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SECTION 010100 - SUMMARY OF WORK

PART 1 – GENERAL

1.1 CONTRACT DOCUMENTS

A. The Contract Documents include the Drawings as enumerated on the Title Drawing, the general provisions of Contract, including General and Supplemental Conditions, and the provisions of this Project Manual and Addenda as a whole represent and describe the work and requirements of the Project.

1.2 GENERAL REQUIREMENTS

Attention is directed to the general and supplementary conditions and Division 1 including all sub-divisions therein attached in this document and drawings, which are made a part of this section.

1.3 SUBSTANTIAL COMPLETION

A. The Date of Substantial Completion shall be April 1, 2025 for Contract work.

1. The Date of Substantial Completion shall remain the same, as stated above, regardless of any alternate(s) chosen to be included in the Contract by the Owner.

B. The Contractor shall obtain a Certificate of Substantial Completion from the Architect on or before the Date of Substantial Completion.

1.4 PROJECT DESCRIPTION

A. **DCU Arena Sound System Replacement**

1. The project scope generally consists of the replacement of the existing arena bowl sound system, including rigging and motors, speakers, wiring, amplifier, power supplies and all related and required electrical equipment as described in this project's drawings and specifications, to provide a modern arena sound system suitable for a civic arena. The contractor will be required to coordinate their work and the work of all their sub-contractors and suppliers with blackout dates to accommodate events produced by ASM Global, the facility operator.

B. A qualified electrical contractor shall be the prime contractor for the Work to be performed.

C. For the Work of this project, the electrical contractor and the general contractor shall be assumed to be the same entity.

D. The Work of this project also includes the requirements in the Contract, the Sub-Contract(s), Sections 0 and Division 1 Sections, in their entirety.

RELATED WORK UNDER OTHER CONTRACTS

A. Work by other contractors, which will be under separate contract, may take place during the work of this contract adjacent to and within work areas of this site.

B. Cooperate fully with other contractors so that work under those contracts may be carried out smoothly, without interfering with or delaying work under this contract.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies; perform demolition work in accordance with applicable rules, regulations, codes, and ordinances of local, state and federal authorities.

B. Obtain and pay for necessary building permits, licenses and certificates and give notices as required during the performance of the Work.

C. Provide electronic files and if required, 4 copies, of shop drawings and literature for Architects review and approval for the items referenced in the specifications.

D. Provide schedule and work plan within one week of the contract signing.

E. Attend weekly meetings (or as scheduled) with the Architect and Owner's Representative as scheduled.

F. Provide all Closeout documents including, final acceptance, warranties, guaranties and bonds as hard copies and digitally.

1.6 RELATED WORK UNDER OTHER CONTRACTS

A. Work by other contractors, which will be under separate contract, may take place during the work of this contract adjacent to and within work areas of this site. This work, under other contract, shall be coordinated between the different General Contractors.

B. Cooperate fully with separate contractors so that work under those contracts may be carried out smoothly, without interfering with or delaying work under this contract.

1.7 WORK SEQUENCE SCHEDULING AND COORDINATION

A. The Work shall be sequenced, scheduled, and coordinated to achieve the Date of Substantial Completion.

   1. All deliveries must be scheduled at a minimum of 48-hours in advance with the Architect and Owner.

B. The General Contractor and each Sub-Contractor shall establish and increase or decrease as appropriate the workforce, days of work, number of shifts, work hours, materials, tools and equipment needed to maintain and achieve the Date of Substantial Completion.

C. The General Contractor and each Sub-Contractor shall increase the workforce, days of work, number of shifts, work hours, materials, tools, and equipment needed to maintain the Date of Substantial Completion as necessary to accommodate any

additional work authorized by Construction Change Directives and Change Orders modifications.

D. General Contractor will be responsible for the proper conduct of the work to ensure that all trades work together, and in harmony, to achieve substantial and final completion as specified.

1.8 WORK HOURS

A. Normal working hours are to be Monday thru Friday from 7:00 AM to 3:30 PM, except Legal Holidays. Any working hours outside of these times shall be considered “Extended Hours” and treated as described below.

Conduct Work during daylight hours on Monday through Friday, and within the time between 6:00 a.m. and 10:00 p.m. No work is to be done on outside of the work hours described above without prior approval by the Owner. Building will be occupied during the project. Coordinate schedule and areas of work with the arena operator (ASM Global). Work to be conducted outside the workdays and hours described above must be approved by the Owner with a minimum of 48-hour notice. No equipment or machinery may be started at the sites before 7:00 a.m. and all equipment must be shut off by 10:00 p.m.

The Contractor may request to work other than the work hours specified. However, approval to work other than normal hours is at the sole discretion of the Owner. If allowed, the Contractor shall be responsible for reimbursing the Owner for any expenses resulting from working outside of hours.

B. Extended work hours shall require prior scheduling and coordination with the Architect and Owner at a minimum of 48-hours in advance. At any time, if the project related activities are deemed to disrupt the enjoyment and use of abutting areas within the building, the contractor will stop that portion of the work causing such disruption, when requested by the owner's representative or delegated representative onsite. Such work will then be rescheduled to occur when the owner deems such work will not create the same disruption."

C. Any project related activities may not interfere with the enjoyment and use of abutting areas within the building or adjacent properties during any normal or extended work hours. At any time, if the project related activities are deemed to disrupt the enjoyment and use of abutting areas within the building, the contractor will stop that portion of the work causing such disruption, when requested by the owner's representative or delegated representative on-site. Such work will then be rescheduled to occur when the owner deems such work will not create the same disruption.

D.

1.9 CONTRACTOR USE OF THE PREMISES

A. General Contractor shall have use of the site from date of contract to the Date of Substantial Completion as described above in the Work Hours paragraph.

B. Construction vehicle access and deliveries to the project shall be made during working hours.

C. All contractor personnel shall enter and exit the construction area through DCU Center Door 4A.

D. Do not close or obstruct the loading docks, driveways or sidewalks without the proper permit. Conduct operations with minimum traffic interference.

E. The General Contractor shall also be responsible for returning the public areas adjacent to each work area back to the original condition it was in prior to their work starting. This shall be done prior to finishing the work in that area.

F. There will be no washing or washing out of any vehicles at the project site. The contractor shall make necessary provisions to accommodate this work off site.

G. All cleaning and wash-down of tools and/or equipment shall be performed in areas designated only by the Architect. This will be strictly enforced.

1.10 CONTRACTOR USE OF CITY STREETS

A. The General Contractor's personnel, and all other personnel employed by the project, shall limit their parking on the site. Parking within the Arena area, during work, is acceptable, providing it does not interfere with the safety of the contractor's and owner's personnel or adversely affect the facility. No idling of vehicles within the facility is allowed. Additional parking can be found, as legally allowed within the City limits or the adjacent Major Taylor Parking Garage, at the contractor's expense. As events and access allow, the ASM Global management company may offer additional parking within the facility.

B. Driveway entrances, walks, and yards to abutting properties shall be kept unobstructed at all times.

1.11 WORK CONDITIONS

C. Neither the General Contractor, nor Sub-Contractors at any level, nor their employees shall bring illegal substances or alcoholic beverages on the premises.

D. Vulgar, abusive, obscene language or behavior will not be tolerated.

E. Contractor's personnel engaging in the above shall be removed from the job-site.

F. Radios or any type of “music” broadcasting systems are not allowed.

G. This site is smoke-free; therefore smoking is prohibited within the site limits.

1.12 PROJECT MANAGER, SUPERINTENDENTS, FIELD ENGINEER AND FOREMAN

A. The General Contractor shall provide a qualified General Superintendent, who shall be present, full time, on site daily during all work in progress until the Date of Substantial Completion, and for such additional time thereafter as the Architect may determine. Only under extenuating circumstances, with the approval of the Architect and Owner, will the

Contractor be allowed to substitute for the General Superintendent prior to the date of Final Completion.

B. The General Superintendent shall supervise and direct the activities of other superintendents and foremen on site. He shall not perform the work of foremen, tradesmen, or home office staff.

C. Each subcontractor shall provide a Lead Foreman, responsible to be on site full time during the workday.

D. Each foreman, in addition to his regular duties shall be responsible for establishing, maintaining, and providing record drawings, which are required to be updated prior to submitting the current period's draft Application for Payment.

E. The General Superintendent and Lead Foreman shall not be discharged or changed without prior written consent of the Architect, which will not be unreasonably withheld. The Architect will require that all as-built information be updated and current prior to granting consent.

1.13 DAILY REPORTS AND WEEKLY OUTLINE SCHEDULE

A. The General Superintendent shall provide a "Daily Report" to the Owner containing the following:

1. Name and manpower of each Contractor and Sub Contractor.
2. Equipment used.
3. Delivery of products received on site.
4. Weather conditions at start and end of each day and any significant changes or events during the day.
5. Significant problems, hazards or accidental injury occurring during each shift.
6. Summary of progress made each day.

B. A photocopy may be made of the same "Daily Report," containing the information above, that is used by the General Superintendent. The General Superintendent may obscure confidential portions of his "Daily Report" if desired. Reports are due the following day.

C. The Superintendent shall provide the Owner a written “Two Week (look ahead) Outline Schedule” of work activities planned for each week. The “Two Week Outline Schedule” may be a simple listing of each trade’s activities delineating areas where work is to be scheduled. Note any significant milestones.

1.14 CERTIFICATE OF SUBSTANTIAL COMPLETION

A. The Architect shall issue a Certificate of Substantial Completion for the work when and if all of the following conditions have been met:

1. The work is sufficiently complete to allow the Owner beneficial use of the premises. The work remaining to be done is not a danger to the proposed occupants and is of a minor nature.

2. The work is sufficiently complete that the Architect may make affidavits to the Building Official as required by Controlled Construction provisions of the Building Code.

6. The Building Official has issued a Certificate of Occupancy without restrictions or conditions relating to the contractor's work.

1.15 CITY OF WORCESTER ORDINANCES, LICENSES, PERMITS, AND FEES

A. All Contractors shall comply with City Ordinances which may affect the work of this contract and which have not been previously covered in the Contract Documents. Requirements and fees listed are those in effect as of this writing and each Contractor shall be responsible for verifying the requirements and fee cost as currently in effect and throughout the duration of this project. This includes, but is not limited to, the following:

Worcester Police Department:

Police Details
Hourly rate for one-half day or full day.
Permits for Sunday and Holiday work
Fee Required.

Department of Inspectional Services

Building Permit
Orders of Building Official under Chapter 1, 780 CMR.
Ticket violation under Chapter 33, 780 CMR.

Trash Control
Ticket for Violations

Environmental Control
Air, Water, Noise Pollution - Ticket for Violations
Conservation Commission Enforcement Officer

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 012000 - PROJECT MEETINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, are hereby made a part of this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for project meetings, including, but not limited to, the following:

1. Pre-Construction Conference.
2. Pre-Installation Conference.
3. Weekly Progress Meetings.
4. Coordination Meetings.
5. Project Closeout Conference.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section 01 2900 “Payment Procedures” for procedures on submitting requisitions.
2. Division 1 Section 01 3100 “Project Management and Coordination” for procedures for coordinating project meetings with other construction activities.
3. Division 1 Section 01 3300 “Submittal Procedures” for submitting the Contractor's Construction Schedule.
4. Division 1 Section 01 7700 “Closeout Procedures” for procedures and issues surrounding Project Completion.

1.3 PRE-CONSTRUCTION CONFERENCE

A. Schedule a pre-construction conference before starting construction, immediately after execution of the Agreement. Conference is to be held at the Project Site, or other agreed upon location, at a time convenient to both the Owner and Architect. Conduct the meeting to review responsibilities and personnel assignments. Submit agenda to Architect and Owner three (3) days prior to meeting date.

B. Attendees: Authorized representatives of the Owner, Architect, and their consultants; the Contractor and its superintendent; major subcontractors; manufacturers; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Discuss items of significance that could affect progress, including the following:

1. Introduction of All Project Members.
2. Distribution of Contract Documents.
3. Procedures Outlined for Contract Compliance Issues.
4. Tentative Construction Schedule; Making Notes of Critical Dates.
5. Critical Work Sequencing.
6. Pre-Installation Conferences.
7. Work Hours.
8. Use of the Premises.
9. Deliveries.
10. Security Procedures.
11. Parking and Site Access Issues.
12. Office, Work, and Storage Areas.
13. Housekeeping & Cleaning of Construction Areas.
14. Safety Procedures.
15. First Aid.
16. Procedures for Creating Monthly Cash Flow/Schedule.
17. Procedures for processing Draft Application for Payment Periodic Submittals Certification Statement.
18. Procedures for processing Applications for Payment.
19. Procedures for the submission of up-dated as-built drawings for any concealed work, showing locations and sizes, with all applications for payment.
20. Procedures for RFI's, SI's, RFP's, COP's, CCD's, CO's, etc…
21. Procedures for Keeping Logs on RFI's, SI's, RFP's, COP's, CCD's, CO's, etc…
22. Project Coordination Procedures & Drawings.
23. Project Meetings & Meeting Minutes.
24. Quality Control, Inspections, and Testing.
25. Temporary Facilities.
26. Preparation of Project Closeout Documents.

D. The Contractor shall record and promptly distribute minutes of this meeting to all project members (in attendance or not), including the Architect and Owner, and as additionally directed by the Architect.

1. Meeting Minutes shall be in a standard type-written format to remain consistent for every project meeting and include, but not limited to, the following items:

    a. Detailed notes from all discussions of project business items in chronological order.
    b. Updated Project Contractor, Subcontractor, Vendor List.
    c. Updated Construction Schedule.

1.4 PRE-INSTALLATION CONFERENCES

A. Conduct a pre-installation conference at the Project Site before each construction activity that requires coordination with other construction.

B. Attendees: The Installer and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with

other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Architect of scheduled meeting dates.

1. Review the progress of other construction activities and preparations for the particular activity under consideration at each pre-installation conference, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related Change Orders.
    d. Purchases.
    e. Deliveries.
    f. Shop Drawings, Product Data, and quality-control samples.
    g. Review of mockups or finish samples.
    h. Possible conflicts.
    i. Compatibility problems.
    j. Time schedules.
    k. Weather limitations.
    l. Manufacturer's recommendations.
    m. Warranty requirements.
    n. Compatibility of materials.
    o. Acceptability of substrates.
    p. Temporary facilities.
    q. Existing Occupancies.
    r. Space and access limitations.
    s. Governing regulations.
    t. Safety.
    u. Inspecting and testing requirements.
    v. Required performance results.
    w. Recording requirements.
    x. Protection.

2. The Contractor shall record significant discussions and agreements and disagreements of each conference, and the approved schedule. The Contractor shall promptly distribute the record of the meeting to everyone concerned, including the Owner and the Architect.

3. Do not proceed with the installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.

1.5 PROGRESS MEETINGS

A. Conduct progress meetings at the Project Site bi-weekly. Notify the Owner and the Architect of scheduled meeting dates. Coordinate dates of meetings with preparation of the payment request. General Contractor to record minutes of all meetings.

B. Attendees: In addition to representatives of the Owner and the Architect, each subcontractor, supplier, or other entity concerned with current progress or involved in

planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.

C. Agenda: Review and correct or approve minutes of the previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to the status of the Project.

1. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time or ahead or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to insure that current and subsequent activities will be completed within the Contract Time.

2. Review the present and future needs of each entity present, including the following:

   a. Time & Project Progress.
   b. Work Hours.
   c. Updated Weekly Look-Ahead Schedule.
   d. Critical Work Sequencing.
   e. Off-Site Fabrication Problems.
   f. Deliveries.
   g. Use of the Premises.
   h. Security Procedures.
   i. Parking Issues.
   j. Office, Work, and Storage Areas.
   k. Housekeeping & Cleaning of Construction Areas.
   l. Safety Procedures.
   m. First Aid.
   n. Draft Application for Payment Periodic Submittals Certification Statement (At Appropriately Timed Meeting Each Month).
   o. Updated Submittal, RFI, SI, RFP, COP, CCD, and CO Logs.
   p. New Submittals, RFI’s, SI’s, RFP’s, COP’s, CCD’s, CO’s, etc…
   q. Any Project Coordination Issues or Drawings.
   r. Quality Control, Inspections, and Testing.
   s. Temporary Facilities.
   t. Preparation of Project Closeout Documents.

3. The Contractor shall record and promptly distribute minutes of this meeting to all project members (in attendance or not), including the Architect and Owner, and as additionally directed by the Architect.

   a. Meeting Minutes shall be in a standard type-written format to remain consistent for every project meeting and include, but not limited to, the following items:

      (i) Detailed notes from all discussions of project business items in chronological order.

(ii) Updated Project Contractor, Subcontractor, Vendor List.
(iii) Updated Construction Schedule.
(iv) Updated Weekly Look-Ahead Schedule.
(v) Updated Submittal, RFI, SI, RFP, COP, CCD, and CO Logs.

1.6 COORDINATION MEETINGS

A. Conduct coordination meetings with all trades convenient for all parties involved. In addition conduct coordination meetings when requested by the Architect or Clerk of Works.

1.7 TIME OF PROGRESS AND COORDINATION MEETINGS

A. Conduct both meetings weekly on a day agreeable to all parties, at a designated location at the site, or other agreed upon location.

1.8 PROJECT CLOSEOUT CONFERENCE

A. The Project Close-Out Conference shall be conducted at a time convenient for all parties involved prior to Substantial Completion. Refer to Section 01700 – Project Closeout for additional information for requirements.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 013100 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, are hereby made a part of this Section.

1.2 SUMMARY

A. This Section specifies administrative and supervisory requirements necessary for project coordination including, but not limited to the following:

1. General installation provisions.
2. Administrative and supervisory personnel.
3. Cleaning and protection.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Project meetings, coordination meetings, and pre-installation conferences are included in Section “Project Meetings.”
2. Requirements for preparing and submitting the Contractor's Construction Schedule are included in Section “Submittals.”

1.3 COORDINATION

A. Coordinate construction operations included in various Sections of these Specifications to assure efficient and orderly installation of each part of the Work. Coordinate construction operations included under different Sections of the specifications that depend on each other for proper installation, connection, and operation.

1. Where installation of one part of the Work depends on installation of other components, either before or after its own installation, schedule construction operations in the sequence required to obtain the best results.
2. Where availability of space is limited coordinate installation of different components to assure maximum accessibility for required maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.
4. The General Contractor shall as part of his work provide for all cutting, patching and drilling, not specified to be the work of others.

B. Where necessary, prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and attendance at meetings.

1. Prepare similar memoranda for the Owner and separate contractors where coordination of their work is required.

C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and assure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of schedules.
2. Installation and removal of temporary facilities.
3. Delivery and processing of submittals.
4. Progress meetings.
5. Project closeout activities.

D. Conservation: Coordinate construction operations to assure that operations are carried out with consideration given to conservation of energy, water, and materials.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare coordination Drawings where careful coordination is needed for installation of products and materials fabricated by separate entities. Prepare coordination drawings where limited space availability necessitates maximum utilization of space for efficient installation of different components.

1. Indicate required installation sequences.
2. Format to be as directed by the Architect.

B. Staff Names: Within fifteen (15) days of commencement of construction operations, submit a list of the Contractor's principal staff assignments, including the superintendent and other personnel in attendance at the Project Site. Identify individuals and their duties and responsibilities. List their addresses and telephone numbers. Provide twenty-four (24) hour Emergency telephone numbers listed separately.

1. Post copies of the list in the Project meeting room, ~~the temporary field office~~, and each temporary telephone.
2. The Contractor shall provide a copy of the list, and updates as its changes, to the Worcester Police Department and other City Departments as directed by the Architect.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION PROVISIONS

A. Inspection of Conditions: Require the Installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected in an acceptable manner.

B. Manufacturer's Instructions: Comply with manufacturer's written instructions and recommendations, to the extent that those instructions and recommendations are more explicit or stringent the requirements contained in Contract Documents.

C. Inspect materials or equipment immediately upon delivery and again prior to installation. Reject damaged and defective items.

D. Provide attachment and connection devices and methods necessary for securing Work. Secure Work true to line and level. Allow for expansion and building movement.

E. Visual Effects: Provide uniform joint widths in exposed Work. Arrange joints in exposed Work to obtain the best visual effect. Refer questionable choices to the Architect for final decision.

F. Re-check measurements and dimensions, before starting each installation.

G. Install each component during weather conditions that will ensure the best possible results. Isolate each part of the completed construction from incompatible material as necessary to prevent deterioration.

H. Coordinate temporary enclosures with required inspections and tests, to minimize the necessity of uncovering completed construction for that purpose.

I. Mounting Heights: Where mounting heights are not indicated, install individual components at standard mounting heights recognized within the industry for the particular application indicated. Refer questionable mounting height decision to the Architect for final decision.

3.2 CLEANING AND PROTECTION

A. During handling and installation clean and protect construction in progress and adjoining materials in place. Apply protective covering where required and as necessary to assure protection from damage or deterioration.

B. Clean and maintain all completed construction as frequently as necessary through the remainder of the construction period.

C. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in-progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period. Where applicable, such exposures include, but are not limited to, the following:

1. Excessive vibration.
2. Excessive static or dynamic loading.
3. Excessive internal or external pressures.
4. Excessively high or low temperatures.
5. Thermal shock.
6. Excessively high or low humidity.
7. Air contamination or pollution.

8. Air borne debris/dust or construction particulates.
9. Water or ice.
10. Solvents.
11. Chemicals.
12. Light.
13. Puncture.
14. Abrasion.
15. Heavy traffic.
16. Soiling, staining, and corrosion.
17. Bacteria.
18. Rodent and insect infestation.
19. Combustion.
20. Electrical current.
21. High-speed operation.
22. Improper lubrication.
23. Unusual wear or other misuse.
24. Contact between incompatible materials.
25. Destructive testing.
26. Misalignment.
27. Excessive weathering.
28. Unprotected storage.
29. Improper shipping or handling.
30. Theft.
31. Vandalism.

END OF SECTION 01 3100

SECTION 014200 - REFERENCES

Commented [JS1]: No changes required for this section

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, are hereby made part of this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. Indicated: The term indicated refers to graphic representations, notes, or schedules on the Drawings, or other Paragraphs or Schedules in the Specifications, and similar requirements in the Contract Documents. Terms such as shown, noted, scheduled, and specified are used to help the reader locate the reference. There is no limitation on location.

C. Directed: Terms such as directed, requested, authorized, selected, approved, required, and permitted mean directed by the Architect, requested by the Architect, and similar phrases.

D. Approved: The term approved, when used in conjunction with the Architect's action on the Contractor's submittals, applications, and requests, is limited to the Architect's duties and responsibilities as stated in the Conditions of the Contract.

E. Regulations: The term regulations includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

F. Furnish: The term furnish means supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations to the location within the project where the product will finally be installed.

G. Install: The term install describes operations at the Project site including the actual unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. Provide: The term provide means to furnish and install, complete and ready for the intended use.

I. Installer: An Installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.

1. The term experienced, when used with the term Installer, means having a minimum of five (5) previous projects similar in size and scope to this Project, being familiar with the special requirements indicated, and having complied with requirements of the authority having jurisdiction.
2. Trades: Using terms such as carpentry is not intended to 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 tradespersons of the corresponding generic name.
3. Assigning Specialists: Certain Sections of the Specifications require that specific construction activities shall be performed by specialists who are recognized experts in those operations. The specialists must be engaged for those activities, and their assignments are requirements over which the Contractor has no choice or option. However, the ultimate responsibility for fulfilling Contract requirements remains with the Contractor.

    a. This requirement shall not be interpreted to conflict with enforcing building codes and similar regulations governing the Work. It is also not intended to interfere with local trade union jurisdictional settlements and similar conventions.

J. Project site is the space available to the Contractor for performing construction activities either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is located.

K. Testing Agencies: A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's 16 Division format and MASTERFORMAT numbering system.

B. Specification Content: This Specification uses certain conventions regarding the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words that are implied, but not stated, shall be interpolated, as the sense requires. Singular words will be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.
2. Imperative and streamlined language is used generally in the Specifications. Requirements expressed in the imperative mood are to be performed by the

Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor, or by others when so noted.

a. The words "shall be" are implied wherever a colon (:) is used within a sentence or phrase.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with the standards in effect as of the date of the Contract Documents.

C. Conflicting Requirements: Where compliance with two (2) or more standards is specified and where the standards may establish different or conflicting requirements for minimum quantities or quality levels, refer requirements that are different but apparently equal and other uncertainties to the Architect for a decision before proceeding.

1. 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 the requirements. Refer uncertainties to the Architect for a decision before proceeding.

D. Copies of Standards: Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, the Contractor shall obtain copies directly from the publication source.

E. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the Text provision. Refer to the "Encyclopedia of Associations", published by Gale Research Co., available in most libraries.

1.5 GOVERNING REGULATIONS AND AUTHORITIES

A. Copies of Regulations: Obtain copies of governing regulations and retain at the Project site to be available for reference by parties who have a reasonable need, if requested by the Architect.

1.6 SUBMITTALS

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

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, are hereby made a part of this Section.

1.2 SUMMARY

A. This Section specifies requirements for temporary services and facilities, including utilities, construction and support facilities, security and protection.

B. Temporary construction and support facilities required include, but are not limited to:

1. Waste disposal services.
2. Temporary yard and storage on and off-site.
3. Construction aids and miscellaneous services and facilities.
4. Sweeping compound.
5. Emergency portable generators of size required, if permanent power is temporarily unavailable.
6. Water service and distribution, if water supply to adjacent occupied spaces is temporarily unavailable.
7. Parking

C. Security and protection facilities required include, but are not limited to:

1. Temporary weather protection, enclosures, and covers.
2. Temporary fire protection and fire watch if required by Worcester Fire Department.
3. Barricades, warning signs, lights.
4. Temporary partitions between occupied areas and construction areas, STC 48 or better.

D. Where a distinction is made in this specification section between temporary services to be provided by a General Contractor and those to be provided by a Subcontractor, the purpose is only to clarify which costs are to be included by the applicable parties for inclusion in the applicable bids and contracts that would follow. These distinctions have no bearing upon the Contract between the Owner and General Contractor and do not limit in any way the General Contractor's responsibility to provide all such temporary services without additional cost to the Owner. For the sake of clarity in this specification section, the term General Contractor has been used for the person called the Contractor in other specification sections, when the intent is that that person shall provide a service directly at his own expense rather than at the expense of one of the Subcontractors from whom the Owner has taken filed sub-bids.

E. The temporary services describes in this specification section may not be adequate to provide for all of the needs of the General Contractor or all Subcontractors, but are intended only to provide a basis for obtaining filed sub-bids. The General Contractor

or any Subcontractor requiring additional temporary services for the proper execution of his work or because of climatic conditions shall arrange for and obtain such services at his own expense without further compensation by the Owner.

F. The Contractor shall be responsible for restoring all landscaped areas affected by the work of this project to their original “like-new” state that existed prior to work commencing. This restoration work shall include, but not be limited to, planting beds with mulch, trees, shrubs, and lawn areas. Great care should be taken during the course of the work to not damage nor destroy any landscaping impacted by this work. Any landscaping disturbed, damaged, or destroyed shall be restored, repaired, or replaced in-kind at no cost to the Owner.

1.3 SUBMITTALS

A. Schedule: Submit a schedule indicating implementation and termination of each temporary utility within fifteen (15) days of date established for Commencement of the Work.

1.4 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:

1. Commonwealth of Massachusetts State Building Code requirements; 9th Edition.
2. Federal, State and City Health and safety regulations.
3. Utility company regulations.
4. Police, Fire Department and Rescue Squad rules.
5. Environmental protection regulations.

B. Standards: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:

1. NFPA Code 241.
2. NFPA 70.
3. ANSI A10.
4. NECA NJG-6.

C. Electric Service: Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70.

D. Inspections: Arrange for authorities having jurisdiction to inspect and test temporary utilities prior to use. Obtain required certifications and permits.

PROJECT CONDITIONS

Commented [JS1]: Not needed

E. Conditions of Use: Maintain temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload temporary facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous, unsanitary conditions, or public nuisances to develop or persist on the site.

F. Maintain the continuity of all utility services at all times across all Phases of the Construction Project, unless otherwise directed by the Architect or Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials suitable for the use intended, must not create unsafe conditions, and must not violate requirements of applicable codes and standards.

2.2 TEMPORARY WATER

A. Definitions:
   1. Water Access Point: A point, within the Project area, at which water is available during construction.

B. Charges: The General Contractor shall pay for all facilities to provide water during construction, while the Owner will supply and pay for water during the construction. The General Contractors shall pay for backflow preventer if utilizing Owners Hydrant for water.

   1. The furnishing of water by the Owner shall be conditional upon all contractors being conservative and prudent in its use. In the event of any contractor is repeatedly wasteful in the use of water thus provided, the Owner reserves the right to charge the General Contractor for wasteful usage at an equitable rate for the additional portion of water used.

C. Temporary Water: The General Contractor shall be responsible for all facilities to provide water during construction as defined above and further specified as follows:

   1. Except under unusual circumstances, when otherwise specified or approved by the Architect, all water shall be of potable quality.
   2. The General Contractor shall provide all necessary piping, valving, hose bibbs, hosing, etc. to provide temporary water during construction from a water access point determined by the Owner's Representative. Any facilities running within the building are required not to leak. Any damage incurred due to leaks shall be repaired at the expense of the General Contractor.
   3. The General Contractor shall pay for and be responsible for the protection of Temporary Water, which he installs, from freezing and other damage.

2.3 TEMPORARY HEAT

A. Definitions:

B. Charges:
   1. The furnishing of electrical energy by the Owner shall be conditional upon being conservative and prudent in its use. In the event that any contractor is repeatedly wasteful in the use of electrical energy thus provided, the Owner reserves the right to charge the General Contractor at an equitable rate for the additional portion of electrical energy used.

Commented [JS2]: Not needed - assume building operator will maintain temp

2.4 TEMPORARY SANITARY FACILTIES

Commented [JS3]: Assume contractor can use arena power and lighting

   a. Contractor Personnel may use the building's toilet facilities as approved by the building operator and Owner.

Commented [JS4]: Instead of porta-potti's let contractor use public restrooms somewhere in building?

Commented [JS5]: This should not be necessary

2.5 TEMPORARY FIRE PROTECTION

A. The General Contractor shall take all necessary precautions for the prevention of fire during construction. He shall be responsible that the area within the contract limits is kept orderly and clean and that combustible rubbish is promptly removed from the site. Combustible materials shall be stored on site in a manner and at locations approved by the Architect. The General Contractor shall comply with all suggestions regarding fire protection made by the Insurance Company with which the Owner maintains his fire insurance.

B. The General Contractor shall provide and maintain in good working order, under all conditions, readily available to all portions of the site and work, suitable and adequate fire protection equipment and services. Such facilities shall include, but are not limited to, the furnishing and maintaining in good working order a minimum of two (2) standard, Underwriters' Laboratories labeled, 2-1/2 gallon capacity fire extinguishers per floor.

C. Smoking shall be prohibited on the premises and signs to this effect shall be posted conspicuously.

D. Fires shall not be built on the premises.

2.6 TEMPORARY CRANES, LIFTS, DERRICKS, AND HOISTING SERVICES

Commented [JS6]: Might need, so keep

A. The General Contractor shall furnish, install, operate, and maintain in safe condition all crane services outside of the building for his own use and for the use of all Subcontractors on the project to properly carry out and complete the work, except as may otherwise be specifically provided for in any of the trade sections of the Specifications.

B. All crane services shall be provided at no cost to the Subcontractors for their work.

C. Each Subcontractor shall, however, provide their own lifts, derricks, hoisting services, etc. (excluding crane services outside the building) for their own work outside and inside the building to properly complete their work.

D. All cranes, lifts, derricks, and hoisting equipment, machinery, and operation shall comply in all respects to the governing laws and codes.

Commented [JS7]: Doubtful if any of these are required

2.7 TEMPORARY STORAGE FACILITIES

A. Space for storage of materials shall be confined to the construction areas outside the building and as designated and/or approved by the Architect, Owner or Building Operator.

B. Locations where construction equipment may be stored during non-working hours shall be as acceptable to the Owner. Construction equipment shall not present a hazard when stored.

2.8 NOISE, DUST, AND POLLUTION CONTROL

A. All work performed under the Contract shall conform to the requirements of Chapter III, Section 31C and Section 142D of the General Laws, Commonwealth of Massachusetts and Rules and Regulations adopted thereto by the Commonwealth of Massachusetts, Department of Public Health, and the requirements of local noise, dust, and pollution control laws, ordinances, and regulative agencies applicable to the work.

B. The General Contractor shall provide temporary partitions to prevent noise, dust, pollution or order from entering occupied spaces. Temporary partitions shall have STC of 50. Submit location plan and type of construction for temporary partitions for approval.

C. Control of air borne dust or pollution from the site with spray or as otherwise may be necessary to prevent the migration of any dust or pollutants.

D. Dust Control: Use water mist, temporary enclosures, and other suitable methods to limit spread of dust and dirt. Comply with governing environmental protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, or pollution.
2. Vacuum equipment shall be equipped with HEPA filters.
3. Vacuum carpeted areas.
4. Wet mop floors to eliminate trackable dirt.
5. Sweeping shall be allowed only with the use of a non-oil based sweeping compound followed by vacuuming any remaining residue.
6. Wipe down walls and doors of demolition enclosure.

E. Disposal: Remove and transport debris, in a manner that will prevent spillage on adjacent surfaces and areas, to the construction dumpster(s).

F. Cleaning: Clean areas adjacent to the work area of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

2.9 WATER CONTROL

A. The General Contractor shall be responsible for site drainage and snow removal within the limit-of-work lines and shall maintain such drainage and removal during the life of the Contract in a manner approved by the Owner and Architect, and so as not to adversely affect the adjacent areas.

B. Water from the Work of this Project shall be disposed of in such a manner as not to be a threat to public health nor cause damage to public or private property. It shall not be disposed of over surfaces of roads, walks, and streets, nor be permitted to cause any interference with the normal use of the same.

C. Removal of snow and ice from within the limit-of-work lines at the site as required to maintain the continual progress of the work, including that required to keep work areas, access roads, and storage areas clear, free, and in use, and as required to prevent damage to existing construction and new work in places.

2.10 CONSTRUCTION CLEANING AND CONSTRUCTION DUMPSTERS

A. The General Contractor shall provide and pay for temporary dumpster type trash containers outside the building for use by all Subcontractors, and shall have the containers replaced, hauled away, and the contents legally disposed of at sufficient intervals to maintain them at all times in sufficiently empty condition that they are ready to receive trash and debris.

B. Recycle all cardboard, paper, and metal materials to the greatest degree possible. Provide separate trash receptacles as required.

Commented [LJA8]: (a)Can we add?

C. All construction dumpsters shall be located in the parking lot within the construction staging area and where permitted by the Owner.

D. Each Contractor on the project shall be responsible for removing their own trash and debris from the building to the construction dumpster(s).

E. Waste materials and rubbish, which might otherwise raise dust, shall be sprinkled during handling and loading to minimize this effect. Debris shall be carried out of the structure in containers or dropped in fully enclosed chutes and shall not be passed through, or thrown from, windows or other wall openings, and in no case shall the debris or trash be permitted to drop freely from the openings.

F. The Work Areas shall be inspected daily and all debris, waste, rubbish, etc. shall be removed and placed in a dumpster.

G. All waste materials and rubbish shall be disposed of legally, off the site.

Commented [JS9]: Hopefully not required

2.11 WATCHMEN, FLAGMEN, AND POLICE DETAILS

A. The General Contractor shall provide the services of flagmen, traffic directors, and police details as necessary and as required by authorities having jurisdiction. Please refer to Section 01 0100 – Summary of Work for additional information regarding the police details and the appropriate pay rates.

2.12 PARKING

A. Limited parking will be permitted on site and only as approved by the owner and as stipulated in Section 01 0100 1.8 Work Hours.

2.20 COVID-19 SAFETY GUIDELINES AND PROCEDURES

A. Contractor must abide by all state and federal requirements related to COVID-19, including cleaning and sanitizing the site, providing hand-washing stations for workers, checking the temperature of workers and visitors to the site, and frequent onsite inspections. COVID-19 Order No. 13, Enforcement of the COVID-19 Safety Guidelines and Procedures for Construction Sites, and Addendum 1 Limiting Exposures and Worker Infection Protocol documents are included as attachments to this Section 01 5000.

PART 3 - EXECUTION

3.1 OPERATION, TERMINATION AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Limit availability of temporary facilities to essential and intended uses to minimize waste and abuse.

B. Maintenance: Maintain facilities in good operating condition, until removal. Protect from damage. If damage occurs, repair immediately upon discovery. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour per day basis.

C. Termination and Removal: Unless the Architect requests that it be maintained longer, remove each temporary facility when the need has ended. Clean and renovate permanent facilities that have been used during construction period, including:

1. Replace air filters and clean inside of ductwork and housings.
2. Replace worn parts.
3. Replace lamps.

END OF SECTION

SECTION 017700 – CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections are hereby made a part of this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:

1. Inspection procedures.
2. Contractor's monetized punchlist.
3. Project Record Document Submittal.
4. Project Closeout Manual Submittal.
5. Final cleaning.

B. Closeout requirements for specific construction activities are included in the appropriate Sections in Divisions 2 through 16.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request for which the architect shall review and/or approve.

1. The contractor shall prepare and submit a monetized punchlist. No exceptions will be considered.
2. In the Application for Payment that coincides with, or first allows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.

    a. If 100 percent completion cannot be shown, the contractor shall provide his monetized punchlist including, but not limited to, the following:

        1) A list of incomplete items.
        2) The value of each incomplete item.
        3) A Reason each item is not complete.

3. Advise the Owner of pending insurance changeover requirements.
4. Submit application for reduction of retainage.
5. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents, as further described below.

6. Obtain and submit releases enabling the Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
7. Submit record drawings, maintenance manuals, damage or settlement surveys, and similar final record information, as further described below.
8. Deliver tools, spare parts, extra stock, and similar items.
9. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
10. Complete startup testing of systems and instruction of the Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the site, along with mockups, construction tools, and similar elements.
11. Complete final cleanup requirements, including touch-up painting.
12. Touch-up and otherwise repair and restore, marred, exposed finishes.

B. Inspection Procedures: On receipt of a request for inspection, the Architect will either proceed with inspection or advise the Contractor of unfilled requirements. The Architect will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.

1. The Architect will repeat inspection when requested and assured that the Work has been substantially completed.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 FINAL ACCEPTANCE

A. Preliminary procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the Architect's final inspection list of items to be completed or corrected, endorsed and dated by the Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Architect.
4. Submit consent to surety of final payment.
5. Submit a final liquidated damages settlement statement.
6. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Re-inspection Procedure: The Architect will re-inspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Architect.

1. Upon completion of re-inspection, the Architect will prepare a certificate of final acceptance. If the Work is incomplete, the Architect will advise the Contractor of Work that is incomplete or of obligations that have not been fulfilled, but are required for final acceptance.
2. If necessary, re-inspection will be repeated.

1.5 RECORD DOCUMENTS

A. General: Maintain a complete set of Record Documents at the site. Do not use Record Documents for construction purposes. Provide access to Record Documents for Architect and Owner's reference. Generally, without limitation, Record Documents shall include the following and can be electronic, in PDF format. Submit one hard copy with the electronic copy:

1. Record Drawings: Maintain a clean set of Contract Drawings and shop drawings, updated weekly to show actual installation. Give particular attention to concealed items.
2. Record Project Manual: Maintain a clean Project Manual, including Addenda, Change Orders, Architect Field Orders, and other modifications, updated weekly to show changes in actual work performed. Give particular attention to substitutions, selection of options, and similar information.
3. Record Product Data: Maintain one copy of each approved Product Data submittal, updated weekly to show changes from products delivered, work performed, and from manufacturer's recommended installation instructions.
4. Record Samples: Maintain one copy of each approved Sample submitted.
5. Record Field Test Reports: Maintain one copy of each Field Test Report.
6. Daily Progress Reports: Maintain one copy of each Daily Progress Report.

B. Maintenance of Documents and Samples: Store documents and samples in Contractor's field office apart from documents used for construction. Provide files and racks for document storage. Provide locked cabinet or secure storage space for storage of samples. File documents and samples in accordance with CSI format. Maintain documents in clean, dry, legible condition and in good order. Do not use Record Documents for construction purposes. Make documents and samples available at all times for inspection by Architect.

C. Recording: Label each document "PROJECT RECORD" in neat large printed letters. Record all information concurrently with the progress of construction. Do not conceal any work until required information is recorded.

D. Drawings: Legibly update all Drawings to record actual construction, including the following:

1. Field changes of dimension and detail.
2. Changes made by Field Order or Change Order.
3. Details not in original Contract Documents.

E. Specifications and Addenda: Legibly mark each Section to record:

1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
2. Changes made by Field Order or by Change Order.

F. Submittal: At Contract Closeout, deliver Record Documents to Architect. Accompany submittal with transmittal letter in duplicate, indicating the date, Project title and number, Contractor's name and address, title and number of Record Document, and signature of Contractor or his authorized representative. This submittal can be electronic, in PDF format. Submit one hard copy with the electronic copy:

G.

1.6 PROJECT CLOSEOUT MANUAL

A. General: Prepare and submit Project Closeout Manual as specified in this Section and as approved by the Architect for format. Organize data into suitable sets, bound and indexed using the specification's Table of Contents as a guide. Mark appropriate identification on front and spine of each binder. Can be electronic, in PDF format. Submit one hard copy with the electronic copy:

B. Include the following types of information:

1. Contact Persons' Names
2. Telephone Numbers
3. Pager or Beeper Numbers
4. Cellular Phone Numbers
5. Description of each warranty items covered.
6. Instructions Describing Protocol for Requesting Warranty Service.
7. Emergency Numbers – 911, Fire, Rescue, Police.
8. Utility Company Contacts.

C. Instruct Owner's personnel in use and layout of manual.

D. Format of Data: Prepare data in form of user's guide-type manual for use by Owner's personnel. Format shall be 8-1/2 in. x 11 in., 20-pound minimum, white, typed pages. Text shall be printed or neatly typewritten. Drawings shall be bound with text, with reinforced punched binder tabs. Fold larger drawings to size of text pages. Provide flyleaf for each separate section. Provide typed descriptions of each product and piece of major equipment. Provide indexed tabs to divide sections. Provide reference in each section to other binders for actual Operating and Maintenance Data. Coordinate Project Closeout Manual with Operating and Maintenance Data. Submit only one hard of each Binder required and electronic versions in .PDF format

1. Binders: Provide commercial quality three-ring binders with durable and cleanable plastic covers, with maximum ring size of three (3) inches. Only use one (1) binder for this manual.
2. Binder Cover: Identify each volume with typed or printed title "PROJECT CLOSEOUT MANUAL". List title of Project, identity of separate structure as applicable, and identity of general subject matter covered in the manual.

E. Submittal of Project Closeout Manual: Submit o copies of preliminary draft of proposed formats and outlines of contents prior to start of Work.

1. Architect will review draft and return one copy with comments.
2. Submit one copy of complete data in final form 15 days prior to final inspection or acceptance. Copy will be returned after final inspection or acceptance, with comments.
3. Submit three copies of approved data in final form ten days after final inspection or acceptance.

1.7 OPERATING AND MAINTENANCE DATA

A. General: Prepare and submit Operating and Maintenance Data as specified in this Section and referenced in other pertinent Sections of Specifications. Organize Operating and Maintenance Data into suitable sets, bound and indexed. Mark appropriate identification on front and spine of each binder. Submit only one hard of each Binder required and electronic versions in .PDF format

B. Include the following types of information:

1. Emergency instructions.
2. Spare parts list.
3. Copies of warranties.
4. Wiring diagrams.
5. Inspection procedures.

C. Instruct Owner's personnel in maintenance of products and in operation of equipment and systems.

D. Preparation of data shall be done by personnel trained and experienced in maintenance and operation of described products.

E. Format of Data: Prepare data in form of instructional manual for use by Owner's personnel. Format shall be 8-1/2 in. x 11 in., 20-pound minimum, white, typed pages. Text shall be manufacturer's printed data, or neatly typewritten. Drawings shall be bound with text, with reinforced punched binder tabs. Fold larger drawings to size of text pages. Provide flyleaf for each separate product or each piece of operating equipment. Provide typed description of product and major component parts of equipment. Provide indexed tabs. Submit only one hard copy of each Binder required and electronic versions in .PDF format

1. Binders: Provide commercial quality three-ring binders with durable and cleanable plastic covers, with maximum ring size of two (2) inches. When multiple binders are used, correlate the data into related consistent groupings.
2. Binder Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". List title of Project, identity of separate structure as applicable, and identity of general subject matter covered in the manual.

F. Content of Manual: Neatly typewritten table of contents for each volume, arranged in systematic order, indicating Contractor name and address, and a list of each product, indexed to content of the volume. Provide a separate list with each product, name, address, and telephone number of subcontractor or installer, and local source of supply for parts and replacement.

G. Provide in each volume a copy of each warranty, bond, and service contract issued.

H. Submittal of Maintenance and Operating Manual: Submit one hard of each required and electronic versions in .PDF format of preliminary draft of proposed formats and outlines of contents prior to start of Work.

I. Architect will review draft and return one electronic version with comments.

J. Submit one copy of complete data in final form 15 days prior to final inspection or acceptance. Copy will be returned after final inspection or acceptance, with comments.to be electronic versions in .PDF format

K. Submit one hard copy and one electronic .PDF of approved data in final form ten days after final inspection or acceptance.

1.8 INSTRUCTION OF OWNER'S PERSONNEL

A. Prior to final inspection or acceptance, fully instruct Owner's designated operating and maintenance personnel in the operation, adjustment and maintenance of products, equipment and systems.

B. Operating and maintenance manual shall constitute the basis of instruction.

1. Review contents of manual with personnel in full detail to explain all aspects of operation and maintenance.

1.9 WARRANTIES AND BONDS

A. General: Assemble warranties, bonds, and service and maintenance contracts, executed by each of the respective manufacturers, suppliers, and subcontractors into the Project Closeout Manual.

B. Refer to Section 01 7400 – Warranties and Bonds for additional requirements.

1.10 FINAL CLEANING

A. General: General cleaning during construction operations is specified as Work of Section 01 5000 – Temporary Facilities & Controls.

B. Employ experienced workers or professional cleaners for Final Cleaning. Clean each surface to the condition expected in a normal building cleaning and

maintenance program. Comply with manufacturer's instructions and recommendations.

PART 2 - PRODUCTS

2.1 CLEANING MATERIALS

A. General: Provide cleaning materials that will not create hazards to health nor property, and will not damage surfaces or finishes.
B. Use cleaning materials and methods recommended by manufacturer of surface to be cleaned.
C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. Employ skilled workers for final cleaning.

B. Clean and restore general work areas and adjoining surfaces and other work soiled or damaged during installation; replace work damaged beyond successful restoration. Where performance of subsequent work could result in damage to complete unit or element, provide protective covering and other provisions to minimize potential for damage.

C. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from sight-exposed interior and exterior surfaces.

D. Special Cleaning for Windows: New glass installed as part of this project shall be thoroughly cleaned inside and out by professional window cleaners at the conclusion of all other work and prior substantial completion. All damaged, broken, or scratched items shall be replaced without costs to Owner, as described under the appropriate Trade Section(s).

E. Complete the following cleaning operations prior to requesting inspection for Certification of Substantial Completion:

1. Concrete and masonry shall be cleaned free of all foreign matter. If, in opinion of the Architect, further cleaning of specific areas is required they shall be scrubbed with water or other cleaning agents. Acid cleaners shall not be used, except as may otherwise specifically be permitted in the trade sections.
2. Metal surfaces, hardware, fixtures, appliances, equipment, and similar items shall be cleaned free of all foreign matter and, if necessary, shall be lightly scrubbed at specific stains with clean water, mild soap, and soft rags, thoroughly rinsed and wiped with clean, soft white rags. Abrasive cleaners shall not be used.

3. Architectural woodwork shall be thoroughly dusted and cleaned of all stains, spots, etc., using methods and cleaning agents, which will not damage the various finishes.
4. Ceramic tile, porcelain, and other surfaces with integral finishes, shall be washed with clean water, mild soap and soft rags, thoroughly rinsed, and then wiped with clean, soft white rags. Abrasive cleaners shall not be used.
5. Resilient flooring shall be given final cleaning and buffing.
6. Carpeting shall be vacuum cleaned and shall have all spots and stains removed.
7. Painted surfaces shall be cleaned free of all foreign matter, and if necessary, shall be lightly scrubbed at specific stains with clean water, mild soap, and soft rags, thoroughly rinsed, and wiped with clean, soft white rags.
8. All advertising matter and temporary instructional material shall be removed from exposed surfaces throughout.
9. Remove labels that are not permanent.
10. Clean interior and exterior finishes to a clean, dust-free condition. Remove stains, films, and similar foreign substances.
11. Vacuum and mop hard floor surfaces.
12. Clean plumbing fixtures to a sanitary condition.
13. Clean site areas of rubbish, litter, and other foreign substances.
14. Sweep paved areas broom clean; rake ground surfaces clean.

F. Before final completion and Owner-occupancy, inspect sight-exposed interior and exterior surfaces and work areas to verify that Work is clean.

END OF SECTION

SECTION 11 61 33 - ARENA RIGGING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Integrated Arena Rigging Systems and Equipment as part of the Work.

1.2 SECTION INCLUDES

A. Project instruction for the Contractor, and Arena Rigging System description details

B. Arena Rigging System Product description

C. Project completion instruction for the Contractor

1.3 RESPONSIBILITY

A. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Contractor to supply all materials, equipment, transportation, and labor necessary to provide a fully working, tested, and calibrated Arena Rigging System. Supply accessories and minor equipment items (such as, but not limited to: power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Owner of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.

B. This is a renovation project. Computer based CAD drawings are very limited and available for only the main and section plans with significant level of detail variations on each and as such the documents may not depict every detail or existing condition needed to complete this work. The Contractor is responsible for reviewing all existing site conditions that may affect the installation of this work with any exclusions clearly noted within RFP response. If a specific task implied or described within the drawings and specifications is not listed as excluded, it is assumed to be included and to be provided as part of this work.

C. As a renovation project, existing conditions both physical and related to electronic systems, are present. Reasonable effort to identify conditions prior to bid is expected. Notify Owner immediately of any items or issues discovered during construction which prevent or obstruct progress or completion of scope. Provide a solution or remedy to the issue with a rough order of magnitude cost for workable solution.

D. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Contractor to supply all materials, equipment, transportation, engineering, and labor necessary to provide a fully working, tested, and calibrated system. Supply accessories and equipment (such as, but not limited to: power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.

E. Specifications and drawings are complementary. Work called for by one is binding as if called for by both. Any discrepancies between specifications and drawings shall be brought to the attention of the Owner for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Owner.

F. Execute all work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code, the Occupational Safety and Health Act (OSHA) and all applicable State and Local codes, ordinances, and regulations. If a conflict develops between the contract documents and the appropriate codes and is reported to the Owner prior to bid opening, the Owner will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform Work.

G. Development of final design drawings. Submission to the Owner and structural Engineer of Record for approval.

H. Submission of all information required by public agencies.

I. Registered Engineers' stamp/certification on structural and electrical drawings and calculations as required.

J. Coordination with other contractors and trades.

K. Required licenses, insurance, and permits including payment of charges and fees.

L. Verification of dimensions, load capacities, and conditions at the job site.

M. Preparation of submittal information.

N. Pick-up of Owner Furnished Equipment (OFE) and incorporation into project if applicable.

O. Development and implementation of control system software code and control panel layouts, which will become the property of the Owner.

P. Installation in accordance with the contract document, manufacturer's recommendation, and in conformity with applicable codes and authority having jurisdiction (AHJ).

Q. Touch up and repair of welds, paint, and finishes where work attaches to existing structure or penetrates through architectural features.

R. Final tests and adjustments, written report, and documentation.

S. Instruction of operating personnel.

T. Provision of manuals.

U. Maintenance services and warranty.

1.4 RELATED WORK

A. Electrical
   1. Power is provided for this work at locations shown in the project drawings. The Contractor shall be responsible for breaker panel and distribution of electrical power from the panel to the equipment as required.
   2. A ground point will be provided in each equipment room or enclosure electrical panel. The contractor shall be responsible for connecting ground point to all equipment in accordance with NEC Code, local codes, and standards specified herein.
   3. Conduit infrastructure system, including wire for AC Power and grounding for the Arena Rigging System are provided by the contractor. Coordination between different disciplines is required to achieve a proper conduit system installation and power provisions for the Arena Rigging System. All electrical installation shall be in accordance with division 26 and the National Electric Code.

B. Conduit and Cable Management
   1. Install control cables in conduit provided as shown on the Electrical and AV drawings. If additional conduit/raceway/tray is required for systems, provide at no additional cost.
   2. Conduit/raceway/tray/wire management not shown on these drawings but required for a complete system or by code is to be included in this scope of work.

3. Cabling exposed to public view is to be in conduit. Exterior junction boxes, conduit/raceway, terminations, etc. and those within enclosures where enclosures are exposed to outdoor conditions are to meet NEMA ratings for outdoor electrical applications.

C. Structural
1. The contractor shall be responsible for design and structural engineering for all loudspeaker brackets attaching the loudspeakers (and/or loudspeaker hoisting system) to the building structure at position shown within the drawings. Coordinate weight loads with the Owner's on-staff Structural Engineer.

D. Networks
1. Ensure that the configuration of the control networks are secure, and that all reasonable measures are taken to prohibit unauthorized access to the control features of the Arena Rigging System.
2. Coordinate with the data network installer and in-house IT department to establish non-conflicting IP addresses for all of the control system equipment.

E. Demolition
1. Remove all existing loudspeaker hanging frames, hoists, hoist control, hoist control cabling, hoist system power, and support structure at high steel.
2. Palletize all removed equipment.
3. Coordinate disposal with Owner.

1.5 REFERENCES

A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
1. American National Safety Institute (ANSI)
2. American Society of Testing and Materials (ASTM)
3. Electronics Industries Association (EIA)
4. Federal Communications Commission (FCC)
5. National Electrical Manufacturer's Association (NEMA)
6. National Electrical Code (NEC)
7. Underwriters Laboratories (UL)
8. Occupational Safety and Health Administration (OSHA)
9. Society of Motion Picture and Television Engineers (SMPTE)
10. Building Industry Consulting Service International (BICSI)
11. German Code of Practice VPLT SR3.0

1.6 DEFINITIONS

A. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:
1. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.
2. Install: To set in place, join, attach, link, set up, or otherwise connect and test until complete before turning over to the Owner. All parts, items, or equipment supplied by Contractor.
3. Provide: To furnish and install.
4. The systems shall be called the "Arena Rigging Systems" and the installer the "Arena Rigging System Installer."

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

A. The following is intended to provide an overview of the required work details, system features, and design concepts for the Work as shown on the project drawings and is not intended to be an exhaustive description of the systems.

B. The Work includes provision of a complete and working Arena Rigging System, providing programmed control of the hoist system for the loudspeaker arrays.

C. The Arena Rigging System shall include:
1. Hoists
2. Programmable control system for the hoists
3. Cable management system
4. Loudspeaker Hanging Frames as defined in Section 27 41 16 and shown in AV drawings
5. All hardware and accessories
6. All electrical power and control distribution components
7. Structural steel changes and additions above lower chord steel.

D. Loudspeaker Hoisting System
1. Provide loudspeaker Hoisting System as a turnkey design-build element.
2. Engineer and provide complete system using two chain hoists for each array for holding at the operating position, raising arrays above the bottom chord of steel, and lowering to an elevation accessible from the arena floor for inspection and service.
3. Provide structural engineering shop drawings and calculations for the rigging as it relates to the structure.
4. Provide installation of the loudspeaker rigging attachment points and any additional support structure required. Coordination will be required between the rigging contractor, the sound system contractor, and their structural engineer regarding the array weight and positions for these attachment points at structure.
5. Provide a separate set of attachment points at the structure and at the rigging frame to allow for dead hang cables in order to facilitate the replacement of chain hoists without lowering the cluster to the floor.
6. Electric Chain Hoists:
    a. Hoists are to be mounted at the structure with the chain extended down to the array rigging frame.
    b. Provide chain bag for at each motor able to contain the entire length of chain.
    c. Chain Hoists are to be entertainment industry standard D8+ chain hoists with 10:1 design safety factor and rated for suspending equipment overhead.
    d. Hoists to have overload protection: rated operational range between 125 and 150/160%.
    e. Hoists shall have a clutch outside the load path that functions when disconnected from power.
    f. Meets or Exceeds International Standards.
    g. Duty Cycle: H-4 duty rated for heavy duty application. 2M+ FEM class. 50% Duty Cycle or 300 on/off per hour
    h. Hoist to meet or exceed German Code of Practice VPLT SR3.0
7. Hoist Chain Bags shall be:
    a. Intended for permanent installations and have a steel frame opening.
    b. Include dual stitched seams and reinforced nylon strapping.
    c. flame retardant.
    d. provided with a safety cable to prevent an incident if the chain bag bracket fails.
    e. Hoists shall be rigged to designated points from supplemental structure spanning existing roof joists. Coordination is required to ensure that supplemental supports and pad-eyes, or other termination hardware, are located accurately based on the final design conditions. All design work shall be verified by the Structural Engineer of record.
    f. Provide beam clamps and other associated permanently mounted hardware to support the top chain termination and hoist mount at the truss.
    g. Provide hoist motors with limit switches to stop operation at the extreme extents of travel.

E. Hoisting Control

1. The system shall provide separate modes of control for either group or individual components using the same operating system. This allows each hoist to be moved individually or in a group mode where all the hoists are linked.
2. Components shall be self-leveling with auto stops that are preprogrammed as soft limits.
3. The system shall use a touch screen. The operator can choose between components to control and select from predetermined soft limits.
4. The touch screen control shall have access to the PLC system over dedicated cabling, or a Local Area Network provided as part of this work.
5. Three access points for controller shall be provided in key areas to allow the control device to be utilized within sight of the hoists being operated.
6. Each hoist in the system shall be monitored for position and movement.
7. The system shall have a monitored E-stop system and will shut down power to all hoists in all components upon activation. Reset shall be allowed only at the power cabinet location.
8. The system Power and Control Cabinets shall be designed to provide distribution and operating commands to all hoists in each component. Whenever a component is deselected from operation, power will be removed from all hoists in that component. Each control cabinet shall have local access for a manual remote station allowing override and standard analog operation of the system.
9. Provide all electrical power, control distribution, and enclosures required to house components associated with the controls.
10. Cable Management
    a. Design and provide a cable management system to serve power and control wiring for each hoist and for each loudspeaker array.
    b. Cable management shall incorporate suitable strain relief and guide to prevent cable damage during both hoist operation and static conditions.
    c. Cables shall gather on the hanging frame in durable basket or other suitable enclosure. Chain runner systems that allow cables to festoon adjacent to the lift chain are also acceptable.

1.8 SUBMITTALS

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.

B. Submittals shall contain sufficient information to describe the Work to be performed. Reviewed shop drawings are to be used for final coordination and construction.

C. Shop drawings must be original work produced by the Contractor responsible for performing the work defined in this specification. Scanning, photographic copying, materially copying, or any other reproducing the contents of the drawings or specifications contained within the Contract Documents will be marked as unacceptable and not reviewed for any content. No claim shall be made for delay, undue burden, or additional costs for the effort to produce shop drawings, schedules, and equipment lists addressing this specification or the overall project manual.

D. Supplementary submittal requirements:
    1. Provide the following in one submission for approval within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of Work:
        a. Complete schedule of submittals.
        b. Chronological schedule of Work in bar chart form.
        c. Product Data Sheets:
            1) Submissions that do not follow the format and configuration described will be returned without review.
            2) Provide a complete table of contents with the following information:
            3) Project title.

4) Submittal number. In the case of a resubmittal, use the original submittal number immediately followed by the suffix “R” immediately followed by a unique number and be numbered in consecutive order.
5) Date of submission.
6) Provide a list of and Manufacturer's data sheets on products to be incorporated with the Work. Arrange data sheets in the same order they appear in this specification. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.
7) Submit manufacturer’s product literature for each type of firestop material to be used. Literature shall include documentation of UL classifications or approved third party testing. Manufacturer’s name and number for each part shall be included. Submit drawings of through penetrations, which include the system to be utilized for the firestopping application. Drawing shall indicate construction of wall or floor assembly; size, number and material of penetrating items; firestop system designation; required F-rating, T-rating and remarks.
8) Provide high quality copies with all text legible and illustrations of adequate resolution and sharpness for review. Internet web pages, faxed copies or copies with portions of the information missing or smeared not acceptable.

d. Shop Drawings:
1) Functional Diagrams/Schematics:
2) Detailed wiring diagrams showing interconnection of components and products, wiring and cabling diagrams depicting cable types and cable designators, and device designators. Provide connector designations and terminal strip identification, along with color codes for cables connecting to these devices. Give each component a unique designator and use this designator consistently throughout the project.

e. Coordination Drawings:
1) Prepare and submit a set of coordination drawings showing major elements, components, and devices of the AV Systemin relationship with other building components. Prepare drawings to an accurate scale of 1/8” =1’-0” or larger on suitable sized media.
2) Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all equipment. Indicate locations where space is limited, and where sequencing and coordination of installations is of importance to the efficient flow of the work including but not necessarily limited to the following:
i) Equipment housings
ii) Ceiling and wall mounted devices
iii) Raceways
iv) Cabling

f. Equipment housing: Location of equipment in racks, consoles position on tables or counters. Details to include dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations.

g. Patch panel layouts and labeling strips, including color schemes.

h. Full fabrication details of custom enclosure and millwork indicating size, material, finish, and openings required for equipment and enclosures.

i. Structural rigging and mounting details:
1) Loudspeaker rigging, suspension, and mounting detail drawings shall be signed and sealed by a professional engineer licensed to practice in the state in which the project is located. The signed and sealed drawings noted above to include the following:
2) Analysis of all components in the load path and attachment method to building structure for suspended loudspeakers.

3) Attachment method for mounting brackets at ceilings, walls, or other building features.
4) Detail the product manufacturer, part numbers, and load capacity of the hardware fittings and materials selected for suspended or mounted loudspeakers.
5) A copy of the design calculations.
6) Secondary steel required for attachment to the building structure.
7) Custom brackets, mounts, suspension grids or trusses, loudspeaker cabinet frames, or loudspeaker brackets.
8) Loudspeaker brackets or mounts provided by the specific loudspeaker manufacturer being installed that do not include traceability data.
9) Risk analysis data as referenced in Part 3.2, F
10) Stamping Engineer post-installation sign-off as described in Part 3.2, F
11) Proof of ETCP certification for on-site rigging crew.

j. Fabricated Plates and Panels
1) Provide complete drawings on custom fabricated plates or panels. Drawings shall include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material. Provide samples of plate color options for review.

k. Labeling
1) Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.

l. Schedules
1) Wiring schedule showing source and destination of wiring and indicating which wiring is in conduit. Junction box schedule showing type of box, size, mounting and location. Include this information with remainder of wiring diagrams.

m. Control System Software
1) Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).

n. IP Addresses
1) Coordinated with the venue IT Administrator, provide a list of IP addresses, by device, used in the project.

E. Submittal format:
1. Consultant’s project documents in electronic format will not be supplied to the Contractor for their use as part of submittals.
2. Standards:
a. Floor plan drawings executed at an appropriate scale, not less than 1/8” = 1’-0”.
b. Detail drawings executed at an appropriate scale, not less than 3/8” = 1’-0”.
c. Plate and panel drawings executed at an appropriate scale, not less than 1/2” = 1”.
d. Rack, enclosure, and millwork detail drawings executed at an appropriate scale, not less than 1” = 1’-0”.
3. Electronic Submittals: Submit in non-proprietary PDF format. Combine product literature into a single file for each Part 2 subheading (i.e.: 2.3 Microphones and Accessories, 2.4 Input Sources, etc.). Shop drawings may be combined into logical sections such as legend, floor plan, section, detail, functional, etc.
4. Hardcopy Submittals: Bind submittal in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three-inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.

F. Resubmission requirements:
1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
2. Indicate all changes that have been made by clouding and noting with a revision marker. Drawing title block to track all revisions.
3. Also indicate all changes that have been made other than those requested.

1.9 CONTRACT CLOSE-OUT DOCUMENTS:

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated, after substantial completion but prior to final observation:

B. Supplementary submittal requirements:
   1. Provide the following in one electronic submission for review.
   2. Equipment Manuals:
      a. Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein
      b. Supply manufacturer’s serial numbers for each Product
      c. For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item
      d. Separately bound list by manufacturer, and model or part number, of Products incorporated within the Work, arranged in alpha numeric order. When applicable, bind Manufacturer's warranty statements separately.
   3. Test Reports: Recorded findings of Commissioning.
   4. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
      a. This procedure should describe the operation of system capabilities.
      b. Assume the intended reader of the manual to be technically experienced but unfamiliar with the components and the facility.
   5. Service Information, including service phone number(s) and hours; service schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
   6. Any other pertinent data generated during the Project or required for future service.
   7. Within three weeks of final observation, submit the following in one electronic submission for review. Upon Owners and/or Consultant’s request, provide hard copy files of the following:
      a. Record drawings: Final rendition of Shop Drawings depicting what is incorporated within the Work.
      b. Record drawings in AutoCAD editable DWG format and Adobe PDF format. Resolution to be sufficient to permit Owner’s technicians to be able to clearly read all notes and text on screen.
      c. One set of signed proof-of-training documents.
   8. Submittal Format:
      a. Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1’-0”.
      b. Segregate documents into separate folders containing data relevant to operational, maintenance, and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g.; operational data in a maintenance folder.
      c. Project Record Manual
         1) Provide product data submittal in a single PDF file.
         2) Provide an indexed list of major groupings.
         3) In the index, provide clickable hyperlinks that lead to the page of that major grouping.
         4) Organize index and major groupings in logical signal-flow order.

C. Resubmission requirements:
   1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.
   2. Indicate all changes that have been made other than those requested.

1.10 QUALITY ASSURANCE

A. Qualifications: Contractor to be experienced in the provision of systems similar in complexity to those required for this project, and meet the requirements listed below. Provide documentation at the time of bid to support these qualifications:
   1. Form of corporation.
   2. No less than three years' experience with equipment and systems of the specified types.
   3. Experience with at least three comparable scale projects within the last three years.
   4. Be a franchised dealer and service facility for the manufacturer's products furnished.
   5. Maintain a fully staffed and equipped service facility with full-time field technicians.
   6. Have at least one supervisory on-site employee who has completed and has been certified CTS-I by Infocomm.
   7. Supervision of all rigging by an ETCP certified rigger for all work associated with suspension or mounting of overhead equipment.
   8. Adequate plant capacity and equipment to complete the Work.
   9. Adequate staff with commensurate technical experience.
   10. Suitable financial status (i.e., bonding and materials purchase capacity) to meet the obligations of the Work.
   11. Adequate regional service organization to meet warranty response requirements of the Project.
   12. Provide listing with appropriate explanation regarding the status of Contractor's resolved or unresolved legal disputes within the last six calendar years.
   13. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Contractor has failed to meet construction schedules due to Contractor's cause.
   14. Completed current version of the AIA Contractor's Qualification Form.

B. Subcontractors: at the time of bid, the Contractor shall provide a list of structural, electrical, sound, or any other subcontractors intended to do the Work, or are being retained as local service providers throughout the warranty period. Subcontractors shall be appropriately state licensed in their specialty and must provide the same qualification documents as the Contractor.

C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
   1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
   2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.
   3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

D. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Architect.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Ship product in its original container, to prevent damaging or entrance of foreign matter.

B. Handling and shipping in accordance with manufacturer's recommendation.

C. Provide protective covering during construction, to prevent damaging or entrance of foreign matter.

D. Replace at no expense to Owner, product damaged during storage, handling or the course of construction.

1.12 PROJECT CONDITIONS

A. Verify all conditions on the jobsite applicable to this work. Notify Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The drawings diagrammatically show cables, conduit, wiring, and arrangements of equipment fitting the space available without interference. If conditions exist at the job site which make it impossible to install work as shown, recommend solutions and/or submit drawings to the Owner's Representative for approval, showing how the work may be installed.

C. This installer is responsible for all additional electrical (high and low voltage) and structural work for completed systems.

1.13 WARRANTY

A. Warrant labor and product for two (2) years following the date of the Final Acceptance by Owner.

B. System to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or product within the Warranty period without charge. Any cost required to complete this warranty repair is the responsibility of the contractor.

C. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.

D. Within the warranty period, answer service calls within eight hours, and correct the deficiency within twenty-four hours.

PART 2 - PRODUCTS

2.1 SPECIFIED PRODUCTS, MANUFACTURERS, AND INTEGRATORS

A. Any model numbers and manufacturers included in this specification are listed as a standard of quality. Regardless of the length or completeness of the descriptive paragraph herein, each device shall meet all of its published manufacturer's specifications. Verify performance as required. Where two or more acceptable products are listed, the Installer may use either. Invitation to propose does not necessary imply that vendor has met all qualification requirements.

B. Suppliers approved to respond to this RFP are done so with no implication or certification that their proposed products meet the technical requirements of this specification. Potential vendors are invited to prepare prices for more than one system configuration meeting these specifications (i.e. different material, equipment provider, etc.).

2.2 CHAIN HOISTS:

A. Provide multiple motorized chain hoists sized to the load(s) required and designed for permanent suspension of equipment above the public.

B. Hoist motors shall mount within the truss assembly and must be attached by a removable means to allow annual maintenance and required service.

C. Hoists shall:
   1. Operate at a nominal 208 VAC.
   2. Have a maximum travel suitable to the application.

D. Hoists shall be minimum 1-ton nominal capacity.

E. Hoists shall consist of an integrated motor, gearbox, and brake mounted in a heavy-duty case sealed from dirt and other contaminants.

F. The hoist brake shall be direct-acting electrically released and must provide fail safe braking in the event of a power failure.

G. Each hoist shall have an integrated, field-adjustable limit switch assembly coupled with the drive train. Switches shall sense normal and emergency over-travel positions at both ends of the range of operation.

H. Lifting chain shall be of a specialty alloy sized for the anticipated loads and designed for overhead lifting.

I. As load is lifted, loose chain shall feed into a suitable receptacle attached to the hoist for storage. Provide suitable durable chain buckets and chain guides to collect lifting chain as the hoists are raised.

J. Hoists shall meet minimum SQP2 and VLT-SR3.0 safety level requirements of D8+, suitable for holding loads above the heads of arena personnel and patrons. Proposed substitutions to meet the D8+ requirement that de-rate higher capacity equipment shall be accompanied by suitable engineering analysis documenting how the proposed hoist system shall accommodate the standard.

K. Acceptable manufacturer
   1. Chain Master D8 Plus
   2. CM Lodestar D8+
   3. Stagemaster D8+

2.3 HOISTING CONTROL

A. The system shall provide separate modes of control for either group or individual components using the same operating system. This allows each hoist to be moved individually or in a group mode where all the hoists are linked.

B. Components shall be self-leveling with auto stops that are preprogrammed as soft limits.

C. The system shall use a touch screen. The operator can choose between components to control and select from predetermined soft limits.

D. The touch screen control shall have access to the PLC system over a Local Area Network.

E. Three access points for the LAN shall be provided in key areas to allow the control device to be utilized within sight of the hoists being operated. These locations should be coordinated with the sound consultant.

F. Each hoist in the system shall be monitored for position and movement.

G. The system shall have a monitored E-stop system and will shut down power to all hoists in all components upon activation. Reset shall be allowed at the power cabinet location.

H. The system Power and Control Cabinets shall be designed to provide distribution and operating commands to all hoists in each component. Whenever a component is deselected from operation, power will be removed from all hoists in that component. Each control cabinet shall have local access for a manual remote station allowing override and standard analog operation of the system.

I. Control Cabinets
   1. The Control Cabinet shall contain the main components for the system, including the following:
      a. Control relay board
      b. Power supplies (Linear 12VDC)
      c. Contactor drive relays
      d. Local remote card
      e. Control fuses (TR and AGC type)
      f. All associated circuitry
      g. A front door panel with a 26-pin control connector and a key switch that de-energizes power to the control circuit power supply
      h. Power Cabinets shall be a Hoffman style enclosure.

i. All components mounted on a .125” thick aluminum back place
j. The enclosure will be labeled with:
1) The manufacturer’s name
2) Rating labels indicating the number and horsepower of the hoists for which the system is intended to be used
3) Internal wiring schematic
4) Fuse size chart
5) Control Cabinets shall be Hoffman wall mount enclosures or equivalent.

2. Programmable Logic Control Box (PLC)
a. The PLC shall consist of a Schneider Electric M340 with power supply and I/O modules.
b. The PLC shall have an Encoder Interface Card (s)
c. The PLC shall have terminal blocks for interface (wago spring clamp)

3. Power & Control Fly Boxes
a. Hoffman ASE Series screw cover pull boxes. Standard sizes are 6” x 6” x 4” and 8” x 10“x 4”. Standard finish is ANSI 61 gray polyester powder paint inside and out.
b. Include cover plate manufactured from .090” thick aluminum with a black anodized finish, engraved with manufacturer’s logo and labeled with the connector pin-out designation and part number.
c. Connector choice should be coordinated with sound consultant.

4. Data Encoder Box
a. Data Fly boxes shall have a Neutrik style 6 pin XLR receptacle.
b. Data Fly Boxes shall have a cover plate manufactured from .125” thick aluminum with a black powder coating, engraved with manufacturer’s logo and labeled with the connector pin-out designation and part number.

5. HMI (Human Machine Interface)
a. The HMI shall be comprised of the Schneider Electric Magelis XBTGT or XBTGH series touch screen PLC interface.
b. Depending on the size of the system, the HMI shall be either a hand-held or desktop device, size to be determined by consultant.
c. The HMI shall include an E-Stop mushroom switch.
d. The HMI shall include a Cat5 or Cat6 Ethernet connection.
e. The HMI shall include an NL4 Powercon style connector for E-Stop circuitry.

6. Remote Network Access Box
a. The Remote Network Access Box shall have a 24v dc power supply.
b. The Remote Network Access Box shall have an Ethernet switch.
c. The Remote Network Access Box shall have an NL4 Powercon style output device.
d. The Remote Network Access Box shall vary in size based on the system configuration.

7. The power conditioner shall have a power rating 1440 VA/1008 Watts
a. The power conditioner shall have a low distortion sine wave
b. The power conditioner shall have a transfer time of 4ms typical
c. The power conditioner shall by 60Hz.
d. T.H.D Max w/100% resistive load shall be <3% in battery.
e. Online efficiency w/o charger shall be 94%.
f. The power conditioner shall have an input and output voltage of 120v.
g. The input current shall be 12 amps and the output current shall be 8.5-10.6 amps.
h. The input voltage rage w/o using battery shall be 96-151 volts.
i. Output regulation on mains shall be +/- 10% and on battery shall be + +/- 5%.
j. Backup time shall be 4-6 minutes.
k. The communications interface shall be DB9, USB

8. E-Stop Box
a. The E-Stop Box shall contain a Telemechanique XB4 series mushroom switch.
b. The E=Stop Box shall be a 6” x 6” x 4” enclosure.

c. The E-Stop Box shall have a cover plate manufactured from .125” thick aluminum with a black powder coating, engraved with manufacturer’s logo and labeled with part number.

9. Environmental Specifications
   a. NEMA 1 certified - indoor use only.
10. Ratings and Certifications
   a. The Install Soft Limit System should be listed as defined by the Occupational Safety and Hazard Association (OSHA). It has a cETLus sticker and is designed and built, where applicable, to the following standards: UL1640, UL508A and the Canadian Electric Code (C22.2. NO.14).
   b. Provide all power and control interconnect cabling as required for proper operation of the system.

2.4 LOUDSPEAKER HARDWARE AND SUPPORT STRUCTURE

A. Provide a custom loudspeaker hardware system as required to mount and suspend loudspeakers in the arrangement as shown on the Drawings.
   1. Attachment system to be supplied by vendor who is experienced at fabricating rigging support systems, loudspeaker support systems or similar devices over an audience.
   2. Provide auxiliary support steel and hardware required to attach to building structure and design members to have a minimum safety factor of at least 7:1.
   3. All wire rope used for loudspeaker suspension to have a minimum safety factor of 10:1.
      a. Fabricate all components from powder coated aluminum for maximum resistance to corrosion.
         1) Acceptable loudspeaker frame and connecting hardware manufacturer or approved custom engineered solution by rigging contractor.
         2) Proprietary by loudspeaker manufacturer.
   4. Shoulder Type Machinery Eye Bolts:
      a. Forged Steel – Shoulder, Quenched and Tempered.
      b. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles.
      c. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
      d. Provide product sized for working load limits required.
      e. Acceptable products:
         1) Crosby Group S-279 / M-279 Series.
         2) Chicago Hardware Company 261 Series.
   5. Forged Eye Nuts:
      a. Forged Steel – Quenched and Tempered.
      b. Tapped with standard UNC class 2 threads after galvanizing.
      c. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
   6. Provide product sized for working load limits required.
      a. Acceptable products:
         1) Crosby Group G-400 Series.
         2) Chicago Hardware Company 167 Series.
   7. Anchor Shackles:
      a. Forged - Quenched and Tempered, with alloy pin.
      b. Working Load Limit permanently shown on every shackle.
      c. Hot Dip galvanized or Self-Colored.
      d. Product to meet the performance requirements of Federal Specification
      e. Provide product sized for working load limits required.
      f. Provide all screw pin type shackles with mousing wire or suitable approved substitute.
      g. Acceptable products:
         1) CM Theatrical Shackles (Painted Black)
         2) Crosby Group G-209 / S-209 Series Screw Pin.

3) Chicago Hardware Company 201 Series.

8. Moussing:
   a. Wire
   b. A minimum of 0.020" steel safety wire will be used to secure the shackle pin to the shackle body ensuring the pin will not come loose.
   c. Acceptable Manufacturers:
      1) Loos and Company
      2) Brookfield Wire manufacturers
      3) Nylon Zip Ties (If Approved):
      4) A two-stage zip tie designed to stand up to the rigors of heavy industry will be used to secure the shackle pin to the shackle body ensuring the pin will not come loose.
      5) Acceptable Manufacturers: CERTAG, Advanced Cable Ties
9. Turnbuckles:
   a. Acceptable turnbuckle assembly combinations include: Eye and Eye, Jaw and Jaw, Jaw and Eye.
   b. End fittings are Quenched and Tempered, bodies heat treated by normalizing.
   c. Hot Dip galvanized.
   d. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements.
   e. Product to meet the performance requirements of Federal Specifications FF-T-791b, Type 1 Form 1 - CLASS 4, and ASTM F-1145.
   f. Provide product sized for working load limits required.
   g. All end fittings to be moused to the body with mousing cable.
   h. Acceptable products:
   i. Eye and Eye:
      1) Crosby Group HG-226 Series
      2) Chicago Hardware Company 012/013 Series
   j. Jaw and Eye:
      1) Crosby Group HG-227 Series.
      2) Chicago Hardware Company 026 Series.
   k. Jaw and Jaw:
      1) Crosby Group HG-228 Series.
      2) Chicago Hardware Company 030/031 Series.
10. Swivel Hoist Ring:
   a. All components are Alloy Steel - quenched and tempered
   b. Rated at 100% of Working Load Limit at a 90 degree angle
   c. 360 degree swivel and 180 degree pivot action
   d. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load, and temperature requirements.
   e. Bolt specification to be Grade 8 Alloy socket head cap screw to ASTM A 574.
   f. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles.
   g. Zinc Plated (Yellow Chromate) finish for increased corrosion protection.
   h. Provide product sized for working load limits required.
   i. Acceptable products:
      1) Crosby Group HR-125.
      2) Chicago Hardware Company 860 Series.
11. Wire Rope Slings:
   a. Sling manufactured in accordance with OSHA Standard 1910.84
   b. Wire rope tagged in accordance with OSHA Standard 1910.184
   c. Wire rope slings mechanically swaged with a Flemish eye splice.
   d. Wire Rope: Strands: 7 x 19 Galvanized Utility Cable sized for working load limits required adhering to Federal Specification RR-W-410, Type VI, Class 3
12. Wire Rope Thimble:
   a. Product to meet the performance requirements of Federal Specification EN13411-1:2002.

b. Hot Dip galvanized.
c. Provide product sized for wire rope size required for suspended load.
d. Acceptable product:
1) National Steel Swaging Sleeves
2) Upson-Walton™ Carbon Steel Thimbles

13. Wire Rope Sleeves:
a. Type: Carbon Steel Sleeve for Flemish Eyes
b. Provide product sized for wire rope size required for suspended load.
c. Acceptable product:
1) National Steel Swaging Sleeves
2) Upson-Walton™ Flemish Eye Carbon Steel Sleeves

14. Labeling, Marking, and Signage
a. Labeling and signage shall comply with the requirements of the following standards:
1) ANSI Z535.1-2006, Safety Color Code
2) ANSI Z535.2-2006, Environmental and Facility Safety Sign
3) ANSI Z535.3-2006, Criteria for Safety Symbols
4) ANSI Z535.4-2007, Product Safety Signs and Labels
5) The hoist shall have a label affixed indicating the manufacturers rated capacity of the hoist.
6) Hoist systems shall be marked with their working load limit.
7) Signage or label(s) shall indicate both WLL point load and WLL uniformly distributed load (UDL) of the load-carrying device for each hoist system.
8) Signage shall state the operational limits
9) Signage shall state that operation of the hoist system shall be restricted to authorized persons.
10) Signage shall list the contact information for the supplier of the system.
11) All labeling and signage shall comply with ANSI E1.4-2014.

B. Basic Functional, Safety, and Operational Requirements:
1. Rigging contractor shall include an operations and maintenance manual (“Systems Manual”) for the system. All unique elements of the system shall be identified and documented.
2. The systems manual shall include final print drawings, applicable maintenance requirements, servicing guidelines, and a listing of component working load limits. Manuals shall include inspection processes and results.
3. Provide miscellaneous rigging hardware in necessary sizes and quantities to support the installation described.
4. All hardware shall be of U.S. manufacture bearing identification traceable to the origin.
5. Hardware components shall include
a. Beam Clamps
b. Truss Clamps.
c. Screw Pin Shackles shall have a black phosphate glare resistant finish. Bow shall be forged from micro alloy steel with integral heat-treating. Pins shall be forged from 4140 alloy steel and heat-treated. Shackle shall meet or exceed strength requirements for Federal Specification RR-C-27L.
d. Bridling chains, if required shall be theatrical specialty alloy Stac-type sized for the loads.

2.5 CABLE MANAGEMENT

A. Design and provide a cable management system to serve flexible cable drops for both:
1. Hoist power and control.
2. Loudspeaker power and signal.

B. Design may utilize one of two methods:

1. A chain-runner system to tie to the lift chain and which will allow the cables to festoon vertically up the chain.
2. Custom catch basket(s) mounted to the top of the truss assembly and sized suitable to the cables associated with the hoist and loudspeaker systems.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate incorporation of the Work specified herein with other project work so as to facilitate a cohesive final product.

B. Mount equipment and enclosures plumb and level.

C. Permanently installed equipment to be firmly and safely held in place in accordance with specified safety factors and Federal and State codes and regulations.

D. Work shall be completed within industry guidelines, including, Entertainment Technicians Certification Program (ETCP,) the Entertainment Services and Technology Association (ESTA,) OSHA, National Electric Code, American National Standards Institute, American Society for Testing and Materials, American Institute of Steel Construction, National Fire Protection Association, National Electrical Manufacturers Association, plus any or all local, governmental, or other applicable codes.

E. Where dimensions and loading capacities have been omitted from this specification, they are to be determined by the Arena Rigging System Installer in accordance with the accepted industry standards and guidelines in this section. In no way will the Arena Rigging System Installer be relieved of primary responsibility to provide a safe, fully functional system.

F. The mechanical fabrication and workmanship will incorporate the best practices for good fit and finish. There will not be any burrs or sharp edges to cause a hazard nor will there be any sharp corners accessible to personnel.

G. All equipment will be installed based on the manufacturer's recommendations and for the use intended by the manufacturer.

H. All shop and field welding will meet the qualifications of the AISC manual and will be without spatter or other evidence of poor practices.

I. All finishes which are disturbed during shipping and installation will be touched up to match the original.

3.2 INSTALLATION

A. Installation of cable and wiring
   1. Cabling and Wiring:
      a. Install cable in a manner to adhere to manufacturer’s specifications for maximum cable pulling tension, minimum bend radius, and any other restrictions.
      b. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
      c. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of 48-inch (1.2 meter) intervals. At no point shall the cables rest on light fixtures, acoustic ceiling grids, panels, conduits, sprinkler pipe, water pipe and/or HVAC system ducting.
      d. Horizontal distribution cables shall be bundled in groups of no more than 50 cables when being supported by J-Hook or trapeze systems. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance. An exception to this rule is when cable is installed in cable tray systems.

e. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
f. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.
g. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.
h. Cables shall be identified by a self-adhesive machine label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
i. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
j. Provide splice free wiring and cabling from origination to destination. Cables shall be installed in continuous lengths from origin to destination (no splices). Properly designed transition points, or consolidation points are not considered 'splice' points.
k. Make joints and connections with rosin-core 60/40 solder or with mechanical connectors specifically intended for the type and class of cable being used. Where spade lugs are used, crimp properly with ratchet type tool.
l. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at one end. Shield(s) that are not connected are to be folded back over the cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.
m. Isolate cables and wires of different signals or different levels are to be separated, organized, and routed in order to restrict channel crosstalk, or create feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.
n. Connect cable to active components through XLR connections whenever multiple formats are available. Make connections to speaker transformers with properly sized closed-end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.
o. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.
p. Execute wiring in strict adherence to:
    1) Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.
    2) Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.
    3) AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm, 2009

2. Equipment Housing Cabling and Wiring:
    a. Lace, tie, or harness wire or cable as required herein, and in accordance with accepted professional practice. Dress, lace, or harness all wire or cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag.
    b. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out to their locked position without straining cable.

c. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.
d. Provide plastic cable ties or Velcro straps to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.
e. Install with connections completely visible and labeled.
f. Provide termination resistors, if required, of 5 percent tolerance. Mount the termination resistors fully visible.

B. Installation of connectors, plates & panels:
1. Install panel mounted connectors rigidly attached to panels, plumb and level.
2. Custom rack panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.
3. Custom connector plates (loudspeaker, microphone, etc.lamicoi) are typically stainless steel, unless otherwise noted or specified. However, verify plate finish with the Owner.
4. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).
5. Other Plates and Panels may be required to satisfy the requirements of the Work.

C. Installation power and grounding:
1. Coordinate final connection of power and ground wiring to housings.
2. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
3. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing. Provide a minimum of two spare outlets in each rack.
4. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three wire power cord to these busses using 6/32 nuts, bolts and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.
5. Replace manufacturers supplied 18 gauge IEC power cords with UL listed 18 gauge pre-molded 6”, 12”, 18”, or 24”. Use minimum length required. No looped or cable tied IEC power cords will be permitted within the equipment rack.
6. Replace manufacturers supplied 14 gauge IEC power cords with UL listed 14 gauge pre-molded 18” or 36” folamr all equipment IEC capable. Use minimum length required and minimize looped or cable tied IEC power cords present in the equipment rack.

D. Installation of electronic equipment:
1. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
2. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
3. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamicoid labels.
4. Mount equipment plumb and level, firmly and safely held in place.

E. Installation of equipment housing:
1. Mount equipment in racks or other project specific equipment housing apparatus. Fully wire and test before delivery to job site. If field conditions prevent prior assembly of racks, notify Owner in writing that racks will be fabricated on site and the reasons for the change.
2. Provide rear support for housing mounted equipment greater than 15 inches deep.
3. Provide blank panels to fill unused panel space within the equipment housing.
4. If Key door locks are required, key each housing type alike.
5. Looking at the rack from the rear, locate AC power and speaker wiring on the left; line level audio, video, and RF wiring on the right.
6. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.

7. If forced-air active thermal management is used, provide ventilation blocking material on the front, sides, and rear of the equipment rack as needed. Reference Middle Atlantic Products “Controlling the Temperature Inside Equipment Racks”. Air temperature inside of the rack is not to exceed 90 degrees Fahrenheit.
8. Panels, or equipment mounted on the rear rack rails, shall not block access to any front mounted components.
9. If equipment rack is not equipped with casters, provide two inch high wood base to isolate equipment rack from floor. Wood base should be capable of supporting the load.

F. Installation of loudspeakers:
1. The Contractor is responsible for final design and engineering of loudspeaker rigging, attachments, brackets, and hoisting.
2. Loudspeakers shall be mounted at the operating position in a safe, secure, and permanent manner.
3. Provide custom rigging as needed.
4. Suspension and Mounting:
   a. Static and dynamic equipment loads shall be suspended or mounted in compliance with the following ANSI/ESTA standards, using the latest available versions of the standards:
      1) ANSI E1.4-2-2021 Statically Suspended Rigging Systems
      2) ANSI E1.56-2018 Rigging Support Points
      3) ANSI E1.6-1-2021 Powered Hoist Systems
      4) ANSI E1.8-2012 Loudspeaker Enclosures Intended for Overhead Suspension
   b. Rigging, mounting, and support systems for loudspeakers shall be reviewed and certified by a registered Professional Engineer (PE), in the employ of the Contractor, licensed to practice in the State in which the project is located. Documentation shall be included as a submittal item. Once the systems are installed, the PE shall physically inspect, at the Contractor’s cost, the methods and means used to verify compliance with the original design.
5. General Guidelines:
   a. Paint loudspeakers, supports, and related hardware color as directed by the Owner.
   b. The aiming direction of all loudspeakers shall be adjustable by no less than ±5 degrees horizontally and vertically.
   c. Loudspeakers are to be oriented parallel to their mounting surface unless otherwise noted.
   d. Provide a safety cable connected to a secondary location for each loudspeaker.
   e. All loudspeakers located in ceiling tiles shall be located in the center of the tile unless noted otherwise.
   f. Paint loudspeakers to match surroundings. Confirm color selection with the Architect during the submittal phase.
   g. Exterior loudspeaker cabinets shall be constructed of materials designed for permanent outdoor exposure conditions with a minimum IP 54 rating, and a minimum expected 10-year life span. Exterior and interior surfaces of the cabinets shall be protected from the effects of water, moisture, and humidity. The exterior surface shall also be protected from the effects of ultraviolet radiation to prevent fading and color change. The cabinets shall be shaped and oriented in a manner that minimizes the possibility of water pooling on any cabinet surface. Associated hardware shall be inherently non-corrosive, performing to the standards of 304 Stainless Steel or higher.

3.3 LABELING OF EQUIPMENT

A. Mark and label each roller/hoist with its unique location and number, load capacity, and centerline locations with appropriate labels or paint.

B. Provide labels clearly indicating date of manufacture, cloth type, manufacturer's name and address, size (width and height using 3/4" minimum lettering), and unique ID number (to be coordinated with Owner) will be sewn into the back side of the lower hem at both ends of each drape panel.

3.4 CONTRACTOR COMMISSIONING

A. Prior to energizing or testing the System ensure the following:
1. Products are installed in proper and safe manner according to manufacturer's instructions.
2. Dusts, debris, solder splatter, etc. is removed.
3. Labeling has been provided.
4. Temporary facilities and utilities have been properly disconnected, removed and disposed of off-site.
5. Products are neat, clean, and unmarred. All parts securely attached.
6. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired, and debris cleaned up and discarded. Job site shall be left broom clean.
7. All end-of-travel and emergency over-travel limit switches must be set and verified as part of the commissioning process.

B. Provide two portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover entire project.
1. Include rechargeable batteries and re-charger along with "holster" for wearing on belt. Radios to be available for duration of testing process, including any follow-up visits required prior to final acceptance.

3.5 FINAL INSPECTION AND TESTING

A. Upon completion of installation, initial adjustments, tests, and measurements specified in Part 3, and submission and review of the results, a final inspection and test will be observed by the Owner and/or Owner's Consultant no earlier than two weeks after receipt of the written results.

B. Provide a minimum of two (2) persons for inspection and testing familiar with aspects of the System to assist the Owner.

C. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.

D. The following procedures will be performed on each System:
1. Inspection of the methods and means employed to incorporate the System within the facility.
2. Verification of proper operation, from controlling devices to controlled devices.
3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each setting, and appropriately record these settings within the Record Documents.
4. Other tests on equipment or systems deemed appropriate.

E. In the event the need for further adjustment or work becomes evident during testing, the Rigging System Installer is to continue his/her work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the inspection and testing period is required, the contract price will be reduced for the additional time and expenses of the Owner, at the standard rate in effect at that time.

F. System installer shall return to the jobsite six months after acceptance to inspect the rigging hardware and attachments, hoists, controls, and associated components. Provide a report detailing inspection findings and recommendations.

3.6 INSTRUCTION OF OWNER PERSONNEL

A. After final completion, provide instruction to Owner and/or the Owner's designated personnel on the use, operation, maintenance and care of the System.
   1. Develop training course based on the use of the System and manufacturers' recommendation. Provide four hours of training. The training period shall be divided into two segments and shall be scheduled at least two weeks apart. All training shall be scheduled at the convenience of the owner and designated personnel.
   2. Submit an outline of the course with sample instructional aides for approval thirty days (30) prior to scheduled instruction sessions.

B. If a representative of the manufacturer is used in the instructional course, the Rigging Systems Installer must be present throughout the extent of the course and ensure that the representative abides by the requirements set forth in these specifications.

3.7 CLEANUP AND REPAIR

A. Upon completion of the work, remove refuse and rubbish from and about the premises. Leave areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.

END OF SECTION 11 61 33

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 TIME, MANNER, AND REQUIREMENTS FOR SUBMITTING SUB-BIDS

A. Sub-bids shall be submitted in accordance with provisions of the General Laws (Ter. Ed.), Chapter 149, Section 44A to 44L, inclusive, as set forth under INSTRUCTIONS TO BIDDERS.

B. Each Sub-Bid filed with the Awarding Authority must be accompanies by BID BOND, CASH or CERTIFIED CHECK, or a TREASURER'S CHECK or CASHIER'S CHECK issued by a responsible bank or trust company, payable to the NAME OF CITY/TOWN in the amount stipulated in the INSTRUCTIONS TO BIDDERS. A Sub-Bid accompanied by any other form of bid deposit than those specified will be rejected.

C. Each Sub-Bid submitted for the work, under this SECTION, shall be on a form furnished by the Awarding Authority, as required by SECTION 44F of Chapter 149 of the General Laws, as amended.

D. The work to be done under this Section is shown on the following drawings numbered: E1.1, E2.2.1, E2.2.2, E2.2.3, E5.0, E6.0 and E8.0.

E. The Filed Sub-bidder for work under this Division 26 shall list in paragraph E of the FORM FOR SUB-BID the names of each person, firm or corporation whom he proposes to use to perform the following classes of work or part thereof and the bid price thereof: CLASSES OF WORK REFERENCE.

F. In any case in which the Sub-bidder intends to perform with persons on his own staff, the class of work listed above, he must, nevertheless, list his own name under paragraph E of the FORM FOR SUB-BID.

1.2 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.
   1. For example, prior to requesting an occupancy permit, the MEP documentation listed in Part 3 of Division 20 (in paragraph "MEP and Fire Protection Completion Requirements", subparagraph "Occupancy Permit" must be submitted and approved so the Engineer can certify that the MEP systems and life safety provisions are completed.

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

1.3 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.

1.4 DEFINITIONS

A. Emergency Systems: Loads defined by NFPA 70, Article 700 “Emergency Systems”. Those systems intended to supply egress lighting.

B. Legally Required Standby Systems: Loads defined by NFPA 70, Article 701 “Legally Required Standby Systems”. Those systems classified as legally required intended to supply loads such as smoke exhaust systems.

C. Optional Standby Systems: Loads defined by NFPA 70, Article 702 “Optional Standby Systems”. Those systems intended to supply loads such as laboratory equipment.

D. Feeder: All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent. Feeders may be identified in the “Legend of Feeder Sizes” identified on the drawings. All feeders are required to be in conduit. MC cable is not permitted unless specifically approved by the Engineer via an RFI or substitution request form. Submittal reviews of product does not permit use of MC cable for feeders.

E. Branch Circuit: The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s) device. Branch circuits may be identified in the “Branch Circuit Schedule” on the drawings.

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

G. NBR: Acrylonitrile-butadiene rubber.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08.

C. Coordinate application of firestopping specified in Division 07.

1.6 MATERIALS AND WORKMANSHIP

A. Work shall be neat and rectilinear. Install material and equipment in accordance with manufacturers written instructions. Installation shall operate safely and without noise, vibration

or corrosion. Work shall be properly and effectively protected, and raceway openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new, factory tested and delivered ready for field installation. Provide supplies, accessories and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents. Equipment damaged during installation shall be repaired to new condition or replaced with new material. The contractor shall be responsible for all costs associated with testing, replacing to repair, including but not limited to, all replacement or repair costs, preparations prior to testing, all testing costs, extended warranties, re-commissioning of the equipment, etc. with no additional cost to the contract.

C. The contractor shall take steps necessary to ensure that all materials and equipment can be delivered and installed in sections sufficiently small to fit within openings in the building and that the weight and size of all equipment pieces so not exceed the capacity of the hoisting and/or elevator system.

D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

1.7 EQUIPMENT LOCATION

A. If discrepancies regarding the locations of connection boxes exist between the electrical drawings and any other drawings associated with the project, notify the Architect. Any reasonable change in location of boxes shall not involve additional expense to Owner. The term “reasonable” shall be interpreted as moving outlet 10’-0” in any direction from the location indicated on the Electrical drawings. Refer to specifications 200000 for additional information.

1.8 CABLE TERMINATION TEMPERATURE RATINGS

A. All equipment terminations connecting to wire and cable, rated 600V or less shall be rated for 75 deg. C for conductors 1 AWG and smaller and/or where conductor ampacities are 100 A or less.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

2.2 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.3 ACCESS AND ACCESS PANELS

A. This Section supplements requirements of Division 08.

B. Description: Interior construction access panels,

C. Available Manufacturers:
1. Milcor.
2. Knapp.
3. Nystorm.
4. Inland Steel.

D. Coordinate selection with other Sections supplying similar access panels.

E. Access panels shall have same fire rating classification as surface penetrated.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

C. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

D. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly which may void warrantee. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

E. The Electrical Contractor shall not allow any equipment, ductwork, or piping foreign to the electrical installation to be installed or pass through any room in which electrical systems or equipment is located, such as electrical room, electric closets telephone or data closets. The Electrical Contractor shall notify the Construction Manager of such violations and request removal of such equipment, ductwork, or piping.

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

G. 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.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Use pipe sleeves.

B. 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.

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

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

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

F. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

G. 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.

H. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07.

3.3 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.

3.4 ELECTRICAL CONNECTIONS

A. General
   1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
   2. Sound system equipment is defined as products provided under other divisions that require power 120 volts and higher.
   3. Provide conduit and power wiring for connection to sound system equipment, etc. Refer to Sound System drawings for location and quantity of equipment to be connected. Provide connections from local 120-volt panel via 20 ampere circuit breaker.
   4. All control wiring shall be provided by others, unless noted otherwise in the specification or drawings.

B. Coordination
   1. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

C. Examination
   1. Examine the areas and conditions under which the equipment is to be installed.
   2. Verify that equipment is ready for electrical connection, wiring, and energization.

D. Installation
   1. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.

3.5 ACCESS PANELS

A. Provide access panels in accordance with this Section and requirements of Division 08.

B. Access panels are generally not shown on the drawings, but shall be provided to allow access to system components.

C. Provide proper access to materials and equipment that require inspection, replacement, repair or service, and coordinate their delivery with the installing Trade. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access which may result.

D. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to a representative of the installing Trade. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify all access panels.

E. Provide access panels to all items requiring maintenance including at electrical boxes or other items that require access and are concealed in wall, furred space or above ceiling.

F. Ceilings consisting of lay-in or removable splined tiles do not require access panels and dampers, splitters, or test hole openings above ceiling shall have location marked with thumb tack on finished ceiling panel. Location shall be noted on record drawings.

G. Access panels shall have same fire rating classification as surface penetrated.

H. Panels within 8” of the surface being penetrated shall be the sized for the greater of 12”x12” or size required to allow removal of the component being maintained; panels further than 8” from the surface being penetrated and access at all equipment requiring service (including disconnects) shall be a minimum of 24”x24”.

3.6 CONNECTIONS TO OWNER AND ARCHITECT EQUIPMENT

A. General
   1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source to owner and architectural equipment for complete and operational equipment.
   2. All control wiring shall be provided by others, unless noted otherwise in the specification or drawings.

B. Coordination
   1. Coordinate location of equipment with Architect and Owner.
   2. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
   3. Obtain wiring diagrams and installation methods from equipment manufacturers.

C. Examination
   1. Examine the areas and conditions under which the equipment is to be installed.
   2. Verify that equipment is ready for electrical connection, wiring, and energization.

D. Installation

1. Make conduit connections to vibrating equipment using flexible conduit. Use liquid tight flexible conduit in damp or wet locations.
2. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
3. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes for vibrating equipment or for cord drops from ceilings.
4. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
5. Install disconnect switches. Connect with conduit and wiring as indicated.
6. Each motor terminal box shall be connected with a minimum 12 inch, maximum 24 inch piece of flexible conduit to a fixed junction box. A green wire run through the flexible conduit shall interconnect the motor frame and the branch circuit ground wire. Use liquid tight flexible metal conduit for connection. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
7. Check for proper rotation of each motor.

3.7 CLEANING

A. Cleaning shall be performed on a day-to-day basis and a final cleaning prior to commissioning.

B. Equipment
   1. All electrical equipment shall be cleaned inside and out prior to initial energizing.
   2. Cleaning shall consist of vacuuming busses, windings, enclosures (inside and out), etc. After vacuuming is complete, the equipment shall be wiped down.
   3. If equipment is wet or contains moisture, it shall be thoroughly dried out and inspected by the manufacturer’s representative before energizing.

C. Raceways
   1. All raceways shall be blown out and dried prior to installation of conductors.
   2. Raceways installed in or below the slab shall have a mandrel pulled through to clear any dirt and debris.

D. Pull, Junction and Work Boxes
   1. All boxes shall be cleaned of debris prior to installation of conductors.

E. Final Cleaning
   1. All rubbish, discarded materials and unused materials shall be removed from site.

END OF SECTION

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

B. 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. Conductors
2. Connectors and splices

1.3 DEFINITIONS

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

B. NBR: Acrylonitrile-butadiene rubber.

C. Feeder: All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.

D. Branch Circuit: The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

1.4 SUBMITTALS

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

B. Field quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS

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. General Cable Corporation.
   2. Southwire Company.
   3. CERRO Wire.
   4. Encore Wire Corporation.
   5. Alcan Products Corporation; Alcan Cable Division.
   6. American Insulated Wire Corp.; a Leviton Company.

B. Copper Conductors: Comply with NEMA WC 70 and ASTM B-496. Copper conductors shall be soft drawn annealed copper, having a conductivity of not less than 98 percent of that of pure copper.
   1. Conductor Insulation:
      a. Comply with NEMA WC 70 for Types THHN-THWN
      b. All copper conductor insulation shall be Type “THHN” or “THHN/THWN”.

2.2 MULTI-CONDUCTOR CABLE

A. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC with ground wire.

B. Multiconductor cables run in parallel shall include full size grounding conductor in accordance with NFPA 70 Article 250.122

C. MC Cable
   1. Basis-of-Design Product: Subject to compliance with requirements, provide AFC Cable Systems, Inc. or comparable product by one of, but not limited to the following:
      a. Southwire Company.
      b. Encore.
   2. General
      a. Cable shall be multi-conductor Metal Clad (UL-Type MC) Power cable that meets or exceeds the requirements of UL Standard 83, UL Standard 1063, UL Standard 1569 for Type MC, Federal Specification A-A59544, IEEE 1202 (70,000 Btu/hr) Vertical Cable Tray Flame Test, and the National Electrical Code.
      b. Cable assemblies shall be prefabricated at the factory and shipped to the job site on cable reels.
   3. Material
      a. Conductors shall be minimum No. 12 AWG, soft drawn copper with 90 deg C, THHN, 600 V rated insulation. Where the length of MC cable exceeds 65 feet for 120 volt circuits and 145 feet for 277 volt circuits provide No. 10 AWG conductor with same properties as listed above. For branch circuits longer than 100 feet for 120 volt and 230 feet for 277 volt refer to the Branch Circuit Schedule on the drawings for the conductor size.
      b. Each length of MC cable shall have a dedicated neutral conductor for each phase conductor. Each length shall include a full size equipment grounding conductor.
      c. Cable shall be UL Classified 1, 2, and 3 hour Through Penetration Firestop Systems: W-J-3037, W-L-3110, W-L-3113, W-L-3117, W-L-3120, W-L-3121, W-L-3160, C-AJ-3115, C-AJ-3140, C-AJ-3142, C-AJ-3145, C-AJ-3173, C-AJ-3202, C-AJ-4065, C-AJ-4066, F-C-3038.

d. Sheath: Interlocking steel or aluminum.

2.3 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

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

C. Copper: All No. 6 AWG and larger copper conductors shall be connected with bolt-on compression connectors by Thomas & Betts (or approved equal) sized as required by codes and specifically intended to connect copper wire and cable to panelboards, substations, disconnect switches, and other equipment. Install with hydraulic crimping tool as required by manufacturer's recommendations, to ensure permanent high conductivity connection.
1. Terminations: Thomas & Betts Series 54200 (or approved equal) two hole connectors shall be used. Exceptions are as follows:
a. Where equipment or device cannot be provided by the manufacturer to accept two hole connectors, T&B Series 54100 (or approved equal) single hole connectors with anti-rotation lug or restraint shall be used.
b. Where equipment or devices cannot be provided by the manufacturer to accept either two-hole or single hole compression connectors, set screw type connectors may be submitted. For a set screw connector to be considered by the Engineer, the manufacturer shall provide deviation with his/her equipment submittals that his/her equipment will not accommodate the required compression connectors. See Division 20 for deviation requirements.
2. Copper to Copper Splices, if allowed, shall be with T&B Series 54500 (or approved equal) compression connectors.
3. Tapping of Copper Conductors shall be with T&B Series 54700 (or approved equal) compression taps.
4. All No. 8 AWG and smaller solid conductors shall be spliced with pre-insulated spring connectors. Connectors shall be Skotch-lok, Buchanan B-Cap or approved equal.
5. For NEC Class 1, 2 or 3 wiring, No. 10 AWG and smaller stranded conductors and terminated with AMP, Inc. "PIDG", UL listed premium grade insulated compression fork connectors or approved equal and shall be spliced in a junction box with AMP, Inc. "Plastic-Grip" UL listed, standard grade insulated butt splices or approved equal. All motor branch circuit conductors terminating at the motor termination box shall be spliced with compression type connectors.

2.4 CABLE SUPPORTS

A. Basis-of-Design Product: Subject to compliance with requirements, provide O.Z./Gedney or comparable product by one of, but not limited to the following:
1. Cross Hinds.
2. Kellem.

B. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs

with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

C. Provide split wedge cable supports with clamps for cable without metallic sheath. Provide basket weave or approved equal cable supports approved by cable manufacturer for cable with metallic sheath.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Stranded Copper Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

B. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or Metal-clad cable, Type MC.

C. Class 1 Control Circuits: Type THHN-THWN, in raceway.

D. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS

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

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

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

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

E. Support cables according to Division 26.

F. Identify and color-code conductors and cables according to Division 26.

G. Provide cable supports and boxes for vertical feeders as required by NEC.

H. Wire from point of service connection to receptacles, lighting fixtures, devices, equipment, outlets for future extension, and other electrical apparatus as shown on Drawings. Provide

slack wire for connections. Tape ends of wires and provide blank covers for outlet boxes designated for future use. Mark future conductors as such with panel and circuit designation.

I. Conductors No. 10 and smaller in branch circuit panelboards, signal cabinets, signal control boards, switchboards and motor control centers shall be bundled. Conductors larger than No. 10 in switchboards, motor control centers and pull boxes shall be cabled in individual circuits.

J. Two or more conduits installed instead of single conduit shall contain duplicate conductors, including neutrals and ground conductors where required; total capacity of duplicate conductors shall be at least equal to capacity of conductors replaced.

K. Follow homerun circuit numbers shown on Drawings to connect circuits to panelboards. Where homerun circuit numbers are not shown on Drawings, divide similar types of connected loads among phase buses so that currents are approximately equal in normal usage. Connect each branch circuit homerun with two or more circuits to circuit breaker or switch in three-wire or four-wire branch circuit panelboard so that no two circuits are fed from same bus. Where panelboard cabinets are recessed, provide conduits with sufficient capacity for future conductors for spare branch circuit protective devices and spaces in panelboard; stub up concealed to junction box. Provide extensions above ceiling.

L. Where conductors have been oversized for voltage drop provide reducers on feeders and branch circuits to accommodate wire size at terminations.

M. Conductors entering panels, junction boxes, equipment cabinets, etc. shall be neatly formed, laced and supported around the equipment or devices. Adhesive glues or tapes shall not be used to support conductors.

3.4 MULTI-CONDUCTOR CABLE APPLICATIONS AND WIRING METHODS:

A. Uses Permitted
1. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.

B. Uses not permitted
1. Branch circuit from panelboard to first box.
2. Feeders.
3. In open spaces such as finished areas.
4. Underground or embedded within concrete.
5. Where subject to physical damage.
6. Theater dimmer circuits.
7. Where exposed at “floating” or hung ceilings.

C. MC Cable Management:
1. Electric Rooms and Electric Closets: Not allowed exposed.
   a. Provide cable tray for MC cable management within electric rooms and electric closets.
2. Other than Electric Rooms and Electric Closets:
   a. At a minimum provide independent Unistrut support for MC cables
      1) Supports shall be installed such that MC cable length is free of sags.
   b. Where more than eight MC cables are bundled together, provide cable tray for MC cable management.
   c. Contractor shall develop cable management plans for review with Owner, Architect, and Engineer indicating:
      1) Locations of rigid raceway
      2) Locations of MC cable including:

a) Locations of cable tray for MC cable management
b) Indicate locations where field conditions cannot accommodate cable tray.
c) Where cable tray is not required or cannot be installed due to field conditions, indicate method of support such as Unistrut, hanger support etc.

d. Metal clad cable shall be secured using mechanical fasteners. Tie wraps shall not be used to secure cables unless installed in cable tray.

3.5 CONNECTIONS

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

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

C. No modifications to any connector or fitting shall be permitted.

D. The approved connector manufacturer's recommended installation tool and procedures shall be used.

E. All bolt and screw connections shall be torqued in accordance with the manufacturer's recommendations. Subcontractor shall include a copy of the manufacturer's recommendations with all applicable submittals.

F. Where conductors are oversized for voltage drop, provide cable reducing adapters for cable terminations. Cable reducers shall be manufactured by Greaves or equal.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

END OF SECTION

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SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

B. 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 and equipment.

B. Equipment grounding system shall be designed so metallic structures, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits operate continuously and ground potential and provide low impedance path for possible ground fault currents.

1.3 REFERENCES

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
1. NFPA 70 National Electrical Code
2. UL 467 Grounding and Bonding Equipment
3. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
4. IEEE/ANSI 142 Latest Edition Recommended Practice for Grounding of Industrial and Commercial Power Systems
5. ASTM B3 Solid Conductors
6. ASTM B8 Assembly of Stranded Conductors

1.4 SUBMITTALS

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

B. Field quality-control test reports that include the following.
1. Test procedures used.
2. Test results that comply with the requirements.
3. If applicable, results of failed tests and corrective action taken to achieve test results that comply with the requirements.

1.5 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Feeder and Branch Circuit Equipment Ground Conductors: Copper stranded conforming to ASTM B8 and B33wire or cable insulated for 600 V sized as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Insulation class other than 600V shall only be provided where otherwise required by applicable Code or authorities having jurisdiction.

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. Mechanical Connectors: Provide mechanical connectors of the two bolt type, 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.
   1. Materials: The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolted pressure type. Split bolt connector types shall NOT be accepted.
   2. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

C. Compression Connectors: Provide compression connectors that meet or exceed the performance requirements of IEEE 837, latest revision. Compression connectors shall be 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.
   1. Materials: The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
      a. The installation of the connectors shall be made with a compression tool and die system as recommended by the manufacturer of the connectors.
      b. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compressions tool settings.
      c. Each connector shall be factory filled with an oxide-inhibiting compound.

PART 3 - EXECUTION

3.1 GENERAL

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

B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

C. Ground connection surfaces shall be cleaned prior to connections.

D. Examine raceway, equipment or area to receive grounding to provide adequate sizes, placement and materials for a complete installation.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

F. Provide equipment ground conductor in same raceway with associated phase conductors.

3.2 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Conductor Terminations and Connections:
1. Equipment Grounding Conductor Terminations: Bolted connectors.

3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits. Terminate each end on suitable lug, bus, enclosure or bushing, per NEC. Provide a ground wire from each device to the respective enclosure.

B. Install equipment ground conductor in common conduit with related phase or neutral conductors, or both.

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
1. Feeders and branch circuits.
2. Single-phase motor and appliance branch circuits.
3. Three-phase motor and appliance branch circuits.
4. Flexible raceway runs.
5. Metal-clad cable runs.

3.4 INSTALLATION

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

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and reported to the Contractor.
   2. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.

B. Grounding system resistance shall be 5 ohms or less.

C. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

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

END OF SECTION

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

B. 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.

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. 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.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Comply with NFPA 70.

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. 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. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Channel Dimensions: Selected for applicable load criteria.

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

C. 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.

D. 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.

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

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
   1. 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.
   2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
   3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
   4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
   5. Toggle Bolts: All-steel springhead type.
   6. Hanger Rods: Threaded steel.

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 as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slottedsupport system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
   1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps or single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

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

B. 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.

C. 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 Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   3. To Existing Concrete: Expansion anchor fasteners.
   4. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
   5. To Light Steel: Sheet metal screws.
   6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, disconnect switches, pull and junction boxes, and other devices on slotted-channel racks attached to substrate.

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

3.3 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

B. 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:
1. Metal conduit and tubing
2. Metal wireways
3. Boxes, enclosures, and cabinets

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RGS: Rigid Steel Conduit.

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

D. FMC: Flexible metal conduit.

E. IMC: Intermediate metal conduit.

F. LFMC: Liquid tight flexible metal 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. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control test reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. Wheatland Tube Company.
3. O-Z Gedney; a unit of General Signal.
4. AFC Cable Systems, Inc.
5. Greenfield.
6. Anamet Electrical, Inc.; Anaconda Metal Hose.
7. Electri-Flex Co.
8. Permacote.
9. Robroy.

B. Rigid Steel Conduit: ANSI C80.1; zinc-coated steel.

C. IMC: ANSI C80.6: zinc-coated steel.

D. EMT: ANSI C80.3; zinc-coated steel.

E. FMC: Spiral wrapped zinc-coated steel with insulated throats.

F. LFMC: Highly flexible, hot-dipped galvanized steel conduit with PVC jacket with insulated throats.

G. Fittings for Conduit (Including all Types and Flexible and Liquid tight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. RSC: Threaded steel insulated bushings and throats. Locknuts shall be steel/zinc plated.
2. IMC: Threaded steel insulated bushings and throats. Locknuts shall be steel/zinc plated.
3. EMT: Steel or die-cast, set-screw or compression type with insulated bushings and throats.

H. Combination Expansion/Deflection Fittings

1. Fittings shall be threaded, hot dipped galvanized malleable iron or steel with internal bonding jumper.
2. Fittings shall include bonding jumper, insulated bushing and short nipple.

I. Cable Terminators
1. Provide cable terminator assemblies by O-Z/Gedney or equal.
2. Assemblies shall have bakelite discs, neoprene rings and sealing compound within a fitting for attachment to raceway.

J. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 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: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. [Manufacturer's standard enamel ivory finish] [Manufacturer's standard enamel gray finish] [Manufacturer's standard enamel finish in color selected by Architect] [Prime coating, ready for field painting].
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. Wiremold Company.
b. Hubbell Wiring Systems.
c. Mono-Systems, Inc.

2.4 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.

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

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage within Mechanical, Electrical and unfinished areas defined by architect: EMT.
2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit with cast metal device boxes. Includes raceways in the following locations:
   a. Loading dock.
   b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   c. Mechanical and Electrical rooms, below 10’-0” AFF.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: Rigid steel conduit with cast metal device boxes.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

B. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

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. General
1. Check raceway sizes to determine that green equipment ground conductor fits in same raceway with phase and neutral conductors to meet NEC percentage of fill requirements. Increase duct, conduit, tubing and raceway sizes shown or specified as required to accommodate conductors.
2. Install raceway systems complete before drawing in conductors. Blow through and swab after plaster is finished and dry, and before conductors are installed. Wire shall not be pulled into raceway until building roof and walls are weather-tight.

3. Install connectors and couplings as recommended by manufacturers. Compression fittings shall not be used with rigid steel conduit. Set screw fittings shall not be used with rigid conduit. Set-screw connectors for EMT shall be tightened to embed screws in conduit.
4. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 lb. Tensile strength. Provide at least 12" of slack at each end of pull wire with labels.
5. Galvanized rigid steel conduit and intermediate metal conduit installed in corrosive environments shall have all field cut threads coated with an approved, electrically conductive, corrosion resistant compound so that the current carrying ability of the conduit is not compromised.
6. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
7. Penetrate waterproof walls of structural slabs and foundation walls only where approved by Construction Manager. Submit proposed penetration points, size openings and penetration methods to Construction Manager for approval.
8. All conduit penetrations through exterior foundation walls shall be sealed. Provide sealing assemblies between conduit and sleeve. Provide cable terminators in conduit for cable seal. Provide appropriate sleeve through wall for conduit required. Assembly shall be tightened to seal out water.
9. Raceways shall be installed in such a way as to not block exit and equipment service space. Raceway on or adjacent to equipment shall be located to allow free access to all removable panels and equipment service.
10. Minimum Raceway Size: 3/4-inch trade size.
11. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
12. Complete raceway installation before starting conductor installation.

C. Support raceways as specified in Division 26.

D. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which two 90-degree bends are allowed.

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

F. 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.

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

H. Terminations
1. Raceway shall enter and be secured to cabinet, junction box, pull box or outlet box with locknut outside and bushing inside, or with liquid-tight, threaded, self-locking, cold-weld wedge adapter.
2. Provide additional locknut for rigid conduit and wrench- tighten locknut for EMT or flexible conduit where circuit voltage exceeds 250 V. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections.
3. Vertical conduit runs that terminate in bottoms of wall boxes or cabinets shall be protected from entrance of foreign material before installation of conductors.
4. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

5. Provide insulated bushings on raceways entering all panels, switchboards, motor controllers, VFDs, etc. and all boxes 12” x 12” and larger to protect conductors.

I. Expansion/Deflection Fittings
1. Raceway buried or secured rigidly on opposite sides of building expansion joints and long runs of exposed raceway subject to stress due to thermal expansion shall have expansion/deflection fittings. Fittings shall safely deflect and expand to twice distance of structural movement.
2. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting, when integral ground is not provided.
3. Coordinate location of expansion/deflection fittings with the structural and architectural drawings.

J. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

K. Box installation:
1. Check these conditions throughout the entire job and notify the Architect/Engineer or discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation.
2. Install boxes, in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National Electrical Contractors Association’s “Standard of Installation” and in accordance with recognized industry practices to ensure that products serve the intended function.
3. Coordinate box installation with electrical raceway and cable work, as necessary for proper interface.
4. Coordinate cutting of masonry walls and drywalls to achieve neat openings for boxes.
5. Provide all necessary hardware to secure boxes in place.
6. Sheet metal pull boxes shall be supported adequately to maintain shape. Larger boxes shall have structural steel bracing welded into rigid assembly formed adequately to maintain alignment in shipment and installation. Secure covers with corrosion-resistant screws or bolts.
7. Provide clamps, grids and other appurtenances to secure cables within pull boxes. No cable shall be unsupported for more than 30 inches.
8. Provide cable troughs of special shapes, design and construction required to install, support and enclose feeder cable throughout indicated routing. Troughs shall be as specified above for junction and pull boxes, with reinforcing, insulating supports and clamping for cable installation. Cables shall be continuous throughout troughs, and shall be racked in distributed phase groupings arranged with phase cables surrounding neutral conductors.
9. Location
    a. Do not install boxes back to back in same wall.
    b. For boxes mounted in exterior walls install insulation behind the box to prevent condensation in box.
    c. Mount boxes flush with wall in all areas unless noted otherwise on the drawings. Boxes in mechanical rooms may be surface mounted where flush mounting is not possible due to construction.
    d. Where boxes are positioned back to back on opposite sides of walls or partitions, and are less than 24 inches apart in wall cavities of fire rated partitions, provide firestop products suitable for the installation. Boxes shall not be installed on opposite side of walls or partitions of staggered stud construction unless a Wall Opening Protective Material is installed with the box in accordance with classification requirements for the protective materials.

e. Junction and pull box covers shall be readily accessible. Do not install junction or pull boxes above suspended ceilings except where ceiling is removable or where access panel is provided.
f. No pull box shall be within 2 feet of another.
g. Pull boxes connected to concealed conduits shall be mounted with covers flush with finished wall or ceiling. No aluminum pull box shall be embedded in concrete.
h. Location of boxes shall be verified with Architect prior to rough-in.

10. Painting
    a. Exposed conduit, junction boxes and equipment back boxes shall be painted to be as inconspicuous as possible. The Design Professional shall approve the paint color selected. The Electrical Contractor shall prepare color samples for inspection by the Design Professional prior to painting.

3.3 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07.

3.4 PROTECTION

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

END OF SECTION

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SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

B. 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. Power raceway identification materials
2. Power and control cable identification materials
3. Conductor identification materials
4. Cable ties
5. Miscellaneous identification products

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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 CONDUCTOR IDENTIFICATION MATERIALS

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

2.2 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.3 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   1. Minimum Width: 3/16 inch.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.
   4. Color: Black except where used for color-coding.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Emergency Power.

B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied color coding conductor tape for sizes larger than No. 8 AWG.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. Colors for 480/277-V Circuits:
         1) Phase A: Brown.

2) Phase B: Orange.
3) Phase C: Yellow.

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

C. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

D. Panelboard Circuit Identification:
1. For each panel provide typewritten directory of circuits that identifies the circuiting as well as breaker size. The directory shall be a full 8.5 inches x 11 inches sheet behind a plastic pocket that is secured to the panelboard.
2. Panel directories shall identify the panel name, their source of power and voltage.
3. Each circuit directory shall include load name and load location.
4. In addition to the hard copy panel directory, the electrical contractor shall provide the electronic version in its native (word or excel) format as well as PDF format as part of the as-built documentation.

E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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.
1. Labeling Instructions:
a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
2. Equipment to Be Labeled:
a. Emergency system boxes and enclosures.
b.
c. Enclosed switches.
d. Enclosed circuit breakers.

END OF SECTION

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division and Section. However, these requirements are applicable to the work of this Section and are hereby incorporated by reference.

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

1.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to the Building Code and SEI/ASCE 7. Refer to Division 26 for additional information.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.3 SUMMARY

A. Provide all labor, materials and equipment to furnish and install all of the items specified herein, indicated on the drawings and as necessary for the proper and complete performance of work.

B. Panelboards shall be fully rated for available fault currents. Series ratings shall not be accepted.

1.4 REFERENCES

A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
   1. National Electrical Code (NEC)
   2. National Electrical Manufacturer's Association (NEMA).
      a. PB-1 Panelboard
      b. PB1.1 General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
   3. Underwriter's Laboratories (UL)
      a. UL 50 Enclosures for Electrical Equipment
      b. UL 67 Panelboards
      c. UL 508 Standard for Safety Industrial Control Equipment
   4. American National Standard Institute (ANSI)

1.5 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.6 SUBMITTALS

A. Panelboards shall be submitted subsequent to the fault current and coordination studies required in 260573. Equipment submittals prior to the required study shall not be reviewed by the Design Engineer and will be returned “rejected.”

B. Panelboards shall be submitted in a logical fashion and follow the order scheduled on the drawings. Disorganized submittals shall not be reviewed by the Design Engineer and will be returned “rejected.”

C. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

D. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus material, configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices confirming fully rated equipment (series rating of circuit breakers is not acceptable).
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.
   7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit selectable ranges for each type of overcurrent protective device.

E. Qualification Data: For qualified testing agency.

F. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

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

H. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, 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 that allows adjustments.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.

B. Inspect and report concealed damage to carrier within their required time period.

C. Protect equipment throughout construction from damage, weather, excessive temperature, and construction operations.

1.9 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
      a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
      b. Altitude: Not exceeding 6600 feet.

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 Owner no fewer than ten <10> days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of panelboards and components with other trades and construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to dedicated equipment space and workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: One year from date of Substantial Completion.

1.12 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers
   1. The design is based on Square D to establish standards of quality for materials and performance. The naming of a specific manufacturer or catalog number does not waive any requirements or performance of individual components described in the specification. Provide Square D Series NQOB and NF for 225A and below for receptacle and lighting panels and I-Line for distribution and panels above 225A.
   2. Eaton Cutler-Hammer panelboards shall be Type PRL-1 for 225A and below for receptacle and lighting panels, Cutler-Hammer PRL-3 for distribution to 225A and Cutler-Hammer PRL-4 for distribution to 1200A.
   3. ABB-General Electric panelboards shall be Series A for 225A and below for receptacle and lighting panels, ABB-General Electric Spectra Series for panelboards and distribution panels above 225A.
   4. Siemens panelboards Type P1, P2 or P3 for 225A and below for receptacle and lighting panels, Type P4 and P5 for panelboards and distribution panels above 225A.

B. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26.

C. Enclosures: Flush- and surface-mounted cabinets as indicated in the contract documents.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover (door in door type). Opening inner door shall expose circuit breaker operator handles and panelboard directory. Opening outer door shall expose terminals and circuit breakers in a single operation.
3. Where two section panels are required, bolt boxes together to form one unit. Trim shall be two-piece construction with doors of equal size over each section.
4. Power and lighting panels shall have heavy duty, continuous, section vertical-hinging to box section for access to wiring gutters in addition to trim door
5. Skirt for Surface-Mounted Panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   b. Back Boxes: Galvanized steel.
7. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover. Directories shall be typed showing use of each circuit and the panelboard designation.
8. Panelboard designations shall be labeled on the front of the panel with a screw-on nameplate.

D. Incoming Mains Location: **Top and bottom** Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

H. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, listed and labeled for series-connected short-circuit rating by an NRTL.

I. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PANELBOARDS

A. Panelboards shall meet or exceed requirements of NEMA Standard Publication PB-1 and UL-50 and 67. Provide cabinets with flush hinges and combination catch and lock. Provide wiring gutters to accommodate large multiplier feeder cables and lugs. Except as shown otherwise on drawings, wiring gutters shall be at least 4” for lighting and 208V panels and 6” for 480V panels.

B. Increase size of panelboard gutters to accommodate compression connectors for aluminum conductors.

C. Panelboards shall have short circuit current rating equal to or greater than circuit breaker AIC ratings schedule on drawings. Panelboards rated 240 volts shall have the following minimum ratings:
   1. 10k AIC where shown fed via a 150 kVA transformer and less.
   2. 22k AIC where shown fed via a 225 kVA and 300 kVA transformer.
   3. 35k AIC where shown fed via a 500 kVA transformer.

D. Panelboards served from transformers shall have a main breaker, unless an enclosed circuit breaker or fused switch is shown.

E. Main bus bars shall be copper, sized as required by UL standards to limit temperature rise on current carrying parts to 50°C above ambient 40°C maximum. Main bus bars shall be sized at least to full rating of feeders overcurrent device that feeds the panelboard.

F. Provide molded case, bolt-on, thermal-magnetic trip, single, two or three pole branch circuit breakers as shown on drawings. Multiple pole breakers shall be single handle, common-trip. Circuit breakers shall be listed and labeled for 75°C conductor ampacities.

G. Provide bus connections for future overcurrent device with suitable insulation and bracing to maintain proper short circuit rating and voltage clearances, where required on drawings. Provide for ready insertion of future breaker.

H. Provide separate equipment ground bus for each panelboard.

I. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Main and Neutral Lugs: Mechanical type.
   2. Ground Lugs and Bus-Configured Terminators: Mechanical type.

J. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

K. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
   2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
   3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long- and short-time pickup levels.
      c. Long- and short-time time adjustments.
      d. Ground-fault pickup level, time 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
   a. Standard frame sizes, trip ratings, and number of poles.
   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
   d. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
   e. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 PANELBOARD SURGE PROTECTION DEVICES

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards at delivery before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine the areas and conditions under which panelboards are to be installed and notify engineer in writing of conditions detrimental to the proper and timely completion of work.

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

3.2 INSTALLATION

A. Install panelboards where indicated, in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National Electrical Contractors Association’s “Standard of Installation” and in accordance with recognized industry practices to ensure that products serve the intended function.

B. Install all flush mounted panelboards with one spare 1½ -inch and two ¾” conduits from panel to above accessible ceiling.

C. Location:
   1. Maintain the minimum NEC clearances about the equipment.

2. Locate top of enclosures approximately 6’-6” above floor, at a masonry joint if applicable. Panelboard shall never be mounted such that the handle of the highest circuit breaker exceeds 6’-6” AFF.
3. Provide 1/2” spacers for panelboards mounted at exterior walls below grade to establish an air space behind panel.

D. Anchoring:
1. Provide all necessary hardware to secure panelboard in place. Anchor enclosure firmly to walls and structural surfaces, ensuring that they are permanently and mechanically secure.
2. Mount free standing distribution panels on 6-inch high concrete pads with 1-inch chamfered edges.
3. Comply with mounting and anchoring requirements specified in Division 26.

E. Branch circuit wiring shall be peeled out of the wiring gutters at 90 degrees to circuit breakers and terminal lugs for a neat installation.

F. Install overcurrent protective devices and controllers not already factory installed.

G. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 BALANCING LOADS

A. After Substantial Completion, but not more than two months after Final Acceptance, conduct load balancing measurements and circuit changes as follows:
1. Perform measurements during period of normal working load as advised by the Owner.
2. Perform load-balancing circuit changes outside the normal occupancy/working schedule of the facility. Make special arrangements with the owner to avoid disrupting critical 24-hour services such as FAX machines, and on line data processing, computing, transmitting and receiving equipment.
3. Recheck loads after circuit changes during normal load period. Record all load readings before and after changes and submit test record.
4. Tolerance: Difference between phase loads exceeding 20 percent at any one panelboard is not acceptable. Rebalance and recheck as required to meet this minimum requirement.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26.

B. Directories:
1. Fill out the enclosure circuit directory card upon completion of work and install in panelboard.
2. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
3. Incorporate Owner's final room designations. Obtain approval before installing.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26.

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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

C. Perform tests and inspections.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Acceptance Testing Preparation:
1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

F. Panelboards will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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SECTION 27 41 16 – AUDIO VISUAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Integrated Audio-Video Systems and Equipment as part of the Work.

1.2 SECTION INCLUDES

A. Project instruction for the Contractor, and Sound System description details

B. Sound System Product description

C. Project completion instruction for the Contractor

1.3 RESPONSIBILITY

A. This is a renovation project. Computer based CAD drawings are very limited and available for only the main and section plans with significant level of detail variations on each and as such the documents may not depict every detail or existing condition needed to complete this work. The Contractor is responsible for reviewing all existing site conditions that may affect the installation of this work with any exclusions clearly noted within RFP response. If a specific task implied or described within the drawings and specifications is not listed as excluded, it is assumed to be included and to be provided as part of this work.

B. As a renovation project, existing conditions both physical and related to electronic systems, are present. Reasonable effort to identify conditions prior to bid is expected. Notify Owner immediately of any items or issues discovered during construction which prevent or obstruct progress or completion of scope. Provide a solution or remedy to the issue with a rough order of magnitude cost for workable solution.

C. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Contractor to supply all materials, equipment, transportation, engineering, and labor necessary to provide a fully working, tested, and calibrated system. Supply accessories and equipment (such as, but not limited to: power strips, adapters, connectors, mounting hardware, etc.) needed for a complete system, even if not specifically mentioned in these Specifications. Notify the Architect of any discrepancies in part numbers or quantities before bid. Failing to provide such notification, supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.

D. Specifications and drawings are complementary. Work called for by one is binding as if called for by both. Any discrepancies between specifications and drawings shall be brought to the attention of the Owner for clarification during the bidding period. No allowance shall subsequently be made to the Contractor by reason of their failure to have brought said discrepancies to the attention of the Owner.

E. Execute all work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code, the Occupational Safety and Health Act (OSHA) and all applicable State and Local codes, ordinances, and regulations. If a conflict develops between the contract documents and the appropriate codes and is reported to the Architect prior to bid opening, the Architect will prepare the necessary clarification. Where a conflict is reported after contract award, propose a resolution of the conflict and, upon approval, perform Work.

F. Required licenses, insurance, and permits including payment of charges and fees.

G. Verification of dimensions and conditions at the job site.

H. Coordinate location and installation of equipment, power, grounding, and raceways with other building elements.

I. Preparation of submittal information.

J. Pick-up of Owner Furnished Equipment (OFE) and incorporation into project if applicable.

K. Development and implementation of AV control system software code and control panel layouts, which will become the property of the Owner.

L. Installation in accordance with the contract document, manufacturer's recommendation, and in conformity with applicable codes and authority having jurisdiction (AHJ).

M. Final tests and adjustments, written report, and documentation.

N. Instruction of operating personnel.

O. Provision of manuals.

P. Maintenance services and warranty.

1.4 RELATED WORK

A. Coordination between disciplines is required to achieve a proper system installation.

B. Electrical
1. Electrical work shall be coordinated with division 26.
2. Provide breaker panel and distribution of electrical power from the panel to the equipment as required.
3. A ground point will be provided in each equipment room or enclosure electrical panel. Provide connecting ground point to all equipment in accordance with NEC Code, local codes, and standards specified herein.
4. Provide conduit infrastructure system
    a. Conduit and Cable Management
        1) Install cabling in conduit, provided as shown on the Electrical and AV drawings. If additional conduit/raceway/tray is required for systems, provide at no additional cost.
        2) Conduit/raceway/tray/wire management not shown on these drawings, but required for a complete system, or by code, is to be included in this scope of work.
        3) Exterior junction boxes, conduit/raceway, terminations, etc. and those within enclosures where enclosures are exposed to outdoor conditions are to meet NEMA ratings for outdoor electrical applications.

C. Structural
1. The contractor shall be responsible for design and structural engineering for all loudspeaker brackets attaching the loudspeakers (and/or loudspeaker hoisting system) to the building structure at position shown within the drawings. Coordinate device weight loads with the Project’s Structural Engineer.

D. Networks
1. Provide network switches, cable plant, and interfaces as required for two discrete audio systems in the venue: Seating Bowl PA and Back-of-House PA.
2. Provide dedicated network cabling and hardware to support control of, and audio feed to, Priority Communications System processors and amplifiers which are part of the seating bowl public address system.
3. Coordinate with the data network installer and in-house IT department to establish non-conflicting IP addresses for all of the AV equipment. Ensure that the configuration of the audio distribution and control networks for both seating bowl PA and back of house systems audio are secure, and that all reasonable measures are taken to prohibit

unauthorized access to the audio streams, audio routing, and control features of the Digital Audio Network (DAN).

1.5 REFERENCES

A. Published specification standards, tests or recommended methods of trade, industry or governmental organizations apply to Work in this section where cited below:
1. American National Safety Institute (ANSI)
2. American Society of Testing and Materials (ASTM)
3. Electronics Industries Association (EIA)
4. Federal Communications Commission (FCC)
5. National Electrical Manufacturer's Association (NEMA)
6. National Electrical Code (NEC)
7. Underwriters Laboratories (UL)
8. Occupational Safety and Health Administration (OSHA)
9. Society of Motion Picture and Television Engineers (SMPTE)
10. Building Industry Consulting Service International (BICSI)
11. Americans with Disabilities Act (ADA)
12. AVIXA published standards
13. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
14. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
15. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009
16. Middle Atlantic – Thermal Management White Paper

1.6 DEFINITIONS

A. In addition to those Definitions of Division 1, the following list of terms as used in this specification shall be defined as follows:
1. Furnish: To purchase, procure, acquire, and deliver complete with related accessories.
2. Install: To set in place, join, attach, link, set up, or otherwise connect together and test until complete before turning over to the Owner. All parts, items, or equipment supplied by Contractor.
3. Provide: To furnish and install.

1.7 SYSTEMS DESCRIPTIONS AND REQUIREMENTS

A. The following is intended to provide an overview of the required work details, system features, and design concepts for the Work as shown on the project drawings and is not intended to be an exhaustive description of the systems.

B. The Work includes provision of a complete and working Sound System, providing sound to fixed spectator seating areas.

C. This is a renovation project.
1. The Work includes demolition of the existing Main Bowl sound system.
    a. Remove existing loudspeakers with associated rigging systems, amplifiers, mixing console, Digital Signal Processor (DSP) system, and source devices.
    b. Palletize removed equipment and coordinate disposal with the Owner.
    c. Remove cabling not intended for re-use.
    d. Remove conduit and other pathways not intended for re-use.
2. Coordinate with Owner all Audio Control Booth equipment scheduled for re-use: intercom equipment, Video Production interface equipment, etc.
3. Test and refurbish (as needed) analog lines and connectors from Broadcast, Press, and Main Bowl Junction Boxes.

4. A full re-tuning of the Sound systems will be part of this work. Assume a minimum of one day to complete this tuning effort.
5. Provide surface material repair and painting where needed as part of your base bid.

D. The Audio Control Booth will house the mixing console, control room monitors, equipment rack, stage box, input sources, wireless microphone systems, patchbay system, and assistive listening system. ER-MIX will house all rack-mountable equipment.
1. All essential Main Bowl sound system equipment in the control room is to be provided with UPS backup.
2. Locate fan cooled equipment away from the work areas in the Audio Control Booth: Digital Signal Processor (DSP) system, control computer, and network equipment. This equipment will be housed in ER-FOH located in the room adjacent to the Audio Control Booth.

E. A Digital Audio Network (DAN) with Primary and redundant Secondary network equipment and cabling is provided as part of the Work. This DAN will provide control, monitoring, and audio transport capability to each sound system edge device in ER-300, ER-301, ER-MIX and ER-FOH as well as the portable equipment racks connection points.
1. Network equipment associated with the DAN is for use only with the DAN and is not part of the building wide converged network.
2. Coordinate with the Owner a connection to the building WiFi system to allow iPad control of the mixing console.
3. Connections for Main Bowl Audio are point-to-point, do not route through patch.
4. DAN connection points for the portable equipment racks are located on Event Level, Main Concourse Level, and Mezzanine Level.
5. Portable equipment racks housing a Stage Box and Network Switch are provided as part of the Work.

F. Main Array Loudspeakers Type 20 and Type 21
1. Sports Events
   a. Flown in a manner that allows the Main Arrays to lift above lower chord steel for special events. The motorized lift system is to be programmed with stops at floor level, performance trim height level, and at rest above lower chord steel level. Dead-hang points are provided at the rest position above lower chord steel.
      1) Provide custom rigging frames that include mounting for Type 20 and Type 21 loudspeakers, as well as a cable basket for the travel cable, and an equipment rack for power and network distribution.
      2) Provide two 1-Ton motors per main array.
      3) Provide hang points at high steel level for each Main Array that allows the Main Arrays to pass through the lower chord for storage during special events.
   b. Provide an aiming software preset for this configuration.
2. End-stage Events
   a. Type 20 and Type 21 loudspeakers will be dropped from their locations around the center hung scoreboard, reconfigured, and rehung in an end-stage configuration. Provide equipment for portable use as described in Part 2 of this specification, and coordinate other Owner provided equipment for this application with the Owner.
   b. Provide an aiming software preset for this configuration.
3. Reference Arena Rigging Systems Specification 11 61 33.

G. As an aid to the fire alarm system, the Main Seating Bowl systems will receive warning signals and announcements from the main fire command center. Coordinate final configuration with Owner and Authority Having Jurisdiction (AHJ).
1. Provide cabling to interface Audio System with Fire Alarm Panel
2. Provide contact closure(s) interface to the Audio System as needed
3. Provide analog audio input to the Audio System DSP
4. Provide GPIO contact closure points in the Audio System DSP

5. Insert a 24dB/Octave Butterworth 300 Hertz high-pass filter in the DSP Fire Alarm signal path, to reduce Sound System electrical load on the emergency electrical systems

H. A wireless RF Assistive Listening System will be provided for the seating bowl. The system is to operate on a coordinated frequency to provide interference free operation with other radio-frequency systems and will operate on an FCC approved frequency. The transmitter will be located in the Audio Control Booth, with the antenna placed in the seating bowl, providing a clear line of sight to attendees.

I. Equipment Rooms and Power Distribution
1. Main Seating Bowl loudspeakers are served by amplifiers and network equipment located in ER-300 and ER-301 on the Catwalk.
2. Configure the electrical service for the Main Array Loudspeakers, Type 20 and Type 21, for 208VAC.
3. Update electrical service in each equipment rack as needed to serve new equipment.
   a. 120VAC or 208VAC is acceptable for amplifiers. If 208VAC is chosen, adjust circuit size accordingly, relative to the following:
      1) Type 1 Amplifier: 120VAC 30A circuit. One Type 1 amplifiers to a single 120VAC 30A circuit

J. Paint new conduit and other new pathways to match surroundings.

K. Loose Cabling
1. Each cable provided with heat-shrink label identifying facility name and cable length.
2. Each cable provided with a hook and loop tie strip to keep cable coiled. Use a different color of tie for cables of each length.

L. DSP Control System:
1. The DSP Control System and Graphic User Interface (GUI) shall be programmed by an authorized and certified programmer.
   a. Provide this programming service as part of your base bid.
2. Coordinate loudspeaker configuration presets with the Owner to accommodate the different uses of the venue.
3. The Graphic User Interface (GUI) should be designed using these general guidelines:
   a. Use CAD based images of the venue whenever possible to convey geographic information. Include cardinal mapping points to indicate direction in reference to the image used.
   b. Use Owner approved team logos for Touch Panel backgrounds.
   c. Reference Part 3.4 of this specification.
4. Common GUI features to all systems:
   a. Fire Alarm over-ride
      1) Provide Fire Alarm over-ride programming as necessary to mute signals from the Audio System, and route any emergency audio signals as directed by Owner
         a) Provide a bold indicator in DSP Graphic User Interface (GUI) on all computers and Touch Panels to indicate that the Sound System is in an Alarm condition.
   b. System Health
      1) Use a green colored button to indicate “good” and a red colored button to indicate “fault”. This is intended to be a system wide fault detector programmed to include:
         a) Amplifier Fault or Failure
         b) Amplifier Open/Shorted Load
         c) Amplifier Online/Offline
         d) Network Fault or Failure
         e) DSP Online/Offline
         f) DSP Fault or Failure

2) Coordinate with the Owner and Operations team if they wish to receive SMS or an email when a fault occurs.

c. Access Control
1) The Control computers in the Audio Control Booth equipment racks are the only locations where full access, with a password, to the entire system is possible.
2) Access to the system from the Audio Control position is limited to the Main Bowl Sound System.
3) Access to the system from any Touch Panel location is limited to the area that particular Touch Panel is located in.

d. Provide manufacturer loudspeaker settings, loaded into the appropriate signal path, for each loudspeaker with manufacturer settings available.

5. After receiving Notice to Proceed, coordinate monthly DSP Graphic User Interface (GUI) review sessions with the Owner, Architect, and A/V Consultant.
a. Review should include signal flow diagrams, screenshots of control GUI's for computers, wired Touch Panels, and wireless iPads as they are developed.
b. 60 days prior to final system commissioning, the Review should include a working demonstration of all computers, Touch Panels, wireless iPad controllers, and networked Volume/Source selectors.

1.8 ADDITIVE ALTERNATES (ADD/ALT)

A. Provide breakout pricing for each ADD/ALT

B. ADD/ALT1 – Type 24 Upper Deck loudspeakers
1. Provide Type 24 loudspeakers as shown on drawings
2. Amplifier channels as shown on drawings
3. Associated conduit and other pathways
4. Cabling
5. Labor

1.9 SUBMITTALS

A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.

B. Submittals shall contain sufficient information to describe the Work to be performed. Reviewed shop drawings are to be used for final coordination and construction.

C. Shop drawings must be original work produced by the Contractor responsible for performing the work defined in this specification. Scanning, photographic copying, materially copying, or any other reproducing the contents of the drawings or specifications contained within the Contract Documents will be marked as unacceptable and not reviewed for any content. No claim shall be made for delay, undue burden, or additional costs for the effort to produce shop drawings, schedules, and equipment lists addressing this specification or the overall project manual.

D. Supplementary submittal requirements:
1. Provide the following in one submission for approval within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of Work:
a. Complete schedule of submittals.
b. Chronological schedule of Work in bar chart form.
c. Product Data Sheets:
1) Submissions that do not follow the format and configuration described will be returned without review.
2) Provide a complete table of contents with the following information:
a) Project title.

b) Submittal number. In the case of a resubmittal, use the original submittal number immediately followed by the suffix “R” immediately followed by a unique number and be numbered in consecutive order.
c) Date of submission.
d) Provide a list of and Manufacturer's data sheets on products to be incorporated with the Work. Arrange data sheets in the same order they appear in this specification. Where a data sheet shows more than one product, indicate the model being proposed with an arrow or other appropriate symbol.
e) Submit manufacturer’s product literature for each type of firestop material to be used. Literature shall include documentation of UL classifications or approved third party testing. Manufacturer’s name and number for each part shall be included. Submit drawings of through penetrations, which include the system to be utilized for the firestopping application. Drawing shall indicate construction of wall or floor assembly; size, number and material of penetrating items; firestop system designation; required F-rating, T-rating and remarks.
f) Provide high quality copies with all text legible and illustrations of adequate resolution and sharpness for review. Internet web pages, faxed copies or copies with portions of the information missing or smeared not acceptable.

d. Shop Drawings:
1) Functional Diagrams/Schematics:
a) Detailed wiring diagrams showing interconnection of components and products, wiring and cabling diagrams depicting cable types and cable designators, and device designators. Provide connector designations and terminal strip identification, along with color codes for cables connecting to these devices. Give each component a unique designator and use this designator consistently throughout the project.
2) Coordination Drawings:
a) Prepare and submit a set of coordination drawings showing major elements, components, and devices of the AV Systemin relationship with other building components. Prepare drawings to an accurate scale of 1/8” =1’-0” or larger on suitable sized media.
b) Prepare floor plans, reflected ceiling plans, elevations, sections, and details to conclusively coordinate and integrate all equipment. Indicate locations where space is limited, and where sequencing and coordination of installations is of importance to the efficient flow of the work including but not necessarily limited to the following:
(1) Equipment housings
(2) Ceiling and wall mounted devices
(3) Raceways
(4) Cabling

e. Equipment housing: Location of equipment in racks, consoles position on tables or counters. Details to include dimensions; wire routing and cabling within housings; AC power outlet and terminal strip locations.
f. Patch panel layouts and labeling strips, including color schemes.
g. Full fabrication details of custom enclosure and millwork indicating size, material, finish and openings required for equipment and enclosures.
h. Structural rigging and mounting details:
1) Loudspeaker rigging, suspension, and mounting detail drawings shall be signed and sealed by a professional engineer licensed to practice in the state in which the project is located. The signed and sealed drawings noted above to include the following:

a) Analysis of all components in the load path and attachment method to building structure for suspended loudspeakers.
b) Attachment method for mounting brackets at ceilings, walls, or other building features.
c) Detail the product manufacturer, part numbers, and load capacity of the hardware fittings and materials selected for suspended or mounted loudspeakers.
d) A copy of the design calculations.
e) Secondary steel required for attachment to the building structure.
f) Custom brackets, mounts, suspension grids or trusses, loudspeaker cabinet frames, or loudspeaker brackets.
g) Loudspeaker brackets or mounts provided by the specific loudspeaker manufacturer being installed that do not include traceability data.

2) Risk analysis data as referenced in Part 3.2, F
3) Stamping Engineer post-installation sign-off as described in Part 3.2, F
4) Proof of ETCP certification for on-site rigging crew.

i. Fabricated Plates and Panels
1) Provide complete drawings on custom fabricated plates or panels. Drawings shall include dimensioned locations of components, component types, engraving information, plate material and color, and bill of material. Provide samples of plate color options for review.

j. Labeling
1) Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.

k. Schedules
1) Wiring schedule showing source and destination of wiring and indicating which wiring is in conduit. Junction box schedule showing type of box, size, mounting and location. Include this information with remainder of wiring diagrams.

l. Control System Software
1) Provide electronic copies of proposed control system user interfaces within sixty (60) days of issuance of Notice to Proceed (NTP).

m. IP Addresses
1) Coordinated with the venue IT Adminstrator, provide a list of IP addresses, by device, used in the project.

E. Submittal format:
1. Consultant’s project documents in electronic format will not be supplied to the Contractor for their use as part of submittals.
2. Standards:
a. Floor plan drawings executed at an appropriate scale, not less than 1/8” = 1’-0”.
b. Detail drawings executed at an appropriate scale, not less than 3/8” = 1’-0”.
c. Plate and panel drawings executed at an appropriate scale, not less than 1/2” = 1”.
d. Rack, enclosure, and millwork detail drawings executed at an appropriate scale, not less than 1” = 1’-0”.
3. Electronic Submittals: Submit in non-proprietary PDF format. Combine product literature into a single file for each Part 2 subheading (i.e.: 2.3 Microphones and Accessories, 2.4 Input Sources, etc.). Shop drawings may be combined into logical sections such as legend, floor plan, section, detail, functional, etc.
4. Hardcopy Submittals: Bind submittal in titled three ring D style binders sized for 150 per cent of the material. Maximum size: three-inch spine. Use multiple volumes as required. Separate major grouping with labeled binder tabs.

F. Resubmission requirements:
1. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.

2. Indicate all changes that have been made by clouding and noting with a revision marker. Drawing title block to track all revisions.
3. Also indicate all changes that have been made other than those requested.

1.10 CONTRACT CLOSE-OUT DOCUMENTS:

A. Provide close-out submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated, after substantial completion but prior to final observation:

B. Supplementary submittal requirements:
1. Provide the following in one electronic submission for review.
2. Equipment Manuals:
   a. Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein
   b. Supply manufacturer’s serial numbers for each Product
   c. For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item
   d. Separately bind list by manufacturer and model or part number of Products incorporated within the Work, arranged in alpha numeric order. When applicable, bind Manufacturer's warranty statements separately.
3. Test Reports: Recorded findings of Commissioning.
4. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
   a. This procedure should describe the operation of system capabilities.
   b. Assume the intended reader of the manual to be technically inexperienced but unfamiliar with the components and the facility.
5. Service Information, including service phone number(s) and hours; service schedule; description of products recommended or provided for maintenance purposes, and instructions for the proper use of these products.
6. Any other pertinent data generated during the Project or required for future service.
7. Within three weeks of final observation, submit the following in one electronic submission for review. Upon Owners and/or Consultant’s request, provide hard copy files of the following:
   a. Record drawings: Final rendition of Shop Drawings depicting what is actually incorporated within the Work.
   b. Record drawings in AutoCAD editable DWG format and Adobe PDF format. Resolution to be sufficient to permit Owner’s technicians to be able to clearly read all notes and text on screen.
   c. One set of signed proof-of-training documents.
8. Submittal Format:
   a. Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1’-0”.
   b. Segregate documents into separate folders containing data relevant to operational, maintenance, and warranty issues. Appropriately duplicate data within the separate bindings when it will reasonably clarify procedures, e.g., operational data in a maintenance folder.
   c. Project Record Manual
      1) Provide product data submittal in a single PDF file.
      2) Provide an indexed list of major groupings.
      3) In the index, provide clickable hyperlinks that lead to the page of that major grouping.
      4) Organize index and major groupings in logical signal-flow order.
9. Resubmission requirements:
   a. Make all requested corrections or change in submittals required. Resubmit for review until no exceptions are taken.

b. Indicate all changes that have been made other than those requested.

1.11 CUSTOM SOFTWARE

A. Introduction:
1. Proprietary software provided for the Technical Systems shall be subject to this software license between the Contractor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings and agreement.
2. Contractor shall agree that 3rd party proprietary software provided with the system shall be subject to this agreement.
3. Contractor and Owner agree that this software license is deemed to be part of, and subject to, the terms of the Agreement applicable to both parties; and shall supersede any standard manufacturer or Contractor's standard license agreement.
4. Proprietary software shall be defined to include, but not be limited to, device and system specific software and firmware designed to run on conventional computer based operating platforms as well as all micro-processor-based hardware used to program, setup, or operate the system or its components.
5. For sake of this agreement, MS Windows® shall not be considered "proprietary" software, unless a non-public version of Windows® or any of its components are critical to the operation of the system in which case it shall be deemed proprietary.

B. License Grant and Ownership:
1. Contractor hereby grants to Owner a perpetual, non-exclusive, site license to all software for Customer's use in connection with the establishment, use, maintenance and modification of the system implemented by Contractor. Software shall mean executable object code of software programs and the patches, scripts, modifications, enhancements, designs, concepts or other materials that constitute the software programs necessary for the proper function and operation of the system as delivered by the Contractor and accepted by the Owner.
2. Except as expressly set forth in this agreement, Contractor shall at all times own all intellectual property rights in the software. Any and all licenses, product warranties or service contracts provided by third parties in connection with any software, hardware or other software or services provided in the system shall be delivered to Owner for the sole benefit of Owner.
3. Owner may supply to Contractor or allow the Contractor to use certain proprietary information, including service marks, logos, graphics, software, documents and business information and plans that have been authored or pre-owned by Contractor. All such intellectual property shall remain the exclusive property of Owner and shall not be used by Contractor for any purposes other than those associated with delivery of the system.

C. Copies, Modifications, and Use:
1. Source code shall be available to Owner for a period of not less than 10 years.
2. Owner may make copies of the software for archival purposes and as required for modifications to the system. All copies and distribution of the software shall remain within the direct control of Owner and its representatives.
3. Owner may make modifications to the source code version of the software, if and only if the results of all such modifications are applied solely to the system. In no way does this Software License confer any right for Owner to license, sublicense, sell, or otherwise authorize the use of the software, whether in executable form, source code or otherwise, by any third parties.
4. All express or implied warranties relating to the software shall be deemed null and void in case of any modification to the software made by any party other than Contractor.

D. Warranties and Representations:
1. Contractor represents and warrants to Owner that:

a. It has all necessary rights and authority to execute and deliver this Software License and perform its obligations hereunder and to grant the rights granted under this Software License to Owner;
b. The goods and services provided by contractor under this Software License, including the software and all intellectual property provided hereunder, are original to Contractor or its subcontractors or partners; and
c. The software, as delivered as part of the system, will not infringe or otherwise violate the rights of any third party, or violate any applicable law, rule or regulation.

2. Contractor further represents and warrants that, throughout the System Warranty Period, the executable object code of software and the system will perform substantially in accordance with the System Specifications and Agreement. If the software fails to perform as specified and accepted all remedies are pursuant to the policies set forth in the Specification and in the Agreement. No warranty of any type or nature is provided for the source code version of the software which is delivered as is.
3. Except as expressly stated in this Agreement, there are no warranties, express or implied, including, but not limited to, the implied warranties of fitness for a particular purpose, of merchantability, or warranty of no infringement of third party intellectual property rights.

1.12 QUALITY ASSURANCE

A. Qualifications: Contractor to be experienced in the provision of systems similar in complexity to those required for this project, and meet the requirements listed below. Provide documentation at the time of bid to support these qualifications:
1. Form of corporation.
2. No less than three years' experience with equipment and systems of the specified types.
3. Experience with at least three comparable scale projects within the last three years.
4. Be a franchised dealer and service facility for the manufacturer's products furnished.
5. Maintain a fully staffed and equipped service facility with full-time field technicians.
6. Have at least one supervisory on-site employee who has completed and has been certified CTS-I by Infocomm.
7. Supervision of all rigging by an ETCP certified rigger for all work associated with suspension or mounting of overhead equipment.
8. Adequate plant capacity and equipment to complete the Work.
9. Adequate staff with commensurate technical experience.
10. Suitable financial status (i.e., bonding and materials purchase capacity) to meet the obligations of the Work.
11. Adequate regional service organization to meet warranty response requirements of the Project.
12. Provide listing with appropriate explanation regarding the status of Contractor's resolved or unresolved legal disputes within the last six calendar years.
13. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Contractor has failed to meet construction schedules due to Contractor's cause.
14. Completed current version of the AIA Contractor's Qualification Form.

B. Subcontractors: at the time of bid, the Contractor shall provide a list of structural, electrical, sound, or any other subcontractors intended to do the Work, or are being retained as local service providers throughout the warranty period. Subcontractors shall be appropriately state licensed in their specialty and must provide the same qualification documents as the Contractor.

C. Work: Perform Work in compliance with the applicable standards listed herein and governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
1. Drawings and specification requirements govern where they exceed Code and Regulation requirements.
2. Where requirements between governing Codes and Regulations vary, the more restrictive provision applies.

3. Nothing in the Contract Documents grants authority or permission to disregard or violate any legal requirements.

D. Coordinate exact location and installation of equipment, power, grounding, and raceway requirements with the Architect.

1.13 DELIVERY, STORAGE & HANDLING

A. Ship Products in its original container, to prevent damaging or entrance of foreign matter.

B. Handling and shipping in accordance with Manufacturer's recommendation.

C. Provide protective covering during construction of all installed devices, to prevent damaging or entrance of foreign matter.

D. Replace, at no expense to Owner, Products damaged during storage, handling, or through the course of construction.

1.14 PROJECT CONDITIONS

A. Verify conditions on the job site applicable to this work. Notify Architect in writing of discrepancies, conflicts, or omissions promptly upon discovery.

B. The Drawings diagrammatically show cabling and arrangements of equipment fitting the space available without interference. If conditions exist which make it impossible to install work as shown, recommend solutions and/or submit drawings to the Architect for approval, showing how the work may be installed.

1.15 WARRANTY

A. Warrant labor and equipment for one year following the date of substantial completion to be free of defects and deficiencies, and to conform to the drawings and specifications as to kind, quality, function, and characteristics. Repair or replace defects occurring in labor or equipment within the Warranty period without charge.

B. This warranty is in addition to any specific warranties issued by manufacturers for greater periods of time.

C. Within the warranty period, answer service calls within twenty-four (24) hours during normal working hours and correct the deficiency within forty-eight (48) hours.

D. Provide Owner with the name and telephone number of the person to call for service. This information to be part of Project Closeout Documents.

E. Thirty days prior to the end of the warranty period provide a complete checkout of all system components. Repair or replace any defective equipment discovered during the testing. Correct any defects in wiring or other functional problems reported by Owner. Warranty replacement and service of equipment shall not apply to Owner furnished equipment (OFE). Coordinate an observation visit with the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Products quantity is as required. If a quantity is given, provide at least the given amount. Some product listed may not be required to fulfill the obligations of the Work.

B. Equipment and materials shall be new and conform to applicable UL or ANSI provisions.

C. Regardless of the length or completeness of the descriptive paragraph herein, provide Products complying with the specified manufacturer's published specifications.

D. Remove or blank out all manufacturers' names, logos, or other symbols from loudspeakers or other objects placed in view of the public. If logos are removable, remove and repaint to the color of the adjacent surface and reattach.

E. Take care during installation to prevent scratches, dents, chips, etc.

2.2 ACCEPTABLE MANUFACTURERS

A. Model numbers and manufacturers included in this specification are listed as standard of function, performance, and quality, forming the basis of design.

B. If a specified product has been discontinued by a manufacturer, provide the replacement model (as certified by the manufacturer) at no additional cost.

C. Where required, provide manufacturer's rack mount adapter or one manufactured by Middle Atlantic or Winstead unless specified elsewhere.

2.3 MICROPHONES AND ACCESSORIES

A. Wireless Microphone System:
   1. Coordinate Band selection with the Owner
   2. Dante Capable
   3. Acceptable Product:
      a. Shure; to include the following:
         1) Shure ULXD4Q Four Channel Receiver (WRLS)
         2) Shure ULXD2/SM58 Handheld Transmitter (Quantity: 8)
         3) Shure ULXD1 Beltpack Transmitter (Quantity: 4)
         4) Shure WL185 Cardioid Lavalier Microphone (Quantity: 4)
         5) Shure UA874 Remote Directional Antennas (ANT WLM)
         6) Shure SBRC rack mounted battery charger (SBRC)
         7) Shure SBC-AX charging module (Quantity: 4)
         8) Shure SB900B Lithium Ion Battery (Quantity: 8)
      b. Audio-Technica; to include the following:
         1) Audio-Technica ATW-R5220DAN Two Channel Receiver (WRLS) (Quantity to match capability of Shure system above)
         2) Audio-Technica ATW-T5202 Handheld Transmitter (Quantity: 8)
         3) Audio-Technica ATW-C4100 Cardioid Dynamic Microphone Capsule for use with ATW-T5202 Handheld Transmitter (Quantity: 8)
         4) Audio-Technica ATW-T5201 Beltpack Transmitter (Quantity: 4)
         5) Audio-Technica AT898cH Cardioid Lavalier Microphone (Quantity: 4)
         6) Audio-Technica DFINB Remote Directional Antennas (ANT WLM)
      c. Sennheiser; to include the following:
         1) Sennheiser EM6000-Dante Two Channel Receiver (WRLS) (Quantity to match capability of Shure system above)
         2) Sennheiser SKM 6000 Handheld Transmitter (Quantity: 8)
         3) Sennheiser MMD 835 BK Cardioid Dynamic Microphone Capsule for use with SKM 6000 Handheld Transmitter (Quantity: 8)
         4) Sennheiser SK 6000 Beltpack Transmitter (Quantity: 4)
         5) Sennheiser ME 4 Cardioid Lavalier Microphone (Quantity: 4)
         6) Sennheiser ADP-UHF Remote Directional Antennas (ANT WLM)
         7) Sennheiser L 6000 rack mounted battery charger (SBRC)
         8) Sennheiser BA 60 rechargeable handheld battery (Quantity: 12)
         9) Sennheiser BA 61 rechargeable beltpack battery (Quantity: 6)
         10) Sennheiser LM 6060 charging module (Quantity: 6)

11) Sennheiser LM 6061 charging module (Quantity: 2)

B. Seating Bowl Crowd Microphone (AM):
1. Single gang panel mount microphone element
2. Boundary plate pressure zone microphone
3. Hemispherical pickup pattern
4. Acceptable Product:
a. AKG PZM-11LLWR
b. Approved Equivalent

2.4 AV INPUT SOURCES

A. Media Player/Recorder (MPR):
1. Playback from CD, SD card, or USB
2. Record to CD, SD card, or USB
3. AES/EBU Digital input and output on XLR connectors and S/PDIF
4. Balanced analog inputs and outputs on XLR connectors
5. Unbalanced analog inputs and outputs on RCA connectors
6. Networkable
7. Dante capable
8. 1-RU Rack mountable
9. Acceptable Product:
a. Tascam SS-CDR250N with IF-DA2 Dante Card
b. Approved Equivalent

B. Radio Tuner (RT):
1. DSP Based Triple Tuner
2. AM/FM/WR
3. Emergency Alert System Monitor
4. 1RU Chassis
5. Built-In Remote Control via Internet
6. Acceptable Product:
a. Crown Broadcast RFBA-1
b. Inovonics Broadcast RK-00-19 Mounting Rack with Inovonics Broadcast Model 676 NOAA Weather Receiver, Inovonics Broadcast Model 674 AM Receiver, Inovonics Broadcast Model 673 RF Receiver
c. Approved Equivalent

C. AM/FM Antenna (ANT AFW):
1. Provide active, high impedance unit to include:
a. Amplifier as required, and high pass filter
b. Antenna
c. Splitters, as required
d. Twin Lead Adapter, as required
e. Extender Amplifier, as required
f. Attenuators, as required
g. Surge Protector
2. Aluminum tube construction with end-seal elements
3. Wind loading requirement: withstand 100 mph
4. Acceptable Product:
a. Pixel Technologies
b. Blonder Tongue
c. Terk

D. Message Repeater (MR):
1. Playback from SD card or USB
2. Record to SD card or USB

3. MP3 and Wave file compatible
4. AES/EBU Digital input and output on XLR connectors
5. Balanced analog inputs and outputs on XLR connectors
6. Unbalanced analog inputs and outputs on RCA connectors
7. AES-EBU inputs and outputs on XLR connectors
8. SPDIF inputs and outputs on RCA type connectors
9. GPIO
10. Control via front panel, Network, optional remote control, Apple or Android app
11. Dante capable
12. 1-RU Rack mountable
13. Acceptable Product:
    a. Tascam SS-R250N with IF-DA2 Dante Card
    b. Approved Equivalent

2.5 MIX CONSOLE

A. Mixing Console:
1. Inputs: Capability of no less than 64 inputs from analog mic/line inputs, AES/EBU, and DANTE sources
2. Frequency response: +.5/-1.5dB, 20 Hz to 20 kHz with less than 0.05% THD at +4 dBm out
3. Maximum output level: at least +24 dBu
4. Input Module: 150 Ohm microphone or 600 Ohm line balanced input
5. Input attenuator to provide attenuation allowing signal levels from -60 to +10 dBm without overload or distortion
6. Input Channel: high pass filter, insert point, gain, parametric EQ, compressor, limiter, and delay
7. System latency: less than 2.5 ms
8. Dante audio transport
9. Wireless remote control via iPad
10. Acceptable Product:
11. Yamaha, to include:
    a. Yamaha QL-5 Digital Mixing Console (MC)
    b. Yamaha RIO3224-D2 (SB Type 1)
    c. Yamaha RIO1608-D2 (SB Type 2)
    d. Yamaha LA1L Gooseneck console lamps for all lamp ports
    e. Fitted nylon console dust cover
    f. Current model iPad with cover
12. Approved Equivalent

2.6 HEARING ASSISTANCE SYSTEM

A. Provide Assistive Listening Signage, Receiver, Neck Loop, and Earphone quantities based on current ADA or CBC regulations (CBC if applicable, then base quantities on the more stringent standard), coordinating final quantities with the Owner.
1. For bid purposes, provide receiver quantities based on venue capacity of 14,800 for the Main Seating Bowl.
2. Provide break-out unit pricing for additional Receivers and Earphones
3. Mount Antenna at location with unobstructed coverage to all seats.
4. Acceptable Product:
    a. Listen Technologies; to include the following:
        1) Listen Technologies LT-800-216-01 Wireless Transmitter (ALS)
        2) Listen Technologies LA-326 Rack Mount Kit
        3) Listen Technologies LR 4200-216 Receiver
        4) Listen Technologies LA-481 Charger

5) Listen Technologies LA-405 Dual Ear Buds
6) Listen Technologies LA-430 Neck Loop
7) Listen Technologies LA-102 Remote Antenna (ANT ALS)

b. Williams Sound; to include the following:
1) Williams Sound PPA T55 Wireless Transmitter (ALS)
2) Williams Sound RPK 005 Rack Mount Kit
3) Williams Sound PPA R38N Receiver
4) Williams Sound CHG 3512 Charger
5) Williams Sound EAR 042 Dual Earphones
6) Williams Sound NKL 001 Neck Loop
7) Williams Sound ANT-005 Remote Antenna (ANT ALS)

c. Approved Equivalent

2.7 DIGITAL SIGNAL PROCESSING (DSP) SYSTEM

A. Signal processing shall be performed by computer-based system.

B. The DSP system shall be fully operational 60 days prior to the first use of the installed system.

C. The system shall have the following capabilities:
1. Digital Signal Processing Unit:
a. Interior configuration of signal flow and routing to be fully user configurable
b. Unit to permit hardwire connection of external switches for recalling presets
c. Unit to have no external user adjustable controls
d. Dante compatible
e. Provide redundant hardware for each DSP, programmed to seamlessly take over in the case of a primary hardware failure.
f. Acceptable Product:
1) QSC, to include the following:
a) QSC QSYS Core 610
b) QSC SLDAN-128-P Software Based Dante 128 x 128
c) Atterotech Synapse DM16Mio (DIOX)
d) QSC QIO-GP8x8 (GPIO)
e) QSC SL-QUD-610-P UCI Deployment Software License
f) QSC SL-QSE-610-P Scripting Engine Software License
g) RDL TX-70A Speaker Level Input Interface (SLII)
2. BSS
3. Equivalent capabilities to the QSC system based on the BLU-806DA to include Contractor designed and provided control system with interface devices as needed.
4. Biamp
5. Equivalent capabilities to the QSC system based on the Tesira platform to include Contractor designed and provided control system with interface devices as needed.
6. Symetrix
7. Equivalent capabilities to the QSC system based on the Radius platform to include Contractor designed and provided control system with interface devices as needed.

2.8 AMPLIFIERS

A. Power Amplifiers:
1. Provide protection of circuit components in the event of input over-drive, output overload, or short circuits
2. Frequency response: ±1 dB, 20 Hz to 20 kHz with less than 1 percent THD at rated output
3. Noise generation: at least 85 dB below rated output with input shorted
4. Ventilation: variable speed fans that shut off when the amplifier is operating under light or no load conditions

5. Bowl System: adequate power supply capacity or POE+ supported to maintain DSP power through emergency power take over, should building power be lost. Or, provide adequate Uninterruptible Power Supply (UPS) to maintain amplifiers needed for sustaining intelligibility standards through emergency power take over, should building power be lost.
    a. A complete reboot of the amplifiers during transfer to generator backup power is not acceptable.
    b. Amplifiers must be capable of passing audio on all channels within three seconds from power service being reinstated.
    c. Subwoofers, and possibly low-frequency sections of multi-way loudspeakers are not required to sustain intelligibility standards. If UPS is required, provide UPS for amplifiers that work in the frequency range of 300 Hertz and higher.
6. Acceptable Products:
    a. Type 1 Power Amplifier - 1250 Watts Peak per Channel at 70V/4 Ohms:
        1) Dynacord IPX5:4
        2) Powersoft Unica 4L | 5K4
7. Alternate amplifier solutions for the Type 1 amplifiers serving the Main Bowl with internal on-board digital signal processing and monitoring from Powersoft, Lab Gruppen, or Linea Research will be considered, subject to approval by the Owner. For these alternate amplifier solutions to the above listed Type 1 amplifiers, the Contractor must design and provide a Line Interactive UPS system that carries all Type 1 amplifiers through the emergency power take over time, which is dictated by NEC Code to be no more than 10 seconds. Size this Line Interactive UPS system to 120% of anticipated power draw to allow headroom in the system with a minimum hold time of 15 seconds.
    a. Alternate amplifier options with above noted Line Interactive UPS:
        1) Type 1 Power Amplifier – 1250 Watts Peak per Channel at 70V/4Ohms:
            a) Linea Research 44C10
            b) Powersoft Quattrocanali 4804 DSP+D
            c) Lab Gruppen D80:4L
8. Select amplifier and DSP combinations that allow for basic control and monitoring from a single GUI platform.

2.9 LOUDSPEAKERS

A. Type 20 Loudspeaker:
1. Dual 10-inch three-way array loudspeaker
2. 100-degree nominal horizontal beamwidth
3. Adaptive vertical coverage without changing splay angles between array loudspeakers
4. Self powered, amplifier capable of operating at 208VAC and 120VAC
5. Dante capable with Primary and redundant Secondary
6. Six cabinet array not to exceed 70 inches in height
7. Acceptable Product:
    a. EAW Anna
    b. Approved Equivalent

B. Type 21 Loudspeaker:
1. Dual 18-inch subwoofer
2. Adaptive horizontal beamwidth with coverage options for: omni-directional, cardioid, hyper-cardioid, or user defined.
3. Self powered, amplifier capable of operating at 208VAC and 120VAC
4. Dante capable with Primary and redundant Secondary
5. Three cabinet array not to exceed 72 inches in height
6. Acceptable Product:
    a. EAW Otto
    b. Approved Equivalent

C. Type 20 and Type 21 Loudspeaker Hardware:

1. EAW Flybar Anna (Quantity: 6)
2. EAW Caster Pallet Anna (Quantity: 6)
3. EAW Flybar Otto (Quantity: 6)
4. EAW Caster Pallet Otto (Quantity: 6)
5. Approved Equivalents

D. Type 20 and Type 21 Loudspeaker Portable Power and Network Distribution:
1. EAW Power Network Distro Rack 12 box 115V (Quantity: 4)
2. EAW CBL Power Distro 6 box 16-foot (Quantity: 6)
3. EAW CBL Network Short Distro 6 box 16-foot (Quantity: 12)
4. EAW CBL Network Long Distro 6 box 28-foot (Quantity: 4)
5. EAW ACC CBL Extender Network Adaptive 6 box 75-foot (Quantity: 6)
6. EAW ACC CBL Extender Power Adaptive 6 box 75-foot (Quantity: 6)
7. Motion Labs 1300-200A-12-2-00 Main Power Distro (Quantity: 1)
8. Motion Labs 8AWG 5 conductor terminated with male and female L21-30 25-foot (Quantity: 2)
9. Motion Labs 8AWG 5 conductor terminated with male and female L21-30 75-foot (Quantity: 2)
10. 25-foot tactical Category 6 cable with an Ethercon connector at each end (Quantity: 4)
11. 75-foot tactical Category 6 cable with an Ethercon connector at each end (Quantity: 4)
12. Approved Equivalents

E. Type 22 Loudspeaker:
a. Not used

F. Type 23 Loudspeaker:
1. Coaxial horn-loaded components
2. 60 x 60-degree nominal beamwidth
3. Single amplifier channel operation: 8 Ohms nominal impedance
4. 108dB 1W/1M sensitivity
5. 144dB peak SPL
6. 66Hz to 20kHz (-10dB)
7. Acceptable Product:
a. EAW QX366
b. Fulcrum Acoustics FH1566
c. Electro-Voice EVH1152D/66

G. Type 24 Loudspeaker:
1. Coaxial horn-loaded components
2. 90 x 60-degree nominal beamwidth
3. Single amplifier channel operation: 8 Ohms nominal impedance
4. 107dB 1W/1M sensitivity
5. 142dB Peak SPL
6. 66Hz to 20kHz (-10dB)
7. Acceptable Product:
a. EAW QX396
b. Fulcrum Acoustics FH1596
c. Electro-Voice EVH1152D/96

H. Type 25 Loudspeaker:
a. Not used

I. Type 26 Loudspeaker:
1. 12-inch, two-way surface mount loudspeaker
2. Front-loaded components
3. 90 x 60-degree nominal beamwidth
4. Single amplifier channel operation: 8 Ohms nominal impedance
5. 95dB 1W/1M sensitivity
6. 128dB Peak SPL

7. 65Hz to 20kHz (-10dB)
8. Acceptable Product:
    a. EAW MK2396
    b. Fulcrum CX1295
    c. Electro-Voice EVF1122D/96

J. Amplified Control Room Monitor:
1. 5.25-inch, two-way, self-powered loudspeaker
2. Front-loaded components
3. Self-Powered
4. 108dB Peak SPL
5. 49Hz to 20kHz (±3dB)
6. Provide Quantity: 2
7. Acceptable Product:
    a. Tannoy Reveal 502
    b. JBL 305P MkII
    c. KRK ROKIT 5 G4

K. Portable Loudspeaker:
1. 12-inch, two-way, self-powered loudspeaker
2. Front-loaded components
3. Self-Powered
4. 132dB Peak SPL
5. 50Hz to 20kHz (±3dB)
6. Provide Quantity: 6
7. Acceptable Product:
    a. QSC K12.2
    b. Electro-Voice EKX-12P
    c. Yamaha DXR12mkII

2.10 AUDIO CONTROL COMPUTERS

A. Control Computer (minimum specification) (CC):
1. Provide Microsoft Windows latest professional 64-bit OS
2. Computer must accommodate future Microsoft Windows professional OS for at least 7 years.
3. CPU: Intel Core i5 4-core or current Intel equivalent; 2.6GHz base, 4.2 GHz Turbo
4. Enclosure/Case: Rack Mountable, fanless or fan cooled and rated for <35dBA/1M at highest CPU load.
5. Power supply: 400 watts
6. Memory: 32GB, fastest supported for motherboard
7. Internal Hard Drive: 1.0TB SSD, 1 million hrs MTBF, Sequential write rate >450MBs, Sequential read rate > 500MBs
8. LAN: 2 x GB
9. Video: 2 x HDMI 2.0, or DP 2.0. 2GB RAM.
10. WiFi v5 capable (built in or USB dongle)
11. Bluetooth 5 capable (built in or USB dongle)
12. USB: Minimum 4 USB-A 3.0 ports, 1 front panel and 3 rear panel
13. Software to be included:
    a. Microsoft Windows
    b. License all software to the client
    c. ESET Nod32 Antivirus (coordinate with Owner IT group – ESET listed as performance standard)
14. Warranty: Three-Year Onsite Warranty with 24/7 Phone and Next Business Day Service
15. Computer system shall be completely tested by manufacturer prior to delivery
16. Acceptable Product:

a. Dell, HP, Lenovo, Super Logics, Stealth, Intel, Microsoft, Logitech, approved equivalent

B. Rack Mount Keyboard and Monitor (RMK):
1. 1RU integrated Keyboard and Monitor on slides
2. 105 key USB keyboard with integrated keypad
3. 17.3” diagonal LCD display with 1920 x 1080 resolution
4. Acceptable Product:
a. Middle Atlantic RM-KB-LCD17HD
b. Approved Equivalent

2.11 POWER CONDITIONING

A. Power Protection:
1. Provide surge protection devices to maintain clean power to the following equipment:
a. All computer CPU’s and associated video monitors
b. All Audio System Network equipment
c. All low level (mic or line) processing equipment with internal microprocessor or DSP chips
d. Mixing Console(s)
2. Acceptable Product:
a. Surge-X SX-1120RT
b. Furman P-1800 PFR
c. Juice Goose RX100

B. Backup Power:
1. Provide UPS systems for:
a. Computer CPU’s and associated video monitors
b. DSP
c. Audio related network equipment
d. AV Control Systems
2. UPS’s shall be on-line style with sufficient battery reserve to operate for 15 minutes. Size each UPS unit for 25 percent additional capacity.
3. Acceptable Product:
a. APC SMT2200RM2U
b. Juice Goose SCV-30001
c. Tripp Lite SM2200RMXL2UP

C. Rack Lighting and Power Strip:
1. Nema 20A plug
2. 20 Amp/2400 Watt rating
3. Front panel AC voltmeter
4. Dual front panel pullout dimmable lights
5. Spike and surge suppression with over-voltage shutdown
6. Rack Mountable
7. Acceptable Product:
a. Furman PL-Pro C
b. Middle Atlantic PDLT-815RVA
c. Juice Goose JG 8LED

2.12 NETWORK EQUIPMENT

A. Ethernet Switch (Type 1):
1. Compatible and approved by DSP and amplifier system manufacturer
2. Compliant with venue IT Standards
3. Provide Fiber Optic adaptors as required
4. Acceptable Product:

a. Extreme Networks X440-G2 series
b. Hewlett Packard Aruba 2930F series
c. Cisco Catalyst 9300 series

B. Ethernet Switch (Type 2):
1. Compatible and approved by DSP and amplifier system manufacturer
2. Matches EAW Switch in portable distro. Reference 27 41 16 2.9, D
3. Provide Fiber Optic adaptors as required
4. Acceptable Product:
a. Netgear 4200 Series
b. Approved Equivalent

C. Ethernet Switch (Type 3):
1. Compatible and approved by DSP and amplifier system manufacturer
2. Rear-facing ports
3. Provide Fiber Optic adaptors as required
4. Acceptable Product:
a. Luxul AV Series 12-port
b. Approved Equivalent

D. Fiber Patch:
1. Rack Mountable Modular System designed for Fiber Optic Termination
2. Provide for dark fiber
3. Acceptable Product:
a. Panduit LGX compatible enclosures as required with Panduit LGX adaptor plates as required
b. Corning
c. Approved Equivalent

2.13 MISCELLANEOUS EQUIPMENT

A. Patch Panel – 96 Point:
1. Field verify existing patch points and destination. Provide the quantity of patch panels to accommodate all patch points required
2. Identification strips to be printed labels of different color for each major connector grouping. Use a combination of colored fonts on white background and black fonts on colored backgrounds. Manufacture colored insert markers are also acceptable to identify normalling and signal types
3. Non-terminated inputs to be shorted through normalling contacts on rear panel.
4. Type: Longframe, two rows of 48 jacks
5. Termination: 18-28 AWG stranded, oversize split cylinder capable of two wires per terminal
6. Labeling: Standard label strips and color-coded, numbering required for each terminal.
7. Normals: Sleeve Normals out
8. Tool: Provide one tool and tip to Stadium Operator
9. Labeling: Circuit designation strip and title block
10. 2-U Rack Mountable
11. Acceptable Product:
a. Bittree B96DC- FNSST/E3 M2OU12B
b. Approved Equivalent

B. Patch Cords:
1. Patch Cords to be 2, 3 and 4 feet long
2. Provide different color cords for each cable length
3. Provide patch cord holder for unused cords
4. Provide all patch cords from single manufacturer
5. Provide the following:

a. 24” Patchcable; Black (Quantity: 36)
6. Acceptable product:
a. Bittree
b. Approved Equivalent

C. Patch Cable Holder:
1. Provide in Audio Control Booth
2. Acceptable Product:
a. Bittree PCHA
b. Approved Equivalents

D. Transformers:
1. Frequency response ±0.25dB, 25-20,000 Hz
2. Maximum input level +18 dBV at >30 Hz
3. Magnetic and Faraday shield
4. Acceptable Products:
a. Bridging: Jensen JT-MB-C
b. Input transformer (1:1): Jensen JT-11P-1
c. Input transformer (4:1): Jensen JT-10KB-D
d. Isolation transformer: Jensen Iso-Max
e. Approved Equivalents

2.14 EQUIPMENT HOUSING & ACCESSORIES

A. Configure equipment racks for proper airflow and cooling

B. Middle Atlantic systems listed below are approved for use on this project and are listed to set the acceptable standard of performance. Equipment housing systems from Lowell or other approved equivalents are also acceptable provided they meet the performance specifications of the approved listed equipment housing systems.

C. Audio Equipment Racks:
1. Type: Frame and panel with locking rear door
2. Size: 36-inches deep with 44 units of vertical space
3. Construction: Factory assembled 16-gauge cold-rolled steel frames with all corners welded
4. Black enameled finish
5. Provide all necessary side panels, trim pieces, tops, and blank panels
6. Provide Middle Atlantic VBK-W27-W32 Vent Blocker kit(s) and configure for proper airflow and cooling of rack
7. Acceptable Product:
a. Middle Atlantic Products MRK series

D. Wall Mounted Audio Equipment Racks:
1. Type: Wall mounted, hinged rack with 90-degree pivot capability
2. Size: 28 to 32-inches deep
3. Construction: Factory assembled 16-gauge cold-rolled steel frames with all corners welded
4. Black enameled finish
5. Provide Middle Atlantic VBK-W27-W32 Vent Blocker kit(s) and configure for proper airflow and cooling of rack
6. Acceptable Product:
a. Middle Atlantic Products SR series

E. Wall Mounted Audio Equipment Racks:
1. Type: Wall mounted, hinged rack with 90-degree pivot capability
2. Size: 17 to 22-inches deep

3. Construction: Factory assembled 16-gauge cold-rolled steel frames with all corners welded
4. Black enameled finish
5. Provide Middle Atlantic VBK-W27-W32 Vent Blocker kit(s) and configure for proper airflow and cooling of rack
6. Acceptable Product:
    a. Middle Atlantic Products DWR series

F. Portable Equipment Rack:
1. 6RU with integral handle and wheels
2. Integral power distribution
3. Acceptable Product:
    a. Gator Cases GRR-6PL-US
    b. Approved Equivalent

G. Rack Drawer:
1. Spring loaded latch
2. Black textured finish
3. Acceptable Product:
    a. Middle Atlantic TD series

H. Low Profile Keyboard Shelf:
1. Sliding black laminate shelf
2. Single rack space
3. Acceptable Product:
    a. Middle Atlantic SSL

I. Computer Shelf:
1. Flanged construction
2. 16 Gauge steel
3. Black powder coat finish
4. Acceptable Product:
    a. Middle Atlantic U4

J. Universal Rack Shelf:
1. Black textured powder coat finish
2. Acceptable Product:
    a. Middle Atlantic RSU-129

K. Universal Mounting Trays:
1. Multiple Devices
2. Acceptable Product:
    a. Extron RSU 126
3. Single Device
4. Acceptable Product:
    a. Extron RSB 126

L. Blank Rack Panels:
1. Flanged construction
2. 16 Gauge steel
3. Black powder coat finish
4. Acceptable Product:
    a. Middle Atlantic SB series

M. Vent Rack Panels:
1. Flanged construction
2. 16 Gauge steel
3. Black powder coat finish
4. Acceptable Product:

a. Middle Atlantic VTF series

N. Rack Fan:
1. 10” or 4.5”(x4), 115V
2. Include cord and hardware
3. Acceptable Product:
a. Middle Atlantic FAN10 with GUARD-10
b. Middle Atlantic FAN with GUARD

O. Fan Thermostat Control:
1. Switched 15A duplex outlet
2. Temperature Range: 50 – 90 Degrees
3. On and Stand-by LED indicators
4. Integral mounting ears
5. Provide for each rack fan assembly
6. Acceptable Product:
a. Middle Atlantic FC-4-1C

P. Rack Temperature Display:
1. Provide one display in top front panel space of each rack
2. Decora mount in 1-RU rack panel
3. Digital readout in Fahrenheit or Celsius
4. Connect to DAP GPIO for high temperature alarm to the Audio Control Booth
5. Acceptable Products:
a. Middle Atlantic TEMP-DEC with DECP-1X1 Panel.

Q. Rack Light:
1. Provide 60W incandescent or 13W fluorescent work light
2. Located in all equipment racks over 36 RU’s high
3. Acceptable Product:
a. Middle Atlantic WL-60
b. Lowell RL-1

R. Copper Bus Bars:
1. Material: Solid copper, 1/8 thick and 2-inches wide with threaded 10/32 holes
2. Height: 70-inch for 40-RU or larger racks and 21-inch for racks under 40-RU
3. Wire each circuit ground to bus bar and isolated outlet ground
4. Terminate two #6 wires between rack and buss bar
5. Provide with nylon isolation mounts
6. Provide one bus bar in each rack
7. Acceptable Product:
a. Middle Atlantic BB-40
b. Middle Atlantic BB-12

S. Equipment Rack Screws:
1. Install rack mounted equipment with black 10-32 star post security screws with flat nylon washers
2. Quantity as required
3. Provide one spare bit located in a clear plastic bag attached to the inside of each equipment rack in plain view
4. Acceptable Product:
a. Middle Atlantic HTX
b. Raxxess PNTX

T. Wire Duct:
1. Purpose: signal wire routing in rack
2. Acceptable Product:
a. Panduit Type E Slotted

U. Surface Mount Wire Duct:
   1. Signal level cabling, loudspeaker level cabling, electrical
   2. Acceptable Product:
      a. Wiremold 4000 Series

2.15 PLATES AND PANELS

A. Provide plates and panels and as described in Drawings. Engrave as shown on Drawings. Other Plates and Panels may be required to satisfy the requirements of the Work.

B. Custom panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.

C. Plate finish shall be coordinated with the Architect. Plastic plates are not acceptable.

D. Panel, plate, and label engraving shall be 1/8-inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum pushbuttons, letters shall be black.

E. Custom and/or Engraved Panels:
   1. Custom panels constructed of 1/8-inch brushed aluminum
   2. Finish: black anodize
   3. Acceptable Product:
      a. RCI Custom
      b. ProCo
      c. Whirlwind

F. Patch Panels for Audio/Video plate tie lines:
   1. Flat all-metal Shielded modular patch panels
   2. Mounts to standard cabinets and EIA 19” Racks
   3. 16-ports per 1U panel
   4. Strain relief bar includes cable tie slots for managing and supporting cables
   5. Label area to correspond to unique ID number of AV, AVC, FB plates (Labels to be printed, not hand-written)
   6. Utilizes Mini-Com Shielded snap-in modules
   7. Acceptable Product to include:
      a. Panduit #CP16WSBLY
      b. Panduit TX6 10Gig Shielded Modules
      c. Mounting screws as needed

2.16 CABLES & WIRING

A. All electrical conductors installed under this contract, except where otherwise specified, shall be soft drawn annealed stranded copper having a conductivity of not less than 98% of pure copper, and meet appropriate ratings (e.g., CMR, CMP, etc.)

B. Cable shall carry appropriate fire rating (e.g., CMR, CMP, OFNR, OFNP, etc.) on jacket of cable.

C. Where cables are routed through cable tray, provide tray rated cable of equal specification.

D. Where speaker cables are run exposed through a return air plenum, provide plenum rated cable of equal specification.

E. Where cabling is run through in-grade pathways, provide direct burial cable, underground rated, or cable treated with water blocking. Adjust conduit sizes accordingly to accommodate larger diameter cable.

F. Shielded cables located in raceways shall have aluminum foil shield with drain wire.

G. The Belden cables listed below are approved for use on this project and are listed to set the acceptable standard of performance. If field conditions or actual cable pathway requires tray or plenum cable, provide version of cable that meets required rating. Cables from Liberty, Commscope, Gepco, Clark, Windy City, and West Penn are also acceptable provided they meet the performance specifications of the approved listed cables.

H. Loudspeaker Cables:
1. Amplifier to Rack Room Terminals:
a. Distance not to exceed 25 feet.
b. 12 gauge twisted pair, jacketed.
c. Acceptable Product:
1) Belden 5000UP
2. Rack Room Terminals to Junction Box Terminals near loudspeaker, low impedance:
a. 10 gauge twisted pair, jacketed.
b. Acceptable Product:
1) Non-Plenum: Belden 5T00UP
2) Plenum: Belden 6T00UP
3) In-grade: Belden 1313A
3. Rack Room Terminals to Junction Box Terminals near loudspeaker, 70V Zones:
a. 12 gauge twisted pair, jacketed.
b. Acceptable Product:
1) Non-Plenum: Belden 5000UP
2) Plenum: Belden 6000UE
3) In-grade: Belden 1311A
4. Drop cable from Junction Box Terminals to Loudspeaker Array:
a. Eight conductors, 10 gauge, twisted pairs, SOOW rubber jacketed.
b. Acceptable Product:
1) General Cable-Carrol 09008
5. Junction Box Terminals to Loudspeaker:
a. Distance not to exceed 15 feet.
b. 12 gauge, twisted pairs, SOOW rubber jacketed.
c. Acceptable Product:
1) General Cable-Carrol 02724 (two-conductor)
2) General Cable-Carrol 02726 (four-conductor)
3) General Cable-Carrol 09208 (eight conductor)

I. Microphone and Line Level Cable:
1. Twisted pairs, shielded, jacketed, 110 Ohm cable.
2. Acceptable Product:
a. Single Pair:
1) Non-Plenum: Belden 1696A
2) Plenum: Belden 1801B
3) Riser: Belden 9451
4) In-grade: Belden 9451WB
b. Six Pair:
1) Non-Plenum: Belden 1218B
2) Plenum: Belden 1816P
3) Riser: Belden 1816R
4) In-grade: Belden 1816WB
c. Twelve Pair:
1) Non-Plenum: Belden 1220B
2) Plenum: Belden 1818P
3) Riser: Belden 1818R
4) In-grade: Belden 1818WB

J. Wireless Systems Antenna Cable:
1. RG8/X

2. Acceptable Product:
   a. Non-Plenum: Belden 9258
   b. Plenum: Belden 7733A
   c. Riser: Belden 7810R
   d. In-grade: Belden 7810WB

K. Ethernet Cable:
1. Category 6 non-bonded pairs
2. Acceptable Product:
   a. Non-Plenum / Riser: Belden 2412
   b. Plenum: Belden 1352A
   c. In-grade: Belden OSP6F
   d. Tactical: Belden 1303E

L. Fiber Optic Cable:
1. Armored Single Mode Fiber Optic Cable
2. Acceptable Product:
   a. 6 Strand:
      1) Non-Plenum / Riser: Belden FDSH0065F
      2) Plenum / In-grade: Belden FDSD006A9
   b. 12 Strand:
      1) Non-Plenum / Riser: Belden FDSH0125F
      2) Plenum / In-grade: Belden FDSD012A9
   c. 24 Strand:
      1) Non-Plenum / Riser: Belden FDSH0245F
      2) Plenum / In-grade: Belden FDSD024A9
   d. 48 Strand:
      1) Non-Plenum / Riser: Belden FDSH048AK
      2) Plenum / In-grade: Belden FDSD048AK

M. Category 6A Patch Cables:
1. Rack Patch Cables
2. Length as required
3. Acceptable Product:
   a. Belden 10GX UTP LSZH series

N. Fiber Patch Cables:
1. Rack Patch Cables
2. Length as required
3. Connector type as required
4. Acceptable Product:
   a. Belden FP series

2.17 CONNECTORS

A. XLR Panel mount Connectors:
1. Provide panel mount XLR connectors with unified metal shell
2. RF-Protector connectors
3. Shell Color: Black
4. Contacts: Silver
5. Terminations: Solder
6. Acceptable Product:
   a. Male Connectors: Neutrik NC*MD-L-1-BAG Series
   b. Female Connectors: Neutrik NC*FD-L-1-BAG Series

B. XLR Cable Connectors:
1. Provide XLR cable connectors with die cast shell
2. No-screw type assembly

3. Chuck-type strain relief
4. Shell Color: Black
5. Contacts: Silver
6. Terminations: Solder
7. Acceptable Product:
    a. Male Connectors: Neutrik NC*MX-BAG Series
    b. Female Connectors: Neutrik NC*FX-BAG Series.

C. ¼” Panel mount Connectors:
1. Provide panel mount ¼” connectors with unified metal shell
2. Shell Color: Black
3. Contacts: Silver
4. Terminations: Solder
5. Acceptable Product:
    a. Female Connectors: Neutrik NJ3FP6C-BAG Series

D. ¼” Cable Connectors:
1. Provide ¼” cable connectors with die cast shell
2. No-screw type assembly
3. Chuck-type strain relief
4. Shell Color: Black
5. Contacts: Nickel
6. Terminations: Solder
7. Acceptable Product:
    a. Male Connectors: Neutrik NP3C-BAG Series

E. BNC Cable Connectors:
1. Provide cable mount BNC connectors
2. Contacts: Brass or copper
3. Terminations: Crimp
4. Acceptable Product:
    a. Kings
    b. Amp
    c. Amphenol
    d. Canare
    e. Liberty

F. RCA Male Cable Connectors:
1. Provide RCA cable connectors with die cast shell
2. Shell Color: Silver
3. Contacts: Silver
4. Terminations: Solder
5. Acceptable Product:
    a. Switchcraft 3502 Series
    b. Liberty

G. F Connector:
1. Provide commercial style gold plated connector with integral sleeