible. Select pins requiring protection based on protected equipment wiring requirements. Protectors shall be designed to be easily installed on multiplex panels with connector spacing at a minimum of 1.0-inch centers.

1. Signal line voltage (max) 15 V peak
2. Leakage at signal voltage <5 mA
3. Voltage protection level 16 V peak
4. Response time 5 nanoseconds or less
5. Impedance per line 40 ohm max.
6. Peak power dissipation 15,000 watts (10/1000 Test Wave form)
7. Temperature range -20° C to +65°C
8. Capacitance:

    a. Data rates <20,000 baud - <2,000 pf
    b. Data rates 20,000 baud to 2 MHz - <100 pf
    c. Data rates >2 MHz to 100 MHz - <40 pf

9. UL 497B listed.
10. Approved Manufacturers: EDCO, Transtector, or Ditek

D. Signal line protection (telephone) - solid state, silicon avalanche diode circuitry for protection from over voltages on 2 or 4 wire signal lines such as balanced pair telephone, metallic pair telephone, buried and overhead field cable, remote radio equipment, and control systems. Unit shall have an external ground lug or wire. Connect ground lug or wire to protected equipment grounding system with a No. 12 green insulated stranded ground wire as short as possible.

1.	L-L & L-G Voltage (peak)	L-L & L-G VPL
	13	16
	27	33
	54	67
	120	150
	160	200
2.	L-L and L-G Leakage @ max L-L and L-G voltage	<5 μA
3.	Response time	<5 nanoseconds
3.	Series impedance (each line)	33 Ohm max.
4.	Peak power dissipation (L-L) or (L-G)	15,000 watts (10 x 1000 Test Wave Form)
6.	Temperature Range	-20°C to +65°C
7.	U.L. 497B listed	
8.	Approved Manufacturers: EDCO, Transtector, or Ditek.	

E. Modem protector for leased lines - solid-state silicon avalanche diode circuitry for non-faulting/non-interrupting protection from over voltages on leased phone lines. Full duplex protection shall be provided for both send and receive channels. Terminals shall be provided for 4-wire leased line input and output to equipment plus ground. Connect ground terminal to equipment ground.

1.	Signal line voltage (max)	160V peak
2.	Leakage @ signal voltage	5 μa
3.	Clamp point	200V peak
4.	Response time	<5 nanoseconds.
5.	Series impedance	33 Ohm max.
6.	Peak power dissipation	15,000 watts
7.	Operating Temperature	-20°C to +65°C

8. Approved Manufacturers: EDCO, Transtector, or Ditek.

F. Modular, twisted pair protection - solid state, silicon avalanche diode circuitry for protection from over voltages on twisted pair data or audio lines. Protectors shall clip mount on 66 punch down blocks furnished with grounding bar or studs and shall be totally enclosed. Units shall be securely mounted at terminal locations where shown and shall be grounded to the main building ground with a minimum No. 8 stranded copper green insulated ground conductor as short as possible. Terminals shall be screw insertion lug type. No crimp fork or ring type permitted.

1. Response time <5 nanoseconds
2. Peak power dissipation (1 ms) 15,000 watts
3. Temperature range -20° C to +50°C
4. Maximum voltage protection levels (peak) utilizing a 10 x 1000 μs waveform for normal and common mode protection shall be 240-380V or 45V as indicated on the drawings.
5. Peak repetitive pulse current

   a. 1 x 2 μs - 225 amp
   b. 8 x 20 μs - 150 amp
   c. 10 x 1000 μs –100 amp

6. Approved Manufacturers: EDCO, Transtector, or Ditek.

G. 75 ohm coaxial cable protectors - Solid state, silicon avalanche diode circuitry for non-interrupting over-voltage protection of RG-59/U coaxial cable. Unit shall be provided with one female input connector for "F" series male connector, one output RG-59/U coax cable terminated with an "F" series male cable end connector and A #16 stranded, 18 inch long grounding wire on output end of unit or similar arrangement. Securely mount adjacent to protection equipment and ground to equipment or local building ground if an equipment ground is not available.

1. Normal Operating Characteristics

   a. Voltage 5.8V max
   b. Current 500 ma max
   c. Frequency DC to 10 MHz
   d. Insertion Loss 3.5 dB @ 4 MHz

2. Protection Requirements

   a. Transient suppression level 7.5 v VPL
   b. Transient response <5 nanoseconds
   c. Operating temp -20°C to +50°C
   d. Energy dissipation 15,000 watts (10X1000 Test Wave)

3. Approved Manufacturers: EDCO, Transtector, or Ditek.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

A. Installation at Service and Distribution Panels: Suppressors shall be installed at Service Entrance switchboards or switch-gear as close as practical to distribution equipment to be protected consistent with the available space, however, do not exceed three feet.

B. Installation at Lighting and Appliance Panelboards: The SPD shall be installed as close as practical to the electrical panel or electronic equipment to be protected, consistent with available space. Pre-wired leads shall be field cut to minimize the length between panel connection point. SPD leads shall be routed as straight as possible and as short as possible to the panelboard breaker. In no case shall leads exceed 18” length.

C. Workmanship: SPDs shall be installed in a neat, workmanlike manner. Lead dress shall be consistent with recommended industry practices for the system on which these devices are installed.

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

E. Disconnect SPD via circuit breaker connection prior to megger testing of service entrance.

F. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

G. Install devices for panel board and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible, but in no case shall the leads be more than 24 inches. Do not exceed manufacturer's recommended lead length, but in no case shall the leads be more than 24 inches. Do not bond neutral and ground.

1. Provide multipole, 30A (for panelboards) 60A (for service entrance equipment) circuit breaker as a dedicated disconnect for suppressor whether shown on drawings or not. Size shall be as required by the SPD manufacturers installation instructions.

3.2 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals, or data terminals to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect equipment installation, including connections.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
2. Perform each visual and mechanical inspection stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section.

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

END OF SECTION 26 43 13

SECTION 27 4117 - PRODUCTION SOUND SYSTEM

PART 1 - GENERAL

1.1 GENERAL DESCRIPTION

A. The purpose of this Section is to provide the Contract Specification for the Production Sound System.

1.2 RELATED DOCUMENTS

A. The Subcontractor shall read, review and understand all documents listed below prior to bidding or proceeding with work. The Subcontractor shall also refer to and understand all other related documents indicated herein.

B. This section of the Specification.

C. The Production Sound, , and Communication Systems drawings.

D. Related Architectural Drawings; for reference only.

E. Related Electrical Drawings; for reference only.

F. Contract

1. In addition to the conditions and work described herein, all conditions of the Contract shall apply.

G. Other drawings as appropriate; for reference only.

1. The terms “Sound, & Communication Subcontractor”, “this Subcontractor”, “this Contractor”, “SVCC” as used in this specification refer to that subcontractor directly responsible for supply and installation of the Sound, & Communication Systems.
2. The terms “engineer” and “engineering” as used in this specification refers to the interpretation, organization, and execution of the design of the Sound, & Communication Systems as provided in the Contract Documents.
3. The term “supply” as used in this specification indicates that the Sound, & Communication Subcontractor shall supply, free issue, including instruction and supervision for installation by others, such equipment, components, and material of the Sound, & Communication Systems so as to fulfill the intent of the Contract Documents.
4. The term “provide” as used in this specification indicates that the Sound, & Communication Subcontractor shall supply, fabricate, install, and make operable such equipment, components, and material of the Sound, & Communication Systems so as to fulfill the intent of the Contract Documents.
5. The terms “pre-approved equivalent” and “or as approved” as used in this specification indicate that acceptance shall be obtained from the Consultant. Refer to “Product Substitution” below.

6. The terms “NIC” or “not in contract” as used in this specification indicate an item or system that shall be furnished under another contract. Preparation for the future inclusion of such an item or system shall be limited to the extent outlined in the Contract Documents.
7. The terms “OEM” or “original equipment manufacturer” or “manufacturer” as used in this specification refer to a direct supplier to the Sound, & Communication Subcontractor.
8. The term “by others” as used in this specification and on the contract drawings indicates work not included in this section of the contract but provided by others as part of the General Contract.
9. “UON” denotes “unless otherwise noted.”
10. “AFF” denotes “above finished floor.”
11. “U” denotes “rack unit,” as in “10U” to denote 10 standard 44mm (1.75”) rack units, for a total of 440mm (17.5”) of rack space.

1.3 SCOPE OF WORK

A. The Sound Subcontractor (SVCC) shall be responsible for all labor, equipment, material, and procedures required for the supply, fabrication, installation, commissioning, and warranty of the Production Sound, and Communication Systems (SV&C Systems) as specified herein and on the SV&C Systems Contract Drawings, including design and engineering responsibilities, and submission for review of shop drawings, reports, samples, and mock-ups. Detailed descriptions of these requirements are included in “PART 1 - GENERAL” and “PART 3 - EXECUTION”.

B. The scope of work of this Section shall include, but not necessarily be limited to, the following systems, equipment, material, arrangements, and procedures as indicated and specified herein.

1. All labor, equipment, and material.
2. Supply nonstandard back boxes and sequential power switching system equipment for installation by Divisions 26 and 27 except where noted.
3. Termination of receptacles in Sound, & Communication equipment racks.
4. Provide supplemental conduit, junction/pull boxes, fittings, and electrical hardware, as required for connection of SV&C equipment to the Sound, & Communication empty conduit system as supplied by Division 27.
5. All wire, wire pulling, and termination.
6. All tools and measuring & testing equipment required for installation.
7. Daily and final cleanup.
8. Shop drawings, samples and mock-ups, as-built documentation, and operating manual.
9. Testing and adjustment, interim shop inspection, initial test report, final site inspection, final test report, and demonstration and instruction.
10. Guarantee and warranties, and maintenance and service contract.
11. Technical Systems: see specific information about the equipment, components, and material in “PART 2 - PRODUCTS”:

    a. Music Hall

1) Sound Systems

a) Permanent sound systems for each performance venue, providing speech and music reinforcement, archival recording, music, effects, playback and stage monitor/foldback;
b) Flown loudspeaker arrays, including rigging points, and cable management;
c) Sound mixing, control and production positions, including appropriate cabinetry;
d) Flexible system of audio wiring, panels, and receptacles;
e) Interface with in-house and outside broadcast/recording systems, including recording system wiring and connection panels;

C. The following systems, equipment, material, arrangements, and procedures are *not* included in the scope of work of this Section. Coordinate all work of this Section with the work specified in other sections (exceptions as noted):

1. A complete, pull-ready conduit system for installation of Sound, & Communication Systems wiring and devices—including all conduit and raceway, junction/pull boxes, standard back boxes, rack room terminal cabinets and "pull group" boxes, fittings, drag line (pull line), electrical hardware, etc. (Division 27).
2. Installation of nonstandard back boxes for Sound, & Communication Systems devices (to be concurrent with other electrical work) (Division 27).
3. Electrical power service—including transformers, feeder cable, distribution panels, branch circuit panel-boards, and individual wall receptacles (Division 26).
4. Sound, & Communication Systems "sound system" isolated ground AC power network (Division 26). Note: inter-rack AC power wiring, shall be the responsibility of the SVCC. Single-point termination to the racks shall be conducted on-site by the EC.
5. Equipment rooms, rack rooms, and control rooms (including lighting, furnishings, and finishes) (various Sections).
6. Painting and finishing (except as noted below for Sound, & Communication System equipment).
7. House telephone, data, life safety, fire alarm, and security systems (Division 28).

1.4 BID REQUIREMENTS

1. Sound, & Communication Subcontractor Qualification

a. Contractors wishing to qualify for this project shall submit to the Construction Manager the following information:

1) Submit statements of financial responsibility for the past five years, showing assets and liabilities. This information shall be held in strict confidence.
2) Indicate the names of primary stockholders (in excess of 33-1/3%) and

individuals, partnerships, or corporations with which the firm is currently affiliated in joint ventures.

3) List the principal officers, design and service engineers, and project managers. Provide an organizational structure flow chart.
4) Descriptions of Three (3) projects of comparable size, scope and nature for which the candidate has provided full services within the last five (5) years. These services should include: project management, system engineering, shop drawings, custom fabrication, installation (including all electrical work except conduit and back boxes), commissioning, training, and maintenance. For each project indicate the specifics of the scope of engineering, fabrication, and installation. Include name, address, and phone number of the owner, architect, sound system consultant, and the person(s) directly responsible for the operation and maintenance of the equipment in each facility.
5) List all current projects and their approximate contract value. Include name, address, and phone number of the owner, owner's representative, sound system consultant, and architect. For each project name the individual(s) who supervised the project management, system engineering, preparation of shop drawings, fabrication of components, installation of equipment, acceptance testing, and commissioning and training.
6) Provide verification that the Subcontractor employs a full-time staff of competent engineering, installation, and maintenance personnel. Supply names of the persons who would perform the following services, should the contract for this project be awarded to the tenderer: project management, system engineering, supervision of shop drawings, supervision of fabrication, supervision of installation, supervision of acceptance testing, and supervision of commissioning and testing. Also show that the Contractor maintains a sufficient stock of parts and facilities to provide necessary service during the life of the contract and beyond.

B. Bid

1. Subcontractor Submittal

a. As part of the formal bid, all bidders shall submit two (2) copies of the following lists, schedules, and bills of material, including the names of manufacturers, manufacturers' model numbers, quantities, and prices:

1) Music Hall: Category pricing information, separately listing equipment, wire, and labor pricing for each of the following thirty-five (35) categories.

a) Sound System Mixing Console
b) Microphone Splitter
c) Recording, Playback & Effects
d) Power Amplifiers w/ Digital Signal Processing
e) Suspended Main Left & Right Loudspeaker Arrays
f) Subwoofers
g) Front Fill Loudspeakers
h) Box Fill/Announce Loudspeakers

i) Performance Loudspeaker Optimization
j) Wired Microphones, Stand & Accessories
k) Wireless Microphones and Accessories
l) Microphone Cable, Stage Boxes and Multi-cables
m) Stage Monitors, Signal Processing & Amplification
n) House Manager Panel
o) Stage Manger Console
p) Production System Equipment
q) Presentation Equipment
r) Communication Room Rack
s) Sound Control Room
Racks
Stage Right Rack – Basement dd)
Portable Playback/Effects Rack
ee) Portable Microphone Splitter
Rack ff) Wireless Microphone Rack
gg) Audio Program/Paging
System hh) SVC Device Panels
ii) Miscellaneous Portable Equipment, Cables, Adapters & Test Equipment

2) A complete and accurate list of all of the equipment, components, and material specified in the Contract Documents.
3) A schedule of wire and cable as specified in the Contract Documents.
4) A list of requests for approval of equivalent equipment, components, material, or systems, per the requirements listed in “Product Substitution” below.
5) A list of test equipment to be used in system testing and adjustment, per the requirements listed in “Part 3 - Execution: Testing and Adjustment.”

6) A list and description of any equipment or material required for completion of this Section that is not included in the Contract Documents and is not shown on the Architectural or Electrical Contract Documents as being specified by other sections.
7) A list and description of any changes required to the installation of the empty conduit system, including but not limited to relocation or resizing or reduced or additional conduit, for Sound, & Communication Systems equipment provided by Division 26.

b. In the event that additional conduit is required to fulfill the intent of the Sound, & Communication Systems, the bidder shall include any additional wire in the bid.
c. Any financial or scheduling implications for additional work specified in other sections, as recommended by a bidder, shall be assessed prior to award of this Section.

2. Construction Manager and Consultant Review

a. The Construction Manager and Consultant shall refer to the lists, schedules,

and bills of material outlined above in order to determine fulfillment of the requirements of the Contract Documents. Based on the Construction Manager and Consultant's review, a bid not meeting these requirements shall be rejected.

b. These lists, schedules, and bills of material are included for the purpose of evaluation. The acceptance a bid based on these submissions shall not be understood to relieve the Successful Bidder of the responsibility of meeting any and all requirements of the Contract Documents.

3. Product Substitution

a. The Sound, & Communication Systems equipment, components, and material specified are called out in terms of products as supplied by specific original equipment manufacturers. Bids shall only be considered from those bidders who present a bid based exactly on the products specified.

b. If an original equipment manufacturer or other supplier has permanently stopped fabrication of a specified item or has replaced an item with an almost identical item that has a new model number, the bidder shall state this or, if there is sufficient time for amendment of the Contract Documents, notify the Construction Manager and Consultant prior to the closing of the bid period.

1.5 RESPONSIBILITIES

A. General

1. Provide complete and working Sound, & Communication Systems as outlined in the Contract Documents.
2. Carry out work in accordance with best trade practices, and engineer, fabricate, provide and install all items in accordance with the Contract Documents, the manufacturers' recommendations and in compliance with applicable codes, and consult with other trades performing adjoining work in order to provide an installation of first-class quality.

B. Extent

1. Provide all labor, equipment, material, and procedures required, listed, scheduled, mentioned, or implied in the Contract Documents to engineer, fabricate, install, and commission the Sound, & Communication Systems.
2. Provide also all labor, equipment, material, and any necessary incidental items not specifically called for in the Contract Documents but required for a complete and satisfactory installation of the Sound, & Communication Systems.
3. Ensure that all equipment, components, and material specified or otherwise required to complete the installation are compatible with each other and with the conditions of expected use.
4. Any errors, omissions or ambiguities in the Contract Documents are not to condition these requirements, but shall be brought to the attention of the Construction Manager and Consultant for evaluation of any possible effect on the intent of the Contract Documents. Submit all notifications in writing to the Construction Manager and Consultant. Lack of such notification shall be understood to indicate acceptance of all requirements of the Contract Documents, and any future claims shall be

rejected.

C. Coordination

1. The Owner wishes to delay key SV&C Systems equipment purchases until just prior to fabrication and installation in order to take full advantage of technology advancements. Coordinate equipment purchase schedule with Consultant and General Contractor.
2. Refer to Electrical & Technology Drawings to determine Sound, & Communication Systems device quantities and general locations. Refer also to Architectural drawings for exact device locations.
3. Be familiar with the requirements of Divisions 26 and 27 - Electrical to ensure the coordination of the work in this Section with the work of the Electrical Contractor.
4. Provide the Electrical Contractor with drawings, diagrams, and other information in order to ensure proper coordination of the AC power system and Sound, & Communication System empty conduit installations. This work shall be part of this Contractor's early coordination effort, and shall be provided in a timely manner according to a schedule of the project established by the Construction Manager.
5. Coordinate work of this Section with the work of other trades so that all installations are executed in such a manner as to ensure proper system performance. Provide appropriate mounting of equipment and components and avoid conflicts in positioning of the various installations of other contractors and trades.
6. References to the Construction Manager or other trades shall in no way modify the responsibility of this Contractor to provide a coordinated, complete, and working installation of all work required by the Contract Documents.
7. All drawings, schedules, RFIs, and other communication shall be coordinated with and submitted through the Construction Manager.

D. Means And Methods

1. The Sound, & Communication Contractor is solely responsible for the means and methods of all fabrication and installation techniques, sequences and procedures of construction, and shall be responsible for coordination of these items with and through the Construction Manager and the Consultant.

E. Sub-Contractors

1. Use of Sub-Contractors by the Sound, & Communication Subcontractor shall in no way modify its responsibility.

F. Suppliers

1. Use of a product from a particular original equipment manufacturer, whether specified in the Contract Documents or substituted by the Sound, & Communication Subcontractor, shall in no way modify its responsibility. Refer also to General Conditions.

G. Site Dimensions And Conditions

1. The Sound, & Communication Subcontractor is solely responsible for the correctness of dimensions and quantities, shall verify site conditions, and obtain site dimensions and quantities required for proper installation of the work included in this Section; and shall be responsible for coordination of these with and through the Construction Manager. The Sound, & Communication Subcontractor shall take dimensions on site for all equipment and material that shall be provided (including custom fabricated components) and be entirely responsible for their accuracy.
2. Examine the work of other trades at the site to ensure that all aspects of the related work are in the proper condition to receive the work included in this Section.
3. Obtain through the Construction Manager, where necessary, copies of relevant base building Contract Documents, including shop drawings, to ascertain existing field conditions not open to view (e.g., wall or ceiling construction).
4. In particular, verify all necessary field conditions including, but not limited to: the size, routing, and location of all conduit and raceway, pull/junction boxes, cast-in-place back boxes, and accommodation of non-standard backboxes. Also verify size and configuration of the Control Rooms, House Mix Position, and Equipment Rack Rooms. Such information is critical to the production of accurate shop drawings.
5. Provide any additional drawings, information, or templates where work by other trades must be modified for the proper installation and operation of the work included in this Section.
6. Do not begin manufacture of any custom fabricated equipment or components until satisfied that the devices, as designed, shall fit in the space available.
7. Provide all additional items required for the completion of the Sound, & Communication empty conduit system, as specified in Section 27 - 0527 and supplied by the Electrical Contractor, including but not necessarily limited to conduit hardware, back boxes, and wire to accommodate site conditions, and in order to complete the interpretation of the Contract Documents with no change in the contract price. Any changes to equipment details and/or mounting details shall be reviewed and approved by the Construction Manager and Consultant prior to shop fabrication or field installation.

H. Design And Engineering

1. The requirements outlined in the Contract Documents establish basic design parameters including means of operation, control, dimensions, and visual appearance. The Sound, & Communication Subcontractor's design responsibilities shall include:

    a. Interpreting the Contract Documents so as to accomplish the purposes described.
    b. Carrying out the execution of the work.
    c. Modifications of, and additions to, the details as may be required to fulfill the intent of the Contract Documents.
    d. Maintaining the design/control/operation concepts as described in the Contract Documents.

2. The Contract Documents describe performance attributes of the systems that shall

be provided under this Section and, as such, are not Professionally Engineered documents. This Contractor is responsible for the engineering of systems described in the Contract Documents.

I. Painting And Touch Up

1. The Sound, & Communication Contractor shall be responsible for painting all Sound, & Communication Systems equipment and components exposed to view and shall also be responsible for the correction of minor cosmetic damage so that all Sound, & Communication Systems equipment and components are in clean and unblemished condition at the time of the final site inspection by the Owner and Consultant.
2. Any non-cosmetic damage shall be promptly repaired or replaced by this Contractor, prior to the final site inspection and without cost to the Owner.
3. All products used for painting and touch up shall be submitted for approval prior to use and shall comply with the limits for Volatile Organic Compounds (VOC) content given in Section 01 8113.
4.

J. Cleanup

1. In addition to the requirements outlined in the General Conditions, leave work areas clean and in proper order at the end of each workday. Coordinate with Owner's performance and rehearsal schedule, as required.

K. Omissions And/Or Errors

1. Omissions and/or errors within the Contract Documents shall not relieve this Subcontractor of the responsibility for providing a properly functioning installation of the Sound, & Communication Systems as outlined in "PART 2 – PRODUCTS".

L. Safety And Code Requirements

1. The Sound, & Communication Systems equipment, material, arrangements, and procedures shall conform to the applicable local building, electrical and safety codes in the City of Orlando and all other applicable code requirements, with industry standards of operation and practice, and applicable safety requirements. The completed installation shall allow the users to work and operate the Sound, & Communication systems in a safe environment.
2. Regulations, codes of practice, and other reference documents cited in the Contract Documents shall apply to the work of this Section with the same authority as if included word for word in this specification.
3. Where provisions of the Contract Documents supplement those of cited reference documents, the more stringent provisions shall apply. Refer also to General Conditions.

1.6 SUBMITTALS

A. Project Timetable

1. Submit a Sound, & Communication Systems project timetable for approval, after consultation with the Construction Manager and the Consultant.
2. This timetable shall outline scheduling and dates for all project milestones including design and engineering, shop drawing submittal and review, sample and mock-up submittal and approval, shop fabrication, interim shop inspection, site installation, testing and adjustment, initial test report submittal and approval, final site inspection, final test report submittal and approval, operating manual and as-built documentation submittal and approval, demonstration and instruction, and project completion.
3. Be aware of the following when preparing the project timetable:

    a. The Consultant shall be allowed at least fourteen (14) days for review of each submittal.
    b. Each submittal shall be revised and resubmitted as required by the Consultant.
    c. The Consultant reserves the right to modify or disapprove the submittal list or timetable.

B. Pre-Submittal Meeting

1. The Sound, & Communication Subcontractor shall meet with the Construction Manager and the Consultant after the project timetable has been submitted and prior to beginning work on shop drawings. The project manager and chief project designer for the Sound, & Communication Subcontractor must attend and be prepared to review the timetable, and to discuss the concepts described in the Contract Documents and proposed methods of execution of those concepts. The SVCC should expect to attend regular coordination meetings at the site for the full duration of the Project as part of this Contract.

C. Shop Drawings

1. Contractor Submission

    a. Submit, through the Construction Manager as specified in the General Conditions, shop drawings for submittal to the Consultant. Shop drawings shall include all information necessary to fully explain design features, engineering details, appearance, function, fabrication, mounting, installation, and interconnection of all equipment.
    b. This submittal shall include the following:

        1) Block diagrams (indicating all equipment interconnection and wiring).
        2) Schematic diagrams of custom circuitry and equipment.
        3) Equipment rack layouts.
        4) Patch panel layouts (including full-scale drawings of all patch panel labels).
        5) Connector pinouts.
        6) Custom receptacle plate, combination panel, and stage manager console layouts (full scale drawings required).
        7) Custom mounting brackets.

8) Mounting conditions and methods for all devices.
9) Wiring distribution diagrams and wire pulling schedules.
10) Detail drawings as required.

c. Submit names of the original equipment manufacturers or other suppliers, the specific model numbers of all Sound, & Communication Systems components, appropriate OEM catalog sheets, and technical data sheets. Submit also detailed descriptions of any required modifications to the specified equipment.
d. Submit a complete, itemized list of all equipment and material that shall be provided as part of the Sound, & Communication Systems. All equipment and material shall be listed by the same name, and in the same order as it appears in "PART 2 - PRODUCTS." Submit also similar lists for the portable equipment, spare parts, and test equipment to be supplied.
e. Shop drawings shall represent actual fabrication and installation details. Information on all shop drawings shall be designed, engineered, and drafted by this Contractor. Direct reproductions of contract drawings are not acceptable as shop drawings and shall be rejected. Requests for electronic files of contract drawings shall be denied.
f. Provide shop drawings separated into the various systems, where each set of drawings contains that information necessary to describe each system completely. The shop drawing submittal shall also include a fully referenced table of contents.

2. Consultant Review

a. The shop drawings shall be reviewed by the Consultant and shall be approved before the Sound, & Communication Subcontractor begins fabrication and installation of any aspect of the Sound, & Communication Systems. Note that the review of shop drawings by the Consultant is to determine conformance with the design concept and with information included in the Contract Documents. Only those shop drawings returned to this Subcontractor with a satisfactory review status shall be used in the execution of this Section.
b. Non-conformities and errors detected during the shop drawing review shall be noted on the drawings and returned to the Sound, & Communication Contractor upon completion of the review. The Subcontractor is responsible for the completeness and accuracy of the shop drawings.
c. Shop drawings or packages of shop drawings that are incomplete shall be marked "rejected" until such time as the complete set of relevant drawings is submitted. It is impossible for the Consultant to adequately review technical equipment submissions unless all details have been adequately represented.
d. Approval of those shop drawings that include any non-conformities or errors that are not detected during the Consultant's review shall not relieve this Subcontractor of the sole responsibility to provide an installation adhering strictly to the requirements of the Contract Documents.
e. Shop drawing review does not include engineering calculations by the Consultant unless expressly indicated on the drawings.

3. Samples And Mock-Ups

a. After review of appropriate shop drawings, submit one (1) sample each of the following items, clearly labeled with manufacturer name, model number, and other pertinent data, for approval by the Consultant:

1) A typical wall receptacle plate, with connector and engraved legend (e.g., an “IRE” plate).
2) A 300mm x 300mm (12” x 12”) section of a typical combination panel, with one
(1) sample of each type of scheduled connector, and sample engraved legends.
3) Factory or custom finishes for equipment racks, cabinets, blank and vent rack panels, and communication control panels and pendants.
4) All cloth and/or metal grille material, with integral framing or support construction where appropriate.
5) Custom paint samples for Sound, & Communication Systems devices requiring a change in color from that supplied by the manufacturer. Each sample shall be applied to a 150mm x 150mm (6” x 6”) piece of material closely matching the surface characteristics of each device type to be painted. On the back of each sample indicate the painting system, type of paint for each coat (including primer), the color and sheen of the finish coat, and description of the item(s) and location(s) where the color on the paint sample will be used.

4. Record Drawings

a. Keep a complete set of white prints of the specification and all contract drawings for this Section of the work, as well as shop and installation drawings. Any changes made during installation should be carefully noted and transferred to the appropriate documents to show “as-installed” work.
b. At the time of the initial test report submission, submit one (1) corrected set of record drawings and shop/installation drawings for review by the Consultant.
c. Late changes or adjustments, performed as corrections to punch list items or as change orders after practical completion of the contract, shall be reflected on updated record drawings by this Subcontractor.
d. After review by the Consultant, make any required revisions to the record drawings until the contents are satisfactory to the Consultant.

5. Operating Manual

a. Provide four (4) copies of operating manuals. Mark each section with tabular dividers using permanent labels protected by plastic. All drawings (B-size and larger) shall be folded into individual vinyl pockets (often referred to as “sheet protectors”). Include the following items:

1) Title sheet labeled “Sound, & Communication Systems—Operating Manual”, project name, and date.
2) Table of contents.

3) Names, addresses, and phone numbers of Sound, & Communication Contractor, sub-Contractors, and suppliers.
4) Final version of the equipment list.
5) System description.
6) Operating instructions.
7) Periodic maintenance procedures.
8) List of all spare parts and equipment.
9) Complete OEM data sheets, operating manuals, service manuals, and related documentation.
10) Storage media (CD/DVD) containing purchased software, backed-up downloaded software, and digital signal processor software final configuration.
11) Block and schematic diagrams of all systems.
12) Plugging key plan, showing wiring and receptacles (i.e., a quick-reference chart of combination panels, wall receptacles, and patching only).
13) Device, wiring, termination, and hardware schedules.
14) List of equipment design parameters including safe working capacities, maximum simultaneous operations, and similar information.
15) Maintenance instructions for finished surfaces and material.
16) The Final Test Report (see below).

b. Prepare one (1) draft copy of the Operating Manual for review by the Consultant four (4) weeks prior to the final site inspection. The document shall be clearly marked “FOR REVIEW.”
c. After review by the Consultant, make any required revisions to the Operating Manual until the contents are satisfactory to the Consultant. Four (4) copies of the final approved version shall be supplied in accordance with the General Conditions.

6. Mounted Block Diagram

a. Provide a half-size (minimum) print of each Sound, & Communication Systems block diagram in each corresponding control room and equipment rack room. Mount each diagram in a glass enclosed frame and securely mount in each control/rack room adjacent to the equipment racks. Block diagrams shall be of approved record drawings.

1.7 COMMISSIONING

A. Testing And Adjustment

1. Perform tests and adjustments to the Sound, & Communication Systems at the project milestones indicated below, and as specifically outlined in “PART 3 - EXECUTION: Testing and Adjustment.”

B. Interim Shop Inspection

1. Demonstrate the functions of all major systems, equipment, assemblies, and subassemblies of the Sound, & Communication Systems in the shop or factory no later than four (4) months prior to project completion. Perform all tests and

demonstrations in the presence of the Consultant. The systems, equipment, and components that shall be demonstrated include, but are not necessarily limited to, the following:

a. Sound System mixing consoles, with associated portable signal processing racks and cabling.

b. Sound System equipment racks (for Sound Control Room, and Amplifier Rack Room).
c. Stage Manager's Consoles, and associated extension cables.
d. Communication System equipment racks (for Communication Rack Room).

2. Notify the Consultant at least three (3) weeks prior to the date when all systems, equipment, assemblies, and subassemblies are complete and ready for testing. The equipment shall be made available to the Consultant for a period of at least one (1) week for testing and inspection prior to shipment. Do not ship any piece of equipment without either written verification of successful shop testing, or waiver of shop testing from the Consultant.
3. Prepare a draft of the initial test report (outlined below), indicating all pre-installation or shop testing, and submit the report to the Consultant for review prior to shipment of equipment from this Contractor's shop.

C. Initial Test Report

1. Perform all testing outlined in this specification (refer to PART 3 – EXECUTION: Testing and Adjustment). This shall occur after substantial completion of the Sound, & Communication Systems, and before scheduling the final site inspection.
2. Submit a complete report on the results of all testing and adjustments for review by the Consultant, and also certify, in writing, that the work of this Section is complete and operational in every respect, and that the Sound, & Communication Systems are ready for the final site inspection.

D. Final Site Inspection

1. Upon approval of the initial test report, the Sound, & Communication Subcontractor shall notify the Construction Manager and Consultant, in writing, and schedule the final site inspection for a time no later than four (4) weeks prior to the scheduled substantial completion of the project. During this inspection demonstrate all the tests described in this specification, and be prepared to demonstrate the operation of any or all portions of the Sound, & Communication Systems, as requested by the Consultant.
2. Furnish sufficient technicians to operate all equipment and to perform such tests and adjustments as may be required by the Consultant during this inspection. Provide also sufficient engineering and field service personnel to aid the Owner and Consultant, and to direct the technicians in testing, adjusting, and explaining the systems. Ensure that ladders and other means are provided to allow access to all devices to be tested. Ensure that no other work is scheduled in the audience chamber or stage areas during the time of this inspection. All temporary bracing, scaffolding, etc., shall be removed to permit full operation of, and access to, all

equipment.

3. Should the work inspected not be substantially performed at the time of first inspection, this Contractor shall compensate the Owner for any consulting and transportation costs incurred by the Owner and Consultant during all inspections.
4. If the system does not fulfill each and every aspect of the Contract Documents, make all necessary adjustments or other required changes in order to bring the installation into conformance with the Contract Documents at no additional cost to the Owner.

E. Installed System Measurement, Verification and Optimization

1. Upon completion of the Final Test Inspection, proceed with the measurement and optimization of the performance loudspeaker systems as described in PART 3 – EXECUTION: Testing and Adjustment. This Subcontractor shall have arranged for and scheduled operator who will conduct the actual measurements and supervise the optimization of these systems with the Consultant. This measurement process shall be scheduled for a minimum of three (3) consecutive days for the Music Hall. Ensure that no other work is scheduled in the audience chambers or stage areas during the time of this procedure. All temporary bracing, scaffolding, etc., shall be removed to permit full operation of, and access to, all equipment.
2. Furnish sufficient technicians to help operate all sound system equipment and to perform the various corrective tasks that are revealed during this procedure, including rigging adjustments and polarity correction. Provide any relevant backup or spare equipment including loudspeaker drivers, amplifier modules and software/computer spares. Provide all required support equipment such as computer monitors, keyboards, two-way radios, etc. Ensure that ladders and other means are provided to allow access to all devices to be tested.

F. Final Test Report

1. After completion of the final site inspection and loudspeaker system optimization, submit a final version of the complete report on all testing and adjustment outlined in this specification for review by the Consultant. The final test report shall be accompanied by a letter certifying that the Sound, & Communication Systems conform to the Contract Documents, that the installation is complete in all details, that the final site inspection is complete and successful, that the system optimization is complete in all details and that the system ready to be turned over to the Owner. The final test report shall include updated results from the initial test report, printouts of the measurement plots showing pre and post optimization, and hardcopy of final digital signal processor configurations and delay and equalization values.

G. Demonstration And Instruction

1. Instruct the Owner and/or the facility's operating personnel in the operation and care of the systems during two (2) separate sessions for not less than a total of sixteen (16) hours. This instruction shall include:

   a. Operating procedures for proper use of all systems.
   b. Proper maintenance of all systems.
   c. Replacement procedures for user replaceable parts.

2. The first demonstration and instruction session shall occur directly after acceptance of the final test report. The second session shall occur at a time arranged by the Owner and/or the facility's operating personnel, and shall be no sooner than the next day and no later than one (1) month afterwards. The precise timing of these sessions shall be determined by the Owner, at the Owner's convenience. The sessions shall be recorded to digital by this Contractor (or other format as directed by the Owner). One set of DVD's shall be submitted to the Owner within one (1) week following the recording.
3. Instruction shall be by qualified expert operators who have actual experience with the system in performance conditions. Submit instructors' qualifications to the Consultant at least two (2) weeks prior to the demonstration and instruction session. Should the Consultant find this Contractor's instruction personnel lacking in qualifications, the instruction sessions shall be rescheduled with new instructor(s), also pre-approved by the Consultant.
4. As a portion of this instruction, present the final, approved version of the Operating Manual to the Owner, Construction Manager and Consultant for preview at least two (2)weeks prior to the first instruction session. Review the contents of the Operating Manual with the Owner and/or the facility's operating personnel as part of the first session.

H. Guarantee And Warranties

1. General

   a. Furnish the Owner with a written warranty in accordance with General Conditions, covering all engineering, equipment, material, and installation workmanship incorporated into the work of this Section, until two (2) years after date of substantial completion of the project.

2. Service Calls

   a. All guarantee and warranty work shall be carried out at no additional cost to the Owner for any labor, parts, shipping or transportation. Warranty replacement equipment shall be provided within 24 hours of official notice by the Owner.

3. Equipment Warranties

   a. Warranty of replacement equipment and components shall be the same as for the original devices, and shall begin on the date of installation of the replacement item. Replace spare parts used during the warranty period at no additional cost.
   b. In the absence of a maintenance and service contract (outlined below), honor all extended warranties provided by original equipment manufacturers beyond the two
      (2) year guarantee outlined above. The Sound, & Communication Contractor shall not be responsible for any labor, transportation, shipping, or miscellaneous costs not covered by the OEM incurred during service calls to repair or replace extended warranty equipment after the first year.

4. Follow-Up Testing and Adjustment

a. Provide technicians to test and adjust the Sound, & Communication Systems, at a mutually agreed upon time, approximately six (6) months after substantial completion of the project. This follow-up visit shall include any needed testing and repair of all items covered under the guarantee, and testing and readjustment of all items identified in the maintenance procedures. Provide a written report to the Owner and Consultant outlining the extent and results of the follow-up testing and adjustment.

5. Repeated Failures

a. If a particular component, part, or piece of equipment fails more than three times during the warranty period, the failure shall be deemed to be due to engineering and/or installation error. In this event take action within 24 hours of official notice by the Owner to modify or correct the defect by replacement of faulty equipment and/or changes to engineering concepts or installation methods.

Systems. This service contract may be provided directly by this Contractor or through an approved local or regional service center.

b. The service contract shall cover every item provided and supplied under this section of the contract. Service offered shall include, but not necessarily be limited to, repair of components, temporary “loaner” equipment, replacement of parts, and a regular maintenance program for all equipment in the Sound, & Communication Systems. The service contract shall specify a guaranteed response time.

END OF PART ONE

PART 2 - PRODUCTS

2.1 Equipment and Material

1. All equipment and material shall be new, of the highest quality appropriate to the application and of uniform appearance throughout the system. Only equipment and materials from established original equipment manufacturers of sound and communication equipment shall be used. Components shall be commonly available and field replaceable, where possible.
2. All equipment and component enclosures shall be welded or tightly fitted assemblies of sheet steel with angles, channels and tees forming rigid frames for support of outer cabinetwork and internal components. Construction with anodized aluminum is acceptable only where specified.
3. Unless otherwise stated, all rack-mounted electronic and electrical equipment and components shall conform to EIA 19" standard. Any devices not specifically designed to be rack mountable shall be adapted, by professionally acceptable methods, to meet the EIA standard.
4. The rack height of all equipment and components noted in this specification is in 1.75" (44mm) units, or spaces. (i.e., a 5.25" device, that is three rack spaces high = "3U").

2.2 Equipment

A. Sound System Mixing Console & accessories **(OWNER PROVIDED, CONTRACTOR INSTALLED). Contractor shall receive, store, protect, install, startup, calibrate, and commission console and accessories.**

Item	Description	QTY
Rivage PM10 System Components		
MAIN COMPONENTS		
CS-R10- Control Surface	CS-R10 Control Surface	1
DSP-R10	DSP-R10 PM10 DSP Engine	1
I/O COMPONENTS		
RPIO622	RIVAGE I/O Rack. Supports up to 6 RY cards for a total of 96 ports. 2 MY-Card Slots, 2 HY-Card Slots	3
RY16-ML-SILK	RIVAGE Input Card. 16-channel Hybrid Microphone Preamplifier	9
RY16-DA	RIVAGE Output Card. 16-channel analog output card	3
HY256-SMF	RIVAGE High Capacity I/O Card. 256-channel TwinLANe I/O transport card. -Single Mode	4
AIC128-D	Audio Interface Card (To be installed in external computer provided by others)	1
HY144-D-SRC	RIVAGE High Capacity I/O Card. 144-channel SRC, Dante audio network I/O card.	2

Contractor shall be responsible for all labor and materials required to integrate the owner furnished mixing console and accessories per the following performance criteria:

The console needs to have a minimum of 144 mono input channels into the system @ 96K. The audio mixing console will need to have a minimum of 72 mix busses - 36 matrices, a FX plug in suite adequate for live and broadcast mixing. (WAVES with vocal rider). Provide input stage boxes in three locations. Each stage box should have a minimum of 48 XLR inputs and a minimum of 16 output XLR's at each location.
LOCATIONS: Downstage left. Down stage right and the Front of House (FOH) mix position next to the audio console for local inputs / interface into the theaters copper ¼" patch bay system.
This system will need to be DANTE capable for wireless microphones to interface into the console.
The system will have the ability to multitrack record Via DANTE.
The system will have the ability to perform virtual sound check of up to 96 channels.
The System will need to have a Dan Dugan Auto mixer covering up to 32 channels of Dugan Auto mixing.
The system will be patched via Fiber (2 redundant cables).
The Audio Console and audio microphone preamp boxes will need external UPS supplying enough power for the systems to operate for up to 30 mins.
FIBER: Establish/design a closed serial loop consisting of fiber making a data chain "daisy chain" through the audio data fiber system within the theaters infrastructure. We will need access points to insert a console or other various parts of the sound systems gear into this system at various locations around the Chapin Theater. The main fiber patch panel will be Down Stage Left @ A2 area. It will need a fiber patch panel to send signal to all locations within the room as well as jumpers to make connections to all the various break out locations in the room for operation. Multiple fiber runs will need to be located: Upstage Right, Upstage Left, the proscenium catwalk, FOH, in the amp room 4th level, and in the projection booth allowing signal to be routed to all these various locations where the data is needed.

Main System

Qty	Equipment	Description
24	K2	3-way full-range active WST enclosure
2	K2Bar	Extension Bar for K2-BUMP
2	K2bump	Structure for flying K2 arrays (incl. 1 x Extension Sling + 1 TEQSAS Laser Adapter)
6	Kara	2-way modular WST® enclosure
2	KaradownK2	Flying bumper for rigging KARA under K2
2	KS28bump	Lifting beam for flying up to 16 x KS28
12	KS28	Flyable subwoofer 2 x 18"
23	KIVAii	2-way passive WST® enclosure: 2 x 6.5" LF + 1.75 HF diaphragm
1	KIBUii	Rigging frame for flying or stacking KIVA II
2	P1	Digital audio processor and measurement: 16 x 12 mic/line AES/EBU and AVB interfaces. US version
13	LA12X	Amplified controller 4 x 2600W/4 ohms CE mains connector
1	LA4X	Amplified controller with PFC 4 x 1000 W /8 Ohms. Ethernet network. AES/EBU. US version
1	CAL_REG	On-site system calibration and validation 1 day (regional)

Monitor Package

Qty	Equipment	Description
4	ARCS WIDE	2-way Constant Curvature WST® enclosure 30° x 90°
4	SB18m	High power compact subwoofer: 1 x 18"
4	SB18PLA	Removable front dolly on wheels for SB18/SB18m enclosure
4	SB18COV	Protective cover for SB18(m) enclosure
12	X15 HiQ	2-way active coaxial enclosure: 15" LF + 3" HF diaphragm
6	LA12X	Amplified controller 4 x 2600W/4 ohms CE mains connector

It's common for the theater to run 10-16 monitors/mixes on our shows within the Chapin from FOH.
The monitor system will need to have 8 single low profile wedges capable of supporting touring level musicians and volume level.
The system will have 4 Side fills with Subs. (either pole mounted or stacked)
The system will have 1 drum wedge with complimentary sub stacked
4 keyboard wedges
All systems must have adequate power for all monitors to be used at once. All systems will include a variety of cable lengths to interface to all monitors amplifier racks. (10x100'and 10x50' Monitor runs, 8x10', and 8x25' jumpers to tie cabinets together for dual wedge operation)
A power distro with data display and real time monitoring must be supplied to manage all amplifiers within the Monitor system.
The audio drive for the amplifiers could be DANTE, Copper, AES50, or AVB, or AES/EBU so the system will need to have some flexibility within the input stage.
The system must be ready for show operation upon completion of delivery, setup, and tuning.

Spare

Qty	Equipment	Description
1	LA12X	Amplified controller 4 x 2600W/4 ohms CE mains connector

Amp Configuration

HR			
30A	2U	LA12X	Ch 1-4 : K2 1-3
30A	2U	LA12X	Ch 1-4 : K2 4-6
30A	2U	LA12X	Ch 1-4 : K2 7-9
30A	2U	LA12X	Ch 1-4 : K2 10-12
30A	2U	LA12X	Ch 1-2 : Kara x3 ; Ch 3: KS28 ; Ch. 4: KS28
30A	2U	LA12X	Ch 1 : KS28 ; Ch 2 : KS28 ; Ch 3 : KS28 ; Ch 4 : KS28

30A	2U	LA12X	Ch 1 : Kivaii 1-4 ; Ch 2 : Kivaii 5-8 ; Ch 3 : Kivaii 9-12 ; Ch 4 : Kivaii 13-15

HL			
30A	2U	LA12X	Ch 1-4 : K2 1-3
30A	2U	LA12X	Ch 1-4 : K2 4-6
30A	2U	LA12X	Ch 1-4 : K2 7-9
30A	2U	LA12X	Ch 1-4 : K2 10-12
30A	2U	LA12X	Ch 1-2 : Kara x3 ; Ch 3: KS28 ; Ch. 4: KS28
30A	2U	LA12X	Ch 1 : KS28 ; Ch 2 : KS28 ; Ch 3 : KS28 ; Ch 4 : KS28

Stage			
20A	2U	LA4X	Ch 1 : Kivaii 1&8 ; Ch 2 : 2&7 ; Ch 3 : 3&6 ; Ch 4 : 4&5
30A	2U	LA12X	Ch 1 : 2x ARCS WIDE ; Ch 2 : 2x SB18m ; Ch 3 : 2x ARCS WIDE ; Ch 4 : 2x SB18m
30A	2U	LA12X	Ch 1/2: X15 Patch ; Ch 3/4 : X15 Patch
30A	2U	LA12X	Ch 1/2: X15 Patch ; Ch 3/4 : X15 Patch
30A	2U	LA12X	Ch 1/2: X15 Patch ; Ch 3/4 : X15 Patch
30A	2U	LA12X	Ch 1/2: X15 Patch ; Ch 3/4 : X15 Patch
30A	2U	LA12X	Ch 1/2: X15 Patch ; Ch 3/4 : X15 Patch

B. Suspended Left and Right Loudspeaker Arrays

1. General

a. The Left and Right Loudspeaker Arrays, when in use, shall be suspended from existing structure.

2. S&C Contractor shall provide the following:

a. Provide all loudspeaker array components.
b. Provide all required manufacturer-approved mounting hardware, rigging frame and components necessary for a complete and safe attachment of the arrays to the Theater Equipment Contractor-supplied rigging points.
c. Provide loudspeaker array field alignments and adjustments after installation. Note: All loudspeaker array component orientations must be within + 1-degrees of the specified coordinates, and must be capable of pan adjustments of up to 10 degrees left or right.

3. Suspended Left & Right Loudspeaker Array Special requirements:

a. Design and provide all rigging system equipment to be inherently safe and self-sustaining. Design and provide individual components and systems to be

fail-safe and to prevent progressive collapse in event of any failure. Design and provide all rigging system equipment to prevent system failure as result of any single component failure. Include integral redundancy components, such as safety cables, as required to meet these criteria.

b. Design and provide all rigging system equipment using a minimum factor of safety of 10:1 in sizing of components, connections, and terminations. Factor of safety is defined as “ultimate failure stress of material used divided by maximum working stress” and shall be calculated in accordance with good engineering practices.
c. Provide a motorized cable reel with multi-circuit #12 loudspeaker cable. Commutator Ring style Cable Reels are not permitted. Cables shall be connected to combination panels at the attic level and to the loudspeakers via a multi- conductor connector. Cable management system must allow fully operational arrays to travel from maximum out height to platform level height. without requiring that technical personnel ascend to attic or canopy. Design drawings must be approved by the SVC Consultant before fabrication. The Consultant reserves the right to require a fully functional mock-up of the cable management system prior to approval of the design. Coordinate with Theater Equipment Contractor to ensure that motorized rigging safety systems will not be compromised by potential failures of the cable management system.
d. Refer to Drawings for component orientation.
e. Motorized chain lifts are owner provided.
f. Provide sufficient custom dollies to move and stored supplies speakers. Dollies should be designed to allow easy transport of these loudspeakers in and out of service within the platform and stage areas. Confirm that dollies will fit through all doorways, hallways, elevators, etc. between their play position and their designated place of storage. Ensure that all loudspeaker array components will be adequately protected from damage resulting from repeated transport and storage activities. Submit Shop Drawings of dollies to Consultant prior to fabrication. Refer to Architectural and Structural Drawings for further coordination information.

C. Front-Fill Loudspeakers

1. Provide installation of loudspeakers into the cavities located in the front edge of the concert platform. Determine placement with coordination from Consultant. Once wired and thoroughly tested for overall performance quality and correct polarity, close-off and completely fill the surrounding cavity with sound absorbent batting, and oversee application of architectural grille frames. Coordinate with Consultant.
2. Confirm exact locations at the site with Consultant, Architect and with Construction Manager.

D. Performance Loudspeaker System Optimization

1. Provide a complete sound measurement system and the services of an Consultant-approved certified operator to conduct, over two (2) consecutive days, the following: Detailed measurement and correction of the electro-acoustic response of the components in each loudspeaker array plus all secondary and delay fill loudspeaker devices.
2. Components and arrays shall be optimized for individual and combined response. Detailed measurement and verification of the electrical response of the performance loudspeaker system, from the mixing console inputs to the output of the loudspeakers. This shall include permanently installed and portable/patched devices.
3. Comparative measurements and equalization adjustments for each Hall with and without variable acoustic control banners deployed.
4. Additional measurement of system while employing performance microphones, including lavaliere mics (wired and RF), podium and other potentially problematic transducers and/or positions. Corrective equalization filters shall be determined and stored in memory.

END OF
SECTION

PART 3 - EXECUTION

3.1 QUALITY ASSURANCE AND WORKMANSHIP

A. The Sound, & Communication Contractor shall follow good working practices for the industry, and fabricate and install items in accordance with the manufacturer's recommendations and the Consultant's specifications. Provide quality control procedures acceptable to the Owner and Consultant.

B. Provide a properly qualified site supervisor who shall carry out supervision duties only.

C. Provide straight, plumb, true and aligned components throughout, and consult with other trades doing related work and adjoining work in order to provide an installation of first-class quality.

D. The Consultant reserves the right to reject any part of the installation not in compliance with the Contract Documents. The Sound, & Communication Contractor shall carry out any necessary remedial work or replacement free of charge and without delay to the Owner.

E. A standard set of reference guides for the design, engineering, and installation of the Sound and Communication Systems shall be:

1. Audio Systems Design and Installation, by Philip Giddings (Sams Publishing).
2. Sound Systems: Design and Optimization, by Bob McCarthy (Focal Press).
3. Systems in an IT Environment, by Al Kovalick (Focal Press).

F. Additionally, the following standards shall be used in the design, engineering and installation of the Sound and Communication Systems:

1. IEC 60065 Audio, and similar electronic apparatus - Safety requirements
2. IEC 60268 Sound System Equipment
3. IEC 60574 Audio-visual, and television equipment and systems
4. IEC 60942 Specification for Sound Calibration
5. IEC 60958 Serial Digital Audio Interconnect Standard
6. IEEE 1394 High-Speed "Daisy-Chained" Serial Interface for Digital Audio, , and Data Applications with Guaranteed Bandwidth or Latency
7. IEC 61883 Method for Transferring Data, Audio, Digital , and MPEG2 Data over IEEE 1394
8. IEC 60914 Conference Systems – Electrical and Audio Requirements
9. ISO 2603 Booths for Simultaneous Interpretation General Characteristics and Equipment
10. ISO/IEC 13818 Generic coding of moving pictures and associated audio information

3.2 DEFINITIONS

A. Electrical Reference

1. The following electrical references are used throughout the Sound, &

Communication Systems specification:

a. Voltage: dBv = 20log(E_1/E_2)
b. Power: dB = 10log(P_1/P_2)
c. 0dBu = 0.775VRMS; ratio of voltages measured open circuit
d. 0dBv = 0.775VRMS; ratio of voltages measured open circuit
e. 0dBV = 1.0VRMS; ratio of voltages measured open circuit
f. 0dBm = 1mW; power level (typically 0.775V into 600-ohm load)
g. 0VU = +4dBm; power level referenced to 600 ohms

B. Electrical Characteristics

1. Unless otherwise specified in the Contract Documents, electrical characteristics of the Sound, & Communication Systems equipment shall be as follows:

a. Microphone pre-amplifier inputs shall be balanced, have an impedance greater than or equal to 1.2kΩ, and be designed to be driven from sources of 600Ω or less.
b. Line inputs shall be balanced bridging, have an impedance greater than or equal to 10kΩ, and be designed to be driven from sources of 10kΩ or less.
c. Line outputs shall be balanced, have an impedance less than or equal to 100Ω, and designed to drive loads of 600Ω or greater.

C. Connector Polarity

1. Proper polarity of connectors on combination panels, receptacle plates, rack panels, patch panels, and other devices fabricated and/or wired by this Contractor shall be established as follows:

a. Polarity of connectors for OEM devices and equipment may be different, and should be wired to patch panels so as to maintain absolute polarity (e.g., if “pin 3” is high, connect to the patch panel “tip”).

2. Microphone and Line Level

a. Balanced Connection

1) XLR-3 connectors: pin 1 = ground/shield (do not connect to case); pin 2 = high (“hot”); and pin 3 = low (“cold”).
2) Patch panel (“long frame”) connectors: sleeve = ground/ shield; ring = low (“cold”); and tip = high (“hot”).
3) ¼” T/R/S phone connectors: sleeve = ground/shield; ring = low (“cold”); and tip
= high (“hot”).

b. Unbalanced Connection

1) XLR-3 connectors: pin 1 = ground/common/shield (do not connect to case); pin 2 = high (“hot”); and pin 3 = tie to pin 1 only.
2) Patch panel (“long frame”) insert connectors: sleeve = ground/common/shield; ring = input/return high (“hot”); and tip = output/send high (“hot”); unless otherwise noted by mixing console

manufacturer.

3) ¼" T/S phone connectors: sleeve = ground/common/shield; and tip = high ("hot").
4) Phono (RCA) connectors: sleeve or shell = ground/common/ shield; and center pin = high ("hot").

c. Multi-conductor Application

1) Multi-pin connectors: Refer to the manufacturer's specifications.

3. and RF Level

a. BNC-type connectors: sleeve or collar = ground/shield; and center pin = signal ("hot").

b. F-type connectors: sleeve or collar = ground/shield; and center pin = signal ("hot").

4. UTP Level

a. Refer to the manufacturer's specifications.

5. Intercom Level

a. Production Intercom Line

6. XLR-3 connectors: pin 1 = ground/common/shield (do not connect to case); pin 2 =
+30VDC; and pin 3 = audio/signal.

a. Production Intercom Headset

7. XLR-4 connectors: pin 1 = microphone shield ("common") (do not connect to case); pin 2 = microphone high ("hot"); pin 3 = earphone low ("common"); pin 4 = earphone high ("hot").
8. Low Volt Loudspeaker Level

a. Loudspeaker Line

1) Neutrik NL4 series connectors used for bi-amplified or passive (mono-amplified) sound system loudspeakers: pin "1+" = Low frequency or full-range driver "+"; pin "1-" = Low frequency or full-range driver "-"; pin "2+" = High frequency driver "+"; pin "2-" = High frequency driver "-".
2) Neutrik NL4 series connectors used for 70.7 volt lines: pin "1+" = high ("hot"); pin "1-" = N/C; pin "2+" = N/C; and pin "2-" = low ("common").

9. Fiber Optic Level

a. Refer to the manufacturer's specifications.

D. Transducer Polarity

1. Proper polarity of electro-acoustic transducers shall be established as follows, with exceptions as noted:

    a. Microphone: Positive acoustic pressure on the microphone diaphragm produces a positive voltage on pin 2, with respect to pin 3 of the output connector.
    b. Loudspeaker: Positive voltage applied to the (+) terminal produces a displacement of the loudspeaker cone away from the magnet, thus producing a positive acoustic pressure.

3.3 INSTALLATION

A. General

1. All equipment except portable equipment shall be securely held in place with a safety factor of at least three; except that all equipment rigged overhead shall be so done using safe rigging practices and with rated hardware selected to meet a safety factor of at least ten. All equipment shall be installed in such a fashion as to present no safety hazard to operating personnel.
2. All equipment shall be adequately ventilated when operating at maximum power.

3. All metal cabinets connected to the sound system audio ground network shall be effectively isolated from any conduit or other metallic component that is connected to the building electrical safety ground.

B. Wiring

1. General

    a. Ensure by drawing review and field survey that the conduit/raceway infrastructure is sufficient for the proper installation of the specified and required wire and cable, and/or any approved-substitute types of wire and cable.
    b. Do not begin pulling Sound, & Communication Systems wiring through the SV&C Systems Empty Conduit System until all conduit, pull boxes, etc. for each given run (point-to-point) are completely installed by the Electrical Contractor and ready for such wire and cable installation. Undertake a field inspection of the conduit system and pull boxes, reporting any missing conduit, harp edges, missing bushings or drag lines, blocked runs, etc., prior to attempting installation of wire and cable.
    c. The Sound, & Communication Contractor shall ensure that the wire and cable is installed in a manner that shall neither cause nor permit damage to the wire and cable throughout the installation process. Damaged wire and cable (including wire and cable spliced in violation of specified requirements) shall be rejected and replaced by this Contractor at no cost to the Owner.
    d. All microphone level, line level, level, intercom level & DC control, low volt/impedance loudspeaker level, 70.7 volt loudspeaker level, and AC power level wiring shall be restricted to individual and separate conduit systems.
    e. All microphone and line level wiring shall be balanced and floating, unless otherwise indicated.
    f. Take all necessary precautions to prevent electromagnetic, electrostatic, and radio frequency interference.

g. Care should be taken in wiring and installation to prevent damage to wire or equipment. All wire entering racks or other equipment shall have a service loop of at least four (4) feet unused (slack) length after termination. This service loop shall be neatly bundled and harnessed in place.
h. No splices shall be allowed in Group A, B, D or J (microphone, line, /RF, Fiber Optic) cables unless it is physically impossible to install the wire in one length; such splices must be approved by the Consultant on a case-by-case basis. When approved, the following splicing methods may be used:

    1) Crimp-type “butt” splice connectors with an appropriately sized shrink tube for each conductor, as well as an overall shrink tube for all audio and intercom cable types.
    2) Female BNC “barrel” connectors for Group D () cable. Male BNC connectors shall be provided on cable ends at location of the splice.
    3) No splices shall be allowed for Group J (fiber optic) cables.

i. Splices in Group E (intercom & DC control) cables are permitted only when necessary to effect parallel runs such as may be necessary for “H” intercom runs. Terminal strips or other approved means shall be employed, under review of the Consultant.
j. Splices in Group F (loudspeaker) and Group G (70.7 volt loudspeaker) are permitted without prior approval by the Consultant. Such splices shall be kept to a minimum.
k. Any splices made shall occur only at junction boxes, pull boxes or other permanently accessible locations. Such splices shall be listed on a schedule provided with the as-built documentation.

2. Flexible Cords and Cables

a. Flexible cords used shall be selected giving consideration to ambient and conductor temperatures, wear-resistance, flexing, and mechanical stress. Vulcanized rubber, butyl rubber, EP, or silicone rubber insulated cables shall be used in preference to PVC insulated types, wherever possible. All flexible cords and cables shall comply with the current edition of the applicable local Electrical Code in Orlando and appropriate regulations as identified in “PART 1 - GENERAL: Safety and Code Requirements”.
b. Flexible cables used as hanging or trailing leads, for power or control circuits, shall comply with the previous clause and shall, if under tension, be fitted with a strain-relief center core that shall be clamped at both ends to relieve the strain on conductors. Trailing leads shall be of a suitable length for the actual application.
c. The segregation of conductors carrying different category circuits shall be as defined in the applicable regulations (local, state and national Electrical Codes and elsewhere herein) and shall be maintained in all flexible cables used. Adequate insulation shall be ensured on all multi-core and control circuits.
d. Where the final connection to any equipment is by means of a flexible cable, such flexible cable shall have the same current rating as the rest of the circuit. The current ratings for the ambient temperature shall be as given in the applicable local Electrical Code.

3. Labeling and Marking

a. All Sound, & Communication Systems wire and cable shall be logically and permanently marked by the Sound, & Communication Contractor. All wire shall be identified at each termination point, and shall be marked to indicate the discrete destination (i.e., a wire shall show the reference number of the jack or connector to which its other end is terminated). All cable markers shall bear the alphanumeric characters of the circuit shown on the approved shop drawings.
b. Wire and cable shall be marked with an approved system of durable identification markers, such as slip-on type PVC or neoprene sleeves, or with directly heat stamped characters. The use of computer-generated labeling systems is recommended. Cloth or vinyl tape-type markers are not acceptable.
c. The individual pairs of multi-pair cable and individual conductors of multi-conductor cable shall be readily identified by permanent color-coding of the wire insulation. Multi-pair or multi-conductor cable that is identified only by means of the form or order of lay of individual wire is not acceptable.
d. All spare wire shall be marked “spare” at both ends and numbered consecutively. A “spare schedule” shall be provided indicating spare wire and cable numbers, locations and types.

4. Termination

a. All connections and joints shall be made with Tin-Silver-Copper-core solder or an approved mechanical connector.
b. All multi-pin connectors shall have crimp-type gold-plated contacts.
c. Where flexible cable joins fixed wiring the terminations shall be accomplished with either a pair of appropriate mating connectors or a suitable terminal block.
d. All terminations of shielded cables shall consist of a PVC or neoprene heat shrink sleeve covering the shield drain wire and an overall PVC or neoprene heat shrink sleeve covering the point at which the cable jacket and shield end.

5. Audio Grounding

a. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables. Shields shall be continuous from source to input points. Shields shall be connected at input points only, with shields lifted at the source, except as noted below. Provide telescoping shield.
b. Microphone wiring shall have continuous shields from the microphone receptacle to microphone patch jack, and if normalled to a console microphone input, continuous to that point.
c. Tie-line patch points shall have continuous shield connection from one patch jack to another with no permanent connection to the audio ground network.
d. Unbalanced wiring, such as used in certain communication systems, shall have audio shields connected at device inputs and floated at device outputs. Strap shield to “low” side of unbalanced input.
e. No “doubling up” of ground points on multi-pin connectors or terminal blocks shall be allowed.
f. Shielded audio cables that normal through patch panels shall utilize a normalling type jack that has an isolated switching “break” circuit. This shall be used for sleeve normalling.
g. Note: The Consultant recognizes that different contractors use different “in-house” or proprietary patch-panel grounding schemes, and will discuss alternative methods if such are desired by this Contractor. The grounding

scheme employed must be approved by the Consultant.

C. AC Power System

1. Power Distribution

a. AC power for the Sound, & Communication Systems, provided by the Electrical Contractor, is distributed at 120VAC, 60Hz. Refer to the electrical plans for further information.

2. Grounding

a. The sound system audio ground network (“audio ground”), including ground source, ground conductors, and ground distribution points is provided by the Electrical Contractor. The isolation and ground continuity of this network, although the responsibility of the Electrical Contractor, shall be confirmed by the Sound, & Communication Contractor prior to installation of equipment. Any ground shorts or faults shall be reported for correction by the Electrical Contractor.
b. The audio ground network shall be isolated from all other electrical grounds except at the source of the ground network, the building safety ground, specified to be of high quality. Therefore, if the connection between the audio ground network and the source of the ground is disconnected, no continuity between the audio ground and the building electrical ground shall exist.
c. The sound system audio ground network connects all Sound System equipment positions together by a single, low impedance, ground network (specified to be 0.1 ohm). All AC power wall receptacles in Sound, & Communication Systems areas, provided by the Electrical Contractor unless otherwise indicated, will be the isolated ground type, connected only to the associated audio ground spur in that area.
d. All Sound System equipment racks containing active electronics shall be connected to the audio ground network, except as otherwise noted in this specification. Caution must be exercised so that these racks are not permanently, or in any way during operation, capable of being accidentally connected to the building safety ground.
e. All conduits and back boxes containing Sound, & Communication Systems wiring shall be permanently connected to the building electrical safety ground.

f. Note: (RF) and infrared (RF) devices, being unbalanced in nature, shall not be connected to the sound system audio ground network.

D. Electrical Safety

1. No voltage in excess of 25V rms AC or 24V ripple free DC shall be exposed to touch in normal use or in any equipment by the withdrawal of modules or of any plug or connector without the removal of suitably indelibly labeled covers.
2. Unless specifically excepted, all live electrical parts above 50V rms AC or 60V ripple free DC, including terminals, shall remain completely shrouded by insulation or grounded metal when the main access panels are removed. The separate shrouds or covers shall require a tool to remove them to prevent inadvertent contact with live parts.
3. In addition, where enclosures or items of equipment containing predominantly

control, computer, or similar low voltage signals also contain voltages in excess of 50V rms AC or 60V ripple free DC, clear standard warning notices indicating the maximum voltage present shall be provided on all removable access panels. Similar warning notices shall be provided where voltages exceeding 120V are present in any enclosure or item of equipment and such a voltage would not reasonably be expected to be present.

4. Within enclosures, racks and panels identify with prominent, standard, and indelible signage which circuit breakers or disconnects are to be switched off in order to isolate the equipment totally. Warning notices shall also be provided on all equipment that contains live terminals after operation of its circuit breaker or disconnect. These terminals must be completely shrouded to prevent inadvertent contact.
5. All equipment, control stations, equipment racks, enclosures, and all metal cases, raceways, and conduit shall be efficiently grounded. Special hand held or portable equipment that is not double insulated shall have duplicated grounding connections. All grounding shall be in accordance with the current edition of the applicable local, state and national Electrical Codes and as identified within this Section and Divisions 26 and 27.

E. Control System Voltage

1. Control circuits shall generally be operated at a maximum of 24V AC or DC as appropriate, and in compliance with the protection described. Hand held control panels shall not contain line (120V) voltage unless approved. Special arrangements to feed movable panels with both line voltage and control voltage must provide suitable mechanical protection and ensure separation of services using the correct category of cable as defined in the codes and regulations identified in “PART 1 - GENERAL: Safety and Code Requirements”.

F. Equipment

1. General

a. Operating parts of all equipment shall be suitably machined and finished. Tolerances, fits, and finishes, etc., where not specified herein or indicated on the drawings, shall conform with best trade practices and the operational intent of the equipment.
b. All components shall be of new or recent manufacture, built within two (2) years of the date of installation and never used prior to installation.
c. All components and items used in Sound, & Communication Systems shall be by a recognized manufacturer specializing in professional Sound, & Communication and electrical equipment and shall conform to applicable industry and code standards.

d. The quality of workmanship and materials of all equipment and components requiring custom fabrication shall be comparable to that of professional audio equipment as produced by specialized original equipment manufacturers.
e. All components used in the equipment installations shall be selected on the basis that each item, or a similarly performing substitute, will be obtainable by the Owner for a period of five (5) years should further spares be required.
f. All electronic components shall be readily available from at least two recognized manufacturers. Any custom hardware or software shall be

supported by readily available spares.

g. Electrical and electronic components shall be selected for long operating life and reliability. The design of components and assemblies shall ensure that all such components work at a minimum of 25% less than their maximum ratings.
h. All integrated circuits containing program code and all circuits with twenty four or more pins shall be mounted in sockets.
i. All indicators, controls, fuses, relays, contactors, printed circuit cards, and other major components shall each be fitted with a permanent label indicating their type, rating, and duty to expedite any necessary replacement or fault finding. Where applicable, a means of identifying normally open, normally closed, and other contact configurations shall be marked on the component.
j. Annunciators, indicators, and fuses in individual power and electronic systems shall be standardized and approved by the Consultant before design is finalized.
k. Indicating devices shall be of as few different types as possible and wherever practicable shall have a minimum life of 10,000 hours.
l. All contactors and relays (although not necessarily special approved types such as reed relays) shall be of the snap-track type developed for mounting inside equipment rack. Generally the contact rating shall be twice the expected maximum operating or inrush current whichever is the greater.
m. Fuses and circuit breakers shall be panel mounted. Fuses shall be mounted in indicating fuse holders, illuminated when the fuse has failed.
n. Where fuses must be concealed they shall be easily accessible.
o. All panels with concealed fuses shall be marked accordingly on the outside and shall have panel mounted indicator lights. Spare fuses shall be provided in holders mounted within the panel.
p. All internal switches shall be clearly and permanently labeled.
q. All connectors external to the equipment shall be of rugged metal construction with self-contained locking devices. Nonmetallic external connector shells are unacceptable.
r. All key-switches for similar components shall use the same key. Unless otherwise specified, keys shall be removable in all positions. Supply four (4) key copies for each key-switch.

2. Assemblies

a. Manufacturing, assembly, and wiring work shall be carried out by trained and experienced technicians.
b. Ensure that all parts and components of electrical, electronic, or computer installations are readily accessible for inspection, service, and maintenance. All components shall be replaceable without removal of operational components other than those mounted on or carrying the faulty component. All parts shall be replaceable without strain or damage to other parts.
c. Electrical and electronic systems shall be constructed as separately removable modules. Where a system comprises a large number of similar modules, these modules shall be designed so as to be easily interchangeable. Where such equipment is of a plug-in type, withdrawing or replacing the modules with the power “on” shall not cause damage to the units or to other equipment. Electrically dissimilar modules or connectors shall not be able to be wrongly connected.

d. Operating surfaces of control panels/consoles shall be of steel, aluminum, or

other rigid material, reinforced where necessary to prevent noticeable panel deflection. Generally, all sides of a control panel shall be fully supported.

e. Where possible all control and connection panels shall have hinging or drawer access to electronics for installation and maintenance. Panels shall be held closed by captive quick locking hardware. Provide terminal strips, and neatly bundled wiring to facilitate access.
f. Captive fasteners shall be provided for all removable panels or parts. Any inaccessible nuts shall be fixed. Countersunk or instrument head screws shall be used on external surfaces.

3. Custom Fabrication

a. Particular attention shall be paid to the selection of operational components used on custom pendants and control panels. All such components shall be selected for long life under arduous conditions, including rough use in a dusty and dirty environment.
b. Pushbuttons, selector switches, key switches, operating knobs, handles, and similar shall all be rugged industrial-type components, firmly mounted and capable of giving long trouble-free service. Commercial-grade units will not be accepted.
c. All edge connectors, ribbon cable connectors and headers shall have gold-plated contacts. All IC sockets shall be of a face-wipe, gas-tight design.

4. Finishes

a. Unless otherwise indicated, all steel equipment cabinets and panels shall be finished with one coat of primer and two coats of semi-gloss baked enamel after full degreasing and rust preventing processes. Colors shall be as selected by the Consultant or as specified herein.
b. Aluminum panel surfaces shall be anodized black or other color as indicated herein or on the drawings.
c. Finishes subjected to high temperatures shall be of heat-resistant epoxy or other durable high-temperature baked-on enamel finish.
d. Finishes shall be durable and capable of withstanding normal usage in the areas in which they are installed.

5. Equipment Racks

a. All internal wiring of electrical, electronic or computer equipment shall be in accordance with the current editions of the applicable Electrical Code and governing regulations as identified in “PART 1 - GENERAL: Safety and Code Requirements”.
b. All internal wiring shall be of adequate mechanical strength as well as electrical current rating. Multi-strand cables shall be used for low current wiring in preference to solid conductors. The current carrying capacity of all cables within equipment enclosures shall take account of de-rating factors and ambient temperatures in accordance with applicable local, state and national Electrical Code regulations.
c. All terminal strips shall be logically positioned and indelibly marked in accordance with the circuit drawings. Generous space shall be left for installation of the external cables.
d. All terminals, to which connections are to be made by Division 26 shall have clear markings that are unique for each terminal and are as identified on the

shop drawings.

e. All internal wiring shall be color coded and contained within raceways. At least 40% space shall be available as initial spare capacity. All the conductors of a given power circuit shall be contained within the same conduit or raceway. All internal wiring shall be protected from mechanical damage.

6. Labeling

a. All wall receptacle plates shall be engraved and filled to indicate the reference number of the circuit to which each is attached. Such numbers will, when applicable, be referenced to the patch panel jack to which the circuit connects. Refer to the contract drawings for reference numbers and designations.
b. Panels and receptacles must be readable in dim lighting. Quality of engraving and filling, letter sizes, etc. shall comply with “Part 2 - Products: General Equipment - Fixed - Receptacle Plates and Combination Panels” of this specification and as approved by the Consultant through shop drawing and sample submittal.
c. All legends shall be engraved and filled in black on a white background or white on a black background, unless otherwise noted, for maximum contrast against background employed.
d. Where required, engraved, adhesive-backed lamacoid labels shall also be mechanically fixed in place only in those cases where there is no risk of damage to a device’s internal components or wiring.

7. Spare Parts

a. Supply spare parts to be stored on-site for all user serviceable equipment and systems. A sufficient quantity of bulbs, fuses, knobs, switches, and other miscellaneous parts shall be supplied. Refer to “PART 2 - PRODUCTS” for spares of electronic and transducer parts to be supplied.
b. Label all spare parts with manufacturer’s part number, designation, description, and location(s) where part is used. Provide neatly labeled storage containers for all spare parts, including special static free wrapping for electronically sensitive parts.
c. Similar equipment, spares, and replacements shall be electrically and mechanically interchangeable on all equipment forming part of a given system or installation.
d. The spare parts shall be released to the Owner after completion of the commissioning procedure.

G. Noise from Equipment

1. The residual noise and hum output of the systems shall be such that PNC-15 or below can be measured at the center of main floor, and the character of the remaining noise must be random, with no audible discrete frequency components.
2. Where a control panel or rack is to be used or located in an operational area, such as on stage, a gallery, or control room, there shall be no acoustic noise associated with the panel. No internal cooling fans or similar moving or magnetic equipment shall be permitted unless approved by the Consultant in writing.
3. Operation of switches, pushbuttons, relays, solenoids, and similar shall not be audible to members of the audience (even in the control rooms with the window open).

H. Site Work

1. General

a. The Sound, & Communication Contractor shall be responsible for delivery, storage and handling of equipment and tools during the period of the installation.

2. Painting

a. Except for special requirements as approved by the Consultant, each painting system shall use paint products of one manufacturer to ensure compatibility of primer and undercoat with top coats.
b. All paint products shall be factory prepared of the best grade and quality (front line) produced by the manufacturers, subject to approval by the Consultant.
c. Finish coats on components exposed to view at all locations shall be two (2) coats of approved finish.
d. The Sound, & Communication Contractor shall be held wholly responsible for the finished appearance of the painting work. Painting will be in accordance with the highest standards of the trade.
e. All components exposed to view shall be shop painted to match approved samples.
f. Re-touch all shop painted or finished work wherever necessary or as directed, including unpainted screws and other fasteners. Prime paint all patched portions in addition to all other specified coats.

3. Protection Of Work

a. Shipping and Storage

1) The Sound, & Communication Contractor shall be responsible for the satisfactory packing and protection of all components and materials for shipment from the factory to the site. Any items suffering damage during transit due to unsatisfactory packing shall be replaced without charge to the Owner.
2) All equipment shall be packed to withstand the intended method of transport and environmental conditions expected. This Contractor shall take full account of the effects of rough handling, temperature extremes, dust, heavy rain, direct sunlight, and high relative humidity (up to 99%) during transit and installation. The packing shall, where necessary, reduce the effects of condensation.
3) All equipment shall be packed in sturdy containers to provide mechanical protection during shipping and storage. Provide padding, etc., as necessary to protect the equipment from vibration and shock.
4) Inner plastic sheeting shall be provided to protect the equipment from moisture and dust. Such covers shall be kept on equipment until environmental conditions have stabilized and the installation areas have been completed.
5) No equipment shall be shipped to the job site by this Contractor until notification by the Construction Manager that storage facilities are available to protect the equipment prior to installation.
6) The Sound, & Communication Contractor shall be responsible for storage

and protection of portable equipment and components until turning these items over to the Owner during commissioning. Instruct the Owner as to the proper method of storage and protection of the equipment during installation. Refer also to the General Conditions, as amended by the Supplementary Conditions.

b. Installation

1) Installation shall be authorized only when site conditions provide mechanical, electrical, and environmental protection suitable for the electronic equipment.

c. Special Protection of Electronic Equipment and Cable

1) This Contractor shall conform with the following minimum standards and procedures for the storage and protection of the equipment during installation:

a) Class 1 - Cable and distribution apparatus, back boxes, face plates, terminal boxes, and rack frames may be stored and installed in weather-protected spaces under “normal” construction site conditions provided that no electronic components are contained within devices and provided that storage boxes are sturdy, well sealed, and devices are protected with imperforate inner plastic sheeting. When installed, devices must be protected from dirt, dust and moisture by sturdy impermeable plastic sheeting, and completely covered with heavy corrugated cardboard, held in place securely by duct tape. Covers shall not be removed until the area is broom cleaned. Care shall be taken to prevent damage and prolonged exposure to improper site conditions during installation. In no case shall devices remain uncovered overnight during installation or while work is taking place causing high dirt dust or moisture levels in the area of placement.
b) Class 2 - Control panels, spare parts, and test equipment (except as listed under Class 3) shall be protected and treated as per the Class 1 devices with the following additional provisions: Equipment shall be stored in an air-conditioned secure space. Equipment shall not be shipped until such space exists on site and is approved by the Consultant and Contractor. Control panels with electronic components may be installed providing they are protected as described under Class 1 description above, but electronic components must be removed and shall not be installed until the area of installation is broom cleaned and all dirt, dust and moisture producing work is completed in the area. All other equipment in this class shall not be installed until the area of installation is broom cleaned, “blown” clean with pressurized air, mopped, secure, and air conditioned.
c) Class 3 - Mixing consoles, filled equipment racks, and other electronic equipment shall not be shipped to site until the control rooms are finished, air conditioned, dust free, broom and mop cleaned, secure, and in all respects complete and ready for occupation. This class of equipment shall not be unpacked until the system is complete in all other respects. Under no circumstances may any equipment in this class be removed from the control rooms into or through spaces that are not cleaned, air conditioned, and complete.

3.4 TESTING AND ADJUSTMENT

A. General

1. Perform tests and adjustments to the Sound, & Communication Systems as outlined in this specification. These tests and adjustments shall be completed at the time(s) specifically indicated in “PART 1 - GENERAL: Commissioning.”

B. Preparation

1. Ensure that all equipment racks, panels, and back boxes have been adequately cleaned of dirt, dust, and debris. Reassemble all equipment and replace all panels and covers with the necessary screws and/or other appropriate hardware prior to the final site inspection.

2. Before applying line voltage power to Sound, & Communication Systems equipment, perform a complete system inspection on the site to verify that all items are correctly installed and will operate safely as specified in the Contract Documents.
3. Verify also that each individual section of the Sound, & Communication Systems has been correctly installed and is fully operational.

C. Conditions

1. Do not use any major control equipment intended for installation in the Sound, & Communication Systems for the purpose of checking or testing wiring or circuitry until such time as requirements for “Class 3” equipment meet the environmental conditions described in “Special Protection of Electronic Equipment and Cable” above. Provide testing apparatus, substitute control equipment, or other devices for testing wiring and circuitry prior to the existence of these conditions at all locations of Sound, & Communication Systems equipment.
2. Electro-acoustic measurements shall only be made once all interior room finishes are completed and all performance equipment is in place and operational. Such equipment includes, but is not necessarily limited to, audience chamber seating, acoustic isolation doors, acoustic canopies, and acoustic control curtains and banners.

D. Test Equipment

1. The following test equipment, provided at the expense of the Sound, & Communication Contractor, shall be available on site during all testing and adjustment sessions, initial and final site inspections, and demonstration and instruction sessions. Provide all appropriate adapters, cables, and connectors necessary to interconnect the test equipment devices to each other and to the Sound, & Communication Systems equipment.

    a. Sweep/Function Generator
    b. Frequency Counter
    c. Pink Noise Generator
    d. Digital-Storage Dual-Trace Oscilloscope
    e. Digital Multi-meter
    f. Polarity Testing System
    g. Impedance Meter
    h. Audio Component Test Set
    i. Sound Level Meter meeting IEC 60651 Type 1 specifications with octave band measurement capabilities
    j. Real-Time One-Third Octave Audio Spectrum Analyzer
    k. Meyer Sound SIM3 Measurement System and Operator l. Two-Way Radios

E. Procedure

1. Perform the following tests and adjustments to the Sound and Communication Systems. All test results and system adjustments shall be fully documented for inclusion in the Initial and Final Test Reports. Refer to “PART 1 - GENERAL: Commissioning”.

2. General Testing

a. Continuity

1) Test all permanent Sound and Communication Systems wire and cable for continuity after installation in conduit and before termination in panels or racks. Also test for shorting contact between any and all conductors in a multi-pair or multi-conductor cable and between each conductor and the conduit (building safety ground). Use a continuity meter for all tests. Bell and buzzer testing “rigs” are not acceptable.
2) Test all Sound and Communication Systems components to and from the patch panel to ensure that device inputs and outputs, assigned to particular circuits or channels, terminate to the correct location, and that all corresponding labeling is accurate. This shall include, but not necessarily be limited to, devices connected to receptacle plates, combination panels, and patch panels.

b. Polarity

1) Measure and verify electrical and electro-acoustic polarity of all Sound and Communication System components to ensure that the entire system is properly connected (i.e., the system shall be “in phase”). This shall include, but not necessarily be limited to: microphones (and other transducers), loudspeakers, infrared receiver/headsets, all electronic components, all permanent wiring, patching, and receptacle panels, and portable cables. Ensure that absolute polarity is maintained throughout all signal paths, regardless of patching or other routing changes. Refer to polarity details in the “Definitions” section above.
2) Document all wiring or termination changes made in order to maintain system polarity.

c. Impedance

1) Measure and document the impedance of each microphone and line level line at the patch-panel, terminated at the opposite end with a 600-ohm 1% precision resistor, at 250Hz, 1kHz, and 4kHz, while disconnected from any device input. The load impedance value shall be greater than the resistive load.
2) Measure and document the impedance of each low-voltage loudspeaker line to an unconnected receptacle, at the patch panel, terminated at the opposite end with an 8-ohm 1% precision resistor, at 250Hz, 1kHz, and 4kHz, while disconnected from any device input. The load impedance value shall be greater than the resistive load.
3) Measure and document the impedance of each low-voltage (nominal 2 to 8-ohm) loudspeaker line while disconnected from the power amplifier. The load impedance value shall be greater than the total rated impedance of all connected loudspeaker drivers.
4) Test each full-range loudspeaker line at 63Hz, 250Hz, 1kHz, 4kHz, 8kHz, and 16kHz.
5) Test each band-limited loudspeaker line (i.e., bi-, tri-, or quad-amp systems) at the maximum number of test frequencies that fall within the

frequency range of the driver under test.

6) Measure and document the impedance of each 70.7V loudspeaker line at 250Hz, 1kHz, 4kHz, and 8kHz, while disconnected from the power amplifier. The load impedance value shall be greater than the total rated impedance of all connected voice-coil transformers.

d. Radio Frequency Interference

1) Use a minimum 60 MHz bandwidth oscilloscope in conjunction with loudspeaker or infrared receiver/headset monitoring to ensure that the sound and/or communication system under test is free of spurious oscillation and radio frequency interference (RFI). Measure and document all results.

e. Gain Structure

1) Set and document input and output gain controls on all Sound and Communication Systems components to provide appropriate signal balance (i.e. unity gain) and optimum signal-to-noise ratio for each signal path. Unity gain shall be set by adjusting the gain of each active device (excluding power amplifiers and mixer/amplifiers) for input level equals output level by using a reference signal of 0dBv pink noise at the mixing console output.

2) Ensure that a minimum of 18dB of headroom exists for each gain stage. The overall system gain (excluding mixer/preamplifiers, mixer/amplifiers, and power amplifiers) through any signal path from any input to any output shall be unity
+ 1.5dBv.
3) Conduct listening tests from center of coverage of each high-frequency horn device to determine that there is no audible hiss.
4) Final gain adjustment of equalizers and other processing equipment shall be made only after the completion of the equalization process.

f. Electronic Signal Path

1) Measure and document frequency response, signal to noise ratio (S/N), maximum output before clipping, total harmonic distortion (THD), and any spurious noise and/or hum signals of all electronic components in the Sound and Communication Systems. Measured values must be as published by the manufacturer, or better.
2) With unity gain levels set, measure and document electrical frequency response for all discrete signal paths from the mixer through each active device, including mixer/amplifier outputs with the loudspeaker lines disconnected. Also test typical signal paths through each combination of mixer input to output. Use a -60dBv (0.8mV RMS) sine wave signal at microphone inputs from 20Hz to 20kHz and a 0dBv (0.775 VRMS) sine wave signal from 20Hz to 20kHz at line level inputs. Deviation shall be within +/-1.0dBv from the range of 30Hz to 20kHz, or the specified band-pass for a particular circuit. (Refer to manufacturers' published data).
3) With unity gain levels set, measure and document signal to noise ratio for

all discrete signal paths from the mixer through each active device with mixer input shorted.

4) Measure and document maximum output before clipping (headroom) and total harmonic distortion of each active device with methods recommended by the equipment manufacturer.
5) With unity gain levels set, measure and document any spurious noise and hum signals such as 60Hz, 120Hz with harmonics, high frequency oscillation, clicks, pops, or noise spikes for all discrete signal paths from the mixer through each active device, including the mixer/amplifier outputs with loudspeaker lines disconnected. If any unwanted signals are detected, troubleshoot and correct or modify as necessary. See note above under Gain Structure and concerning audible hiss.

g. Power Output

1) Measure and document the output power of each power amplifier and mixer/amplifier, using a sine wave oscillator with less than 0.5% THD as an input source. Terminate each power amplifier channel output with a load resistor to match the nominal loudspeaker impedance. Apply a 1KHz signal at a level to achieve 10 dB below full rated power output of the mixer/amplifier. Observe the sine wave with an oscilloscope to insure that full voltage for rated power can be reached without noticeable deformation of the waveform.

h. Buzzes, Rattles, Distortion

1) Apply a sine wave sweep at a slow rate from 30Hz to 10kHz at 6dB below full rated power output of each amplifier in the Sound and Communication Systems with output connections made to all loudspeaker drivers or voice-coil transformers. Adjust test frequency range to compensate for band-limited low-voltage loudspeaker lines (i.e., bi-, tri-, or quad-amp circuits) or 70.7 voltloudspeaker lines. Listen carefully to each loudspeaker for electromechanical buzzes, rattles, distortion, or other objectionable noises and correct all causes of such defects. If cause is outside S&C Systems equipment and/or the scope of this section of the contract, promptly notify the Owner and Consultant of the cause and suggested corrective procedure.

i. UTP and Fiber Optic Cable Testing

1) Refer to ISO/IEC 11801: Information technology Generic cabling for customer premises.

3. Installed Loudspeaker System Measurement and Optimization

a. General

1) The following tests shall be conducted as part of the SIM3 measurement and optimization process. The goals of this process are as follows: 1) to achieve minimum level, spectral, and ripple variance over the listening area; 2) to achieve maximum coherence; 3) to achieve maximum power capability; and 4) to achieve sonic image control.
2) The SIM3 measurement and optimization process shall be performed for

a minimum of two (2) adjustable room acoustics configurations to be specified by the Consultant.

b. Optimization of Loudspeaker Position, Focus Angle, and Splay Angle

1) Measure and document performance of loudspeakers in specified positions and locations to determine optimal position and location of loudspeakers either singly or with a group. Adjust position and location as necessary.

c. Sound Pressure Level

1) Measure and document sound pressure level of loudspeaker arrays throughout the seating areas and adjust loudspeaker levels, as necessary, to achieve coverage of +/- 3dB, or better, with a peak continuous level of 105dB SPL. Take all readings at seated ear level height.

d. Loudspeaker Time Alignment

1) Measure and document the time alignment of the loudspeakers either singly or within an array. Adjust digital signal processing units as necessary to achieve the best average signal alignment between components.

e. Frequency Response

1) Measure and document the frequency response of each loudspeaker array, as measured in both the reverberant field and near field, to ensure that the frequency response is within +/-3dB from 20Hz to 20kHz. Adjust equalization as necessary.

f. Speech Intelligibility

1) Perform subjective and/or objective speech intelligibility measurements or surveys throughout the facility and make adjustments as necessary to the Sound and Communication Systems for maximum speech intelligibility. Submit proposed methods of testing to the Consultant for approval.

g. Ambient Noise Level

1) Measure and document the ambient noise level at a distance of one meter from each loudspeaker or array over eight ISO octave bands. Plot data on a PNC curve chart and verify that the specified PNC rating has been met.
2) Conduct listening tests from center of coverage of each high-frequency horn device to determine that there is no audible hiss.

4. Communication System Testing

a. General

1) Electro-acoustic testing, measurements, and equalization shall be performed in the following two (2) different acoustic setup conditions, as outlined below, and as directed by the Consultant:
2) All acoustic control curtains completely retracted (all hard wall surfaces exposed).
3) All acoustic control curtains completely extended (most hard wall surfaces covered by dark fabric).
4) Measure and document electro-acoustic testing, as described above, within two (2) different types of environments:
5) Under unoccupied (quiet) conditions.
6) Under “production” conditions (i.e. noise levels equal to or exceeding a normal performance or production situation). Use a suitable source such as program material, live performance, or other as approved.
7) Component Testing: Test all communication control panels at all assigned locations throughout the facility. Test for proper signal flow, switching control, LED operation, and paging operation. Test all volume controls and integral priority paging defeat circuits and switches to ensure that the amplified sound is free from any distortion throughout all attenuation steps and relay/switch settings.

b. Production Intercom

1) Follow manufacturer’s installation manual.

c. Program Monitor/Paging System Loudspeakers

1) Frequency Response

a) Measure and document the frequency response of all ceiling mounted program monitor / paging loudspeakers. Results shall be flat from 100Hz to 3kHz, and shall roll off at a rate of 3dB per octave, from 3kHz to 10kHz,
+3dB.
b) Measure and document the frequency response of all control room monitor loudspeakers. Results shall be flat from 120Hz to 3kHz, and shall roll off at a rate of 3dB per octave, from 3kHz to 10kHz, +3dB.

2) Sound Pressure Level

a) Measure and document sound pressure level of the all program monitor/paging loudspeakers to achieve even coverage of +4dB, or better, with a maximum continuous level of 85dB SPL, (band limited from 500Hz to 3kHz).
b) Measure and document sound pressure level of each control room monitor loudspeaker throughout the control room to achieve even coverage of
+4dB, or better, with a maximum continuous level of 90dB SPL.

3) Distribution Amplifier Performance

a) Check Frequency Response:
b) With a test signal of 100 IRE peak luminance at the input of each device.
c) - With a waveform monitor at the output of each device, the signal should not exceed 4% loss at 4.2MHz.
d) Check and Adjust Gain:
e) Use a test signal of 1V p-p, 75% color bars at the input of each device.
f) With a waveform monitor at the output of each device, adjust for unity gain
$\pm$0.5dB.
g) Check Noise Level:
h) With no signal at the input of each device, measure noise levels at the output(s) on a waveform monitor.
i) Noise voltage levels shall not exceed -55dB, that is 2.0mV p-p ref. 1.0V p-p.

END OF SECTION

Orange County, Florida,
Information Technology Standards

04/26/2018

Table of Contents

1.0 Introduction to Orange County IT Standards

This guide provides a framework for documenting policies, business processes, and internal controls used to effectively support the information technology (IT) resources of the government of Orange County, Florida, Board of County Commissioners (County). It explains the role of the County's Information Systems and Services (ISS) personnel in approving, ordering, delivering, and maintaining IT services and products (hardware, software, networks, security, and other IT components) for employees throughout the County. It identifies County-approved products and procedures for acquiring IT systems and services. This guide also establishes County IT standards for use by third-party vendors providing externally hosted systems to various County departments.

The goal of ISS is to build an efficient, effective, and cost-efficient operation with an excellent return on investment by delivering new technologies and a state-of-the-art network server infrastructure. ISS is dedicated to providing prompt problem resolution through the customer service of its Help Desk. ISS seeks to maintain a diverse computing environment designed to meet the requirements of all County departments, while minimizing the risk of data loss or downtime. All computer hardware and software must be approved by ISS prior to purchase.

The ISS Department is comprised of 160+ employees, who are committed to its customer relationship-building attitude. ISS provides a business approach to serving all County agencies, which together form a partnership with ISS personnel to enhance productivity and service to the community.

The following standards apply to any device approved for connection to the County IT network or in use by County employees:

- ISS personnel are responsible for ordering all new computers, software, servers, telephones, and mobile devices for use by County employees. Hardware and software orders arrive at the ISS Warehouse at 3517 Parkway Center Court, Orlando, FL 32808.
- Submit orders by opening a ticket to request the new equipment or software using the Service Center, New Problem/Request email address. Each department authorizes specific individuals, who are responsible for placing new equipment and software orders through ISS. The emails will include pertinent information about the requested item(s). If sufficient details are not included in the initial email request, ISS staff will reach out to gather necessary information for the order. A list of authorized new products for purchase begins on the following page.
- ISS Warehouse personnel are responsible for applying County asset inventory tags to computer components, as necessary, prior to installation of the equipment.
- ISS Support personnel will install all operating systems and software. At the time of installation, ISS Support personnel must receive a copy of all installation software, along with written installation instructions, and licensing documentation. ISS will not install software without proof of licensing.
- All installed computers must, at a minimum, have the following:
    - ISS-installed anti-virus software
    - Computer configuration policy control for group management of devices by Active Directory
    - Remote access only as designated by ISS (ISS prohibits the use of Virtual Network Computing [VNC] and Remote Desktop computing.)
    - ISS-approved remote monitoring and management tools
    - Only ISS personnel shall have administrative rights.
    - Hardware must be a standard supported model
- ISS Enterprise Security is responsible for ISS video service; however, deployment of video equipment on the local government network must be discussed with staff members of the Network Operations Center (NOC) prior to purchase to determine compatibility, bandwidth, network equipment requirements, and installation feasibility.
- Generally, ISS does not support multicast on the County networks, except in specific special cases.

2.0 Authorized Products for New Purchases

This section includes detailed information about products authorized for use with the County's IT Systems.

2.1 Authorized Hardware

Dell Desktop Computer

Dell OptiPlex 7050 Small Form Factor (SFF) (does **not** include monitor or external speakers)

- Intel Core Processor Options:
  - i5 or i7 Processor – SFF with Digital Versatile Disk/Rewritable (DVD+/-RW)
  - i5 Processor – Micro Form Factor without DVD+/-RW (for conference rooms only)
- Windows 10 Professional 64-bit
- 128 GB Solid State Drive (SSD) Hard Drive
- 8 GB Random Access Memory (RAM)
- Universal Serial Bus (USB) Keyboard and Mouse
- Optional built-in aircard
- Display Port to Digital Visual Interface (DVI) Adapter 6' Cable
- 3-Year basic parts warranty

Dell Precision CAD Workstation

Dell Precision T3420 SFF (does **not** include monitor or external speakers)

- Intel Core i7-6700
- Windows 10 Professional 64-bit
- 512 GB SSD Hard Drive
- 16 GB RAM
- NVIDIA Quadro K1200 4 GB, 4x Mini DisplayPort mDP) Low Profile Video Graphics Card
- USB Keyboard and Mouse
- Display Port to DVI Adapter 6' Cable
- 3-Year basic parts warranty

Dell Latitude Laptop

Dell Latitude 7490 Laptop (does **not** include Docking Station or Carrying Case)

- Intel Core i5-7300U
- Windows 10 Professional 64-bit
- 14" HD (1366x768) Non-Touch Anti-Glare LCD with Mic/without Camera
- 128 GB SSD Hard Drive
- 8 GB RAM (16GB Optional)
- **NO** DVD-ROM Drive
- Dell D6000 Docking Station (Optional Accessories. Must be explicitly requested)
- Internal aircard for cellular service built in (Optional)
- Absolute DDS Protection
- 3-Year basic parts warranty

Dell Windows Tablet

Dell Latitude 12 5285 Laptop

- Intel Core i5-7200U
- Windows 10 Professional 64-bit
- 12.3" 3:2 Touch (1920x1280) Screen
- 128 GB SSD Hard Drive
- 8 GB RAM
- AT&T LTE AirCard
- **NO** DVD-ROM Drive
- Absolute DDS Protection
- 3 Year ProSupport
- Travel Keyboard
- Stylus
- Dell D6000 Docking Station and Targus Rugged Case (Optional Accessories)

2.2 Authorized Software for Desktops and Laptops

- Microsoft Windows 10 Pro
- Internet Explorer 11 and Google Chrome (**Note:** Browser customizations are unsupported.)
- Microsoft Office 2016 Pro, Microsoft Office 2013 Pro
- All Microsoft Office applications on the same PC must have matching software versions (i.e., Project, Visio, Word, Power Point, Access, etc.).
- ISS Desktop Support must pre-approve any application requiring the use of Active X controls. At a minimum, the application must meet the following criteria:
  - It must be an .MSI file with silent installation/distribution from the command line.
  - It must install and operate without end-user administrator permissions.
- Java 1.8.25 – Only supported version of Java
- Silverlight – latest version
- The preference is hosted solutions not requiring installation of local software or configuration files.
- Bomgar or WebEx for remote access

2.3 Authorized Network Connectivity

- AT&T Wireless AirCards
- ShewSoft VPN Client
- Hosted applications must be accessible from devices with automatically assigned network settings. (Dynamic Host Configuration Protocol (DHCP) should supply all settings. Fixed addresses are not allowed.)

For all devices joined to our domain (this also applies to "**vendor supported**" devices and applications):

- ISS must install the Operating System and software on the device.
- ISS must receive a copy of all software and installation instructions.
- Hardware must be a standard supported model (see also hardware section, for example Optiplex 9020, 7040, 7050).
- Kace management client and Antivirus software must be installed.
- PGP is required on all laptops.

- The device must receive Windows updates and computer configuration changes via Active Directory policies.
- Only ISS personnel shall have administrative rights.
- VNC and Remote Desktop are not permitted.

2.4 Authorized Client Based Databases

- Oracle (network based database)
- SQL Server (network based database)

2.5 Authorized Mobile Devices

ISS personnel are responsible for placing orders for all new phones and mobile devices. Individual departments may purchase chargers, holsters, rugged cases, and other accessories, along with other office supplies.

Conventional Phones

Legacy phone with data & texting disabled

- Kyocera DuraXE
- Sonim XP5
- LG B470 Flip
- LG B471 Flip (No Camera)

Android Phones

County Android phones must run Android Version 6.0 or above.

- Samsung Galaxy S7
- Samsung Galaxy S7 Active (AT&T only)
- Samsung Galaxy S8
- Samsung Galaxy Tablet S2
- Samsung Galaxy Tablet S3

2.6 Authorized Peripherals and Accessories

Black and White LaserJet Printers

- HP LaserJet Pro 400 Printer M402n (500 to 2,000 pages per month) < 4 users
- HP LaserJet M506dn (5-10 people, 1,500 to 5,000 pages per month + secure printing)
- HP LaserJet M608dn (10-25 people, 5,000 to 16,000 pages/month + secure printing)

Color LaserJet Printers

- HP Color LaserJet Pro M452 (500-1,500 pages per month, small paper tray)
- HP Color Laserjet Enterprise M652dn (2,500 to 17,000 pages/month + secure printing)

HP Multi-Function Devices (MFD) (Print/Scan/Copy)

- HP MFP M426fdn (750 to 4,000 pages per month, B/W)
- HP color MFP M281fdw (1 or 2 people, occasional scanning)
- HP color MFP M477fdn (750 to 4,000 pages per month)
- HP color MFP M577dn (2,000 to 7,500 pages per month)

Scanners (all come with Adobe Acrobat and Automatic Document Feeders [ADF])

- Fujitsu ScanSnap iX500 (25 pages per minute [ppm], 50 sheet ADF, Connected via USB)
- Fujitsu N7100 (25 ppm, 50 sheet ADF, Networked)
- Fujitsu 5530C2 (50 ppm, 100 sheet ADF, Connected via USB)

Note: Printers must use Original Equipment Manufacturer (OEM) toner cartridges only.

Note: ISS must review and approve Desktop, Copier, and combo unit purchases used for printing from the PC. Contact *ServiceCenter@ocfl.net* for more information and assistance.

3.0 Unsupported Products

3.1 Unsupported Hardware

- Pentium dual-core and older desktop systems, Optiplex 755, 960, 990, 9010
- Latitude D-series Laptops, Latitude E6500, E6510, E6520, E6530, E65xx
- Non-Dell PCs
- Wireless keyboards and mice (except conference rooms)
- Desktops and Laptops over 5 years old
- See also *Section 3.4, Peripherals and Accessories*.

3.2 Unsupported Software

- MS Office platforms prior to Office 2013 (including Visio & Project)
- Non MS Windows-based operating systems
- Safari Web Browser
- MS Office plug-ins or VBScripts
- Windows Applications from the Windows App Store
- Freeware
- Windows XP, Windows 8, and Windows 8.1
- Freelance
- SHL Vision & Vision Express, WIN9x/WINNT/UNIX
- Reflections

3.3 Unsupported Client Databases

- No client-based databases are supported (e.g., Microsoft Access, Filemaker Pro)

3.4 Unsupported Peripherals and Accessories

- Inkjet printers
- Printers over 7 years old
- Scanning to multiple folders per device
- Address books in scanners/copiers (users manage their own)
- Personal (non-County) mass storage devices (hard drives, thumb drives, etc.)

4.0 Prohibited Products

4.1 Prohibited Hardware

- Non MS Windows-based PCs, laptops, and tablets
- Recycled, Remanufactured, and non-OEM toner Cartridges
- Refurbished PCs
- Personal (non-County) computing equipment
- Any network (voice or data) device not operated, administered, or expressly approved by ISS
- Any internet access device not operated, administered, or expressly approved by ISS
- Donated and vendor-provided PCs that do not meet County standards

4.2 Prohibited Software

Note: This list is not all inclusive of prohibited software. If you have questions concerning a specific application, please open a ticket or contact the Desktop Support Supervisor.

- Microsoft Internet Explorer version 10 and below
- Server software is not permitted on workstations (SQL server, print servers, web server, file sharing)
- Cloud-based collaborative software (data must be stored within our datacenter).
- Personal Software (purchased for non-commercial use)
- Firefox, Opera, Vivaldi Web Browsers
- Chrome extensions
- Any Alpha, Beta, Shareware, Trialware software not operated, administered or expressly approved by ISS and Purchasing.
- Anti-virus products not operated or administered by ISS
- Personal firewall products
- Network scanning tools
- Remote access software other than that ISS explicitly authorizes
- Desktop sharing, remote control, or remote communications software such as Remote Desktop
- Web page editing tools (without prior approval)
- Software coding tools (without prior approval)
- User installed screen savers
- Games
- Third Party Desktops
- Disk Compression
- Non-Static BITMAP Backgrounds or screen savers
- iTunes or other content sharing applications
- P2P software
- MS Access Run-time Libraries

4.3 Prohibited Network Protocols

- NETBUI
- AppleTalk
- Any network (voice or data) software or service not operated, administered or expressly approved by ISS.
- Any Internet access service not operated, administered, or expressly approved by ISS.

4.4 Prohibited Peripherals and Accessories

- Portable music devices
- Webcams
- Printer sharing through a PC
- Wireless printing

5.0 Standards for In-House Servers and Server Operating Systems

The following server standards apply to all servers on the Orange County network maintained by County ISS personnel:

- Only ISS personnel shall have administrative rights to server-class devices.
- All servers shall operate in a VMWare-based virtual environment. The ISS Infrastructure Manager must approve in writing any exceptions to this rule prior to project implementation.
- Any device that cannot run in a VMWare-based virtual environment ("stand-alone") must have hardware and software approved by ISS Infrastructure Manager prior to its connection to the County network.
- All servers will comply with ISS standard resource configurations. The ISS Infrastructure Manager must pre-approve any deviation from this standard and may incur additional costs.
- No server shall be configured as a 'file share'. File storage shall be NAS based.
- In addition to the requirements listed above, all stand-alone devices must, at a minimum, meet the following requirements:
    - Be installed at the County Data Center (RCC)
    - Be rack-mountable
    - Only run server-class operating systems
    - Be configured for out-of-band management and have remote monitoring software installed
    - Meet ISS minimum hardware requirements including, but not limited to:
        - Dual power supplies
        - Dual NIC's
        - Dual processors
        - Dual HBA's
        - Dual hard drives, redundant array of independent disks (RAID) configurable for boot drive
        - Use storage area network (SAN) for attached storage devices

The following lists the default standards used for specific server operating systems:

5.1 Microsoft Windows-Based Server Requirements

In no case shall an operating system be installed that is not under current manufacturer support (typically this is N-2 for Microsoft operating systems).

- The Boot partition "C Drive" shall be 40 GB (Thin Provisioned).
- The Data partition shall be 40GB to 100 GB (Thin Provisioned).
- 8 GB RAM
- The C: drive will contain only the operating systems. Databases must reside on separate servers from that of application or Web servers.
- Application, service, or vendor accounts will not be members of the domain administrator's group.
- Application, service, or vendor accounts will not be in the local administrator's group for any server.
- Applications must run as a service. ISS prohibits applications that require a user account to remain logged in.

5.2 Linux-Based Server Requirements

- RHEL 7 or greater, kernel 3.0 or greater, 64 bit architecture
- 40 GB Boot partition
- 4 GB memory
- Applications will **not**:
  - Have a web interface that allows users to access the system as a privileged account.
  - Run root processes.
  - Be installed in any file system that is part of root.
  - Write log files to any file system that is part of root.
  - Update root system's files during installation.
- Applications will be installed using a unique user ID and unique group ID.
- Purge application and system logs, as needed.
- Disable Telnet and the "r" commands on all UNIX servers.
- .rhost file is not available.

5.3 Oracle-Based Server Requirements

- County-supported Oracle versions are Oracle Enterprise Edition 10g or higher.
- County-supported environment for Oracle databases is Oracle Linux on an Oracle Exadata shared environment.
- Database setup shall be compliant with Oracle's Optimal Flexible Architecture (OFA) file naming conventions
- Applications must be installed under separate schema not requiring Database Administrator (DBA) privileges or DBA type privileges. Applications will not require or use the Linix Oracle account.
- Applications will provide a security module to manage user IDs and permissions.
- Application vendors shall provide all database creation scripts and any other required scripts to build, maintain, and support the database environment.
- Application vendors shall provide all documentation related to all database creation scripts and any other required scripts to build, maintain, and support the database environment.
- ISS personnel shall install databases using vendor provided scripts, initialization parameters, and any special performance related parameters.
- Oracle's Administrator (SYSADM) account must not be required for software to operate.
  NOTE: If SYSADM privileges are required for installation, a County Database Administrator shall perform the installation vendor supplied scripts under the application vendor's direction.

5.4 Microsoft SQL-Based Server Requirements

- Microsoft SQL Server versions are Server SQL 2012 Enterprise or higher.
- Database installations must be on a separate server from the application executables and support files. Database installations cannot be installed to the C: drive of the Windows Server. Applications will allow the ISS Database Administrator to specify the drives and directories where the database files will reside.
- MSDE, SQL Server Express, or MS Access based software are prohibited. Applications must support SQL Servers Integrated Security model.
- Applications must contain a security module to manage user ID's and permissions, with no blank or hard-coded passwords allowed.
- Server Administrator privileges are not permitted.

NOTE: If Server Administrator privileges are required for installation, an ISS Database Administrator shall perform the installation.

- ISS prohibits use of applications that create, update, or delete of any files on the database server outside the constructs of the database engine.
- ISS prohibits use of applications that create new databases or persistent database objects as part of its operation.
- Applications shall support application database backups/restores using the County's Enterprise Backup Tool. Currently, the County standard is CommVault's Galaxy iData-Agent for SQL Server.
- Applications must provide an audit mechanism to record the date, time, and user id that last modified a given row in an application table.
- Applications must utilize database referential integrity.

6.0 Network Systems Requirements

6.1 Protocol Node Names and Addresses

- The ONLY protocol allowed on the County Data Network is the Internet Protocol referred to as Internet Protocol (IP) or Transmission Control Protocol/Internet Protocol (TCP/IP) Version 4.
- There can be only one unique address for each node on the network. Node naming and addressing conventions will conform to the guidelines established here.
- The NOC assigns all addresses for all devices connecting to the County Network. All IP addresses must conform to R.F.C. 1918:

  10.0.0.0 - 10.255.255.255/8

  172.16.0.0 - 172.31.255.255/12

  192.168.0.0 - 192.168.255.255/16

- The NOC maintains an addressing plan and uses the plan to assign addresses. The Internet Addressing Authority, a private entity, assigned a block of addresses for the County. The NOC will maintain and assign these addresses, as needed.
- Use of Registered Internet addresses on the County network is not allowed.
- All network numbers for "special function" TCP/IP networks will be assigned by the NOC.
- No INTERNET connections are allowed from any node, modem, or communications device on the network without NOC and Enterprise Security approval.
- A network-wide, shared-use Internet connection is available to all entities.
- TCP/IP DOMAIN NAME SERVERS (DNS) are an alternative to local administration and maintenance of a "hosts" file. Any Divisions, Elected Officials, or agencies wishing to use the DNS may send a list of IP addresses to be included in the DNS to the ISS Service Center, (407-836-2929 or 6-2929), which will be routed to the NOC staff.
- Entities who have dedicated network staff and wish to be assigned their own IP address space will request the assignment from the NOC through the ISS Service Center, (407-836-2929 or 6-2929). These entities will provision their own DNS and be responsible for administration of their own IP address spaces (as assigned by the NOC for the agency to administer).
- Only routed networks with at least 254 IP nodes are eligible for this option. DHCP is provided by the NOC.
- No shared device (printer, server) may use a DHCP address. Static IP addresses are available in limited amounts on request.

6.2 Bridges, Routers, and Gateways

- Routers are required at points in the network where traffic control and/or broadcast domain segmentation needs exist.
- Routers are required on all Wide Area Network connections.
- Protocol conversion is not supported on this network, as one common protocol (TCP/IP) is standard for all nodes.

6.3 Network Security

- All default accounts on all processors connected to the network will either be disabled or have the default password changed. No accounts are allowed without passwords.
- The default "privileged password" on all network electronics will be changed.
- All dial-up access must be provided through secure access servers. No direct access via dial-up lines is allowed on any type of device, processor, terminal, server, or PC connected to the network.
- The NOC provides and maintains a secure access server for Dial-up use. Contact the ISS Service Center (407-836-2929 or 6-2929) for remote access authorization by the Enterprise Security Team.
- The requesting department will provide the hardware & software for the employee's home use, unless the employee provides their own.
- Vendor field service will have remote access through NOC provided access servers. VPN access is available for use.
- No entity on the network shall make any connection to the Internet, dial-up service, wireless provider, or wireless access-point without written permission from the ISS Enterprise Security Team and Network Operations.
- An Internet gateway is provided for all entities on the network to use.
- Any entity that directly connects their network to the Internet may not remain connected to the County network, due to security risks. If the Internet connected entity supplies, at their own expense, an acceptable Firewall between their networks and the County networks, the County network connection can resume via the Firewall provided.

Wireless Local Area Network (LAN) (Ethernet) Security

- All 802.11x wireless LANs must use a DOT1X supplicant for network admission control.
- All 802.11x clients must use VPN triple Data Encryption Standard (DES) or Advanced Encryption Standard (AES) encryption. Client authentication via RADIUS server is required. The RADIUS server is provided and administered by ISS Enterprise Security.
- All access points attached to the County network must be Lightweight Access Point (LWAP). (No stand-alone access points are permitted)

Wireless Wide Area Network (WAN) Security

- The County maintains a contract with a wireless provider. A gateway is available for connecting to the contracted wireless provider. The County prohibits access to the network using any other wireless provider.

6.4 Network Components

Transmission Media

- Fiber-optic, Category 5, 5e, and 6, and Category 3 Unshielded Twisted Pair (UTP), Shielded Twisted Pair (STP), and radio (802.11x) are all permitted for IP data communications in the network.

Transmission Methods

- Optical, metallic cable, leased data circuits (analog, digital), private (analog, digital), and wireless (802.11x) are all permitted for IP data communications in the network.

Supported LAN Types

- ETHERNET, 802.3, 10 BASE T, 100 BASE TX, 100 BASE FX, 1000 BASE xx (Gigabit), 802.11x (wireless Ethernet), 10 GIGABIT.
- Etherchannel: The only Etherchannel protocol supported by the County is 802.3ad Link Aggregation Control Protocol (LACP).

6.5 Network Circuits

- The NOC will design all WAN networks and, if required, procure leased data communications circuits from the Carrier.
- The NOC will act as the central point of contact between all entities using WAN circuits.
- The NOC will be notified by the affected entity and/or the ISS Service Center of service affecting WAN outages.
- The ISS Service Center (407-836-2929 or 6-2929) and the NOC will be responsible for coordinating successful repair of WAN circuits.
- The NOC will be responsible for ordering the disconnection and termination of leased data circuits upon notification by the customer.
- Critical LANs and/or WANs may be designed with duplicate, automatic, redundant circuits and electronics to provide automatic recovery of data communications.
- Circuits leased by any entity (other than the County) will be managed by that entity's technical staff.
- A Remote Site is available for recovery of certain critical applications and County networks in the event of a formally declared disaster. This site is located in Tallahassee at the Northwest Regional Data Center. (NWRDC). The NWRDC is permanently connected to the County networks, and is available and operational 24 x 7 x 365.

6.6 Network Installation

- In situations where installation of network equipment by one entity may affect customers from other entities, the installation will be jointly coordinated by representatives of the NOC and the other entities.
- The NOC will design and install all LAN and WAN networks, except in special circumstance.

6.7 Network Trouble Reporting

- Customers exclusively confined to applications delivered by networks supplied by the NOC will call or e-mail the ISS Service Center (407-836-2929 or 6-2929) to report trouble, request service, and get technical advice. The ISS Service Center will screen all calls, resolve any problems it is able to resolve with ISS Service Center staff, and refer unresolved network problems to the NOC.
- Customers exclusively confined to applications on networks supplied by other entities will call that entity's network staff to report trouble, request service, and get technical advice.
- Customers on a mix of processors and networks supplied by the NOC and other entity's processors and networks will call the ISS Service Center (407-836-2929 or 6-2929) to report trouble, request service, and get technical advice.
- The NOC employs a variety of network management and troubleshooting tools and systems. These network management systems are used by the NOC staff to test, troubleshoot, and diagnose all devices attached to the network.
- All LAN equipment attached to the network must support Simple Network Management Protocol (SNMP) and/or SNMP-2. Remote Monitoring (RMON) is also allowed, but not instead of SNMP. RMON is in addition to SNMP. Older equipment not supporting these standards will be phased out. The NOC is the only organization permitted to run SNMP on network equipment.
- Network problems that can be repaired by the NOC will be scheduled in a repair queue. Repair priority is based on the severity of the problem and quantity of customers affected.

- All devices attached to the network must have at least a minimum SNMP profile entered, consisting of the entity's name, address, and technical support staff phones number(s). This will assist NOC staff in locating the network on which the equipment is located, when troubleshooting.

6.8 Network Performance Management

- The NOC is responsible for monitoring all LAN and WAN performance. This includes all SNMP and RMON.
- Only NOC staff members are allowed to run SNMP/RMON on network devices.
- The NOC will redesign networks, which sustain traffic loads that adversely affect customer interactive response times and/or reliability.
- The NOC will assist other entities with managing the performance of their networks as requested.

6.9 Network Documentation

- Each entity on the network will provide the NOC with a current diagram of network topology, equipment location, and configuration (including building address and floor location).
- The NOC will provide a diagram of the network as well as tables and listings of all physical and logical components to any approved requesting entity.
- Each entity on the network will provide on-going, updated information to the NOC reflecting components, circuits, and logical changes.
- The NOC will add this information to its diagram and database, and will provide the revised network documents to all requesting entities.

7.0 IP Telephony Standards

- The definition of IP telephony is telephones and a Private Branch Exchange (PBX) with an integral Ethernet Network Information Card (NIC) using the Internet Protocol to communicate.
- All telecom related applications must be certified under the Avaya DevConnect program and compatible with the County's current level of Avaya Communications Manager for the appropriate site.
- The Telecom Unit must approve all peripheral applications, or software, prior to purchase.
- IP phones must derive their electrical power from the CAT-5e Ethernet cable. (POE type-1, 802.af standard)
- Ethernet switches in the closets will be used to provide in-line DC power through the CAT-5e patch panels.
- All Ethernet electronics used in this configuration will have a UPS attached.
- If the IP phone has a provision to connect the desktop PC into the same Ethernet as the phone, then the IP phone must use Ethernet switch technology. Use of a hub/repeater is not allowed.
- IP phones must operate in a separate subnet from the attached PC.
- IP phone packets will be given the highest priority of all IP communications traffic on the LAN. Other non-telephony applications will have their "IP Precedence" bit modified at the Ethernet switch to conform to this standard.
- IP phone access to the network through the internet provider will use the ISS provided VPN services.
- Direct access to internal devices is prohibited.

8.0 Externally-Hosted System Standards

This information is for all vendors, networks, systems, and applications that will transmit, process, store, or handle electronic data provided by County.

8.1 Data Input and Processing

- Any use of Social Security Number information shall adhere to and abide by Florida Statutes, specifically F.S. 119.071, which provides detailed guidelines on usage of Social Security Numbers.
- The hosted application shall not have access to Social Security information.
- The hosted application shall not have access to data containing bank information.
- The hosted application shall not have nor be granted direct or indirect access to the County's Active Directory user names.
- The hosted application shall not have access to the County's internal or DMZ networks.

8.2 Data Storage and Handling

- The provider shall encrypt any data accessible from the hosted application meeting the following criteria at rest and in transit:
  - Names
  - Addresses
  - Phone numbers
  - Email addresses
  - Birth dates
  - Federal/state/local documents numbers
  - Account numbers
  - Race or religious information
  - User names
  - Passwords
  - Employee identification numbers
  - All Health Insurance Portability and Accountability Act (HIPAA) information
  - All Purchase Card Industry Data Security Standards (PCI DSS) information
- Any data, accessible from the hosted application or directly accessible from it, should be encrypted.

8.3 Transmission of Data

An encrypted tunnel must be used to transmit any data referenced above.

8.4 Disposal of Data

When no longer needed, or when data must be removed from the system, it shall be sanitized and disposed of using one of the methods listed below:

- **Sanitization** – Overwriting data previously stored on a disk or drive with a random pattern of meaningless information
- **Destruction** – Physically damaging a medium, so that it is not usable by any device that may normally be used to read information on the media, such as a computer, tape reader, audio or video player
- **Purging Data** – Using a strong magnetic device, such as a degausser, to render data unrecoverable

8.5 External Audits

- The vendor must ensure that the web hosting environment and application is secure using IT security best practices.
- The external service, system, and application must pass a yearly penetration test performed by ISS personnel.

9.0 Data Center Standards

In addition to standards outlined in *5.0, Standards for In-House Servers and Server Operating Systems*, the following requirements apply to hardware installed in an Orange County Data Center, such as, network switches, appliances, servers, storage arrays, etc. These requirements apply to orders placed by Orange County personnel, vendor special orders, and orders placed by RCC tenants:

- Standard rack configuration is 42U
- PDU orders need network monitoring (smart PDU) for rack
- Mounting hardware for racks should be included in order
- Dual power supplies for all equipment
- Dual NIC cards for any hardware needing to connect to network

10.0 Acronyms

ADF	Automatic Document Feeder
County	Government of Orange County, Florida, Board of County Commissioners
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DVI	Digital Visual Interface
DVD+/-RW	Digital Versatile Disk-Rewritable
GB	gigabyte
ISS	Orange County Information Systems and Services
IP	Internet Protocol
IT	Information Technology
NOC	Network Operations Center
OEM	Original Equipment Manufacturer
ppm	Pages per minute
RAM	Random Access Memory
RMON	Remote Monitoring
SAN	Storage area network
SNMP	Simple Network Management Protocol
SSD	Solid State Drive
SFF	Small Form Factor
TCP/IP	Transmission Control Protocol/Internet Protocol
USB	Universal Serial Bus
WAN	Wide Area Network
VNC	Virtual Network Computing
VPN	Virtual Private Network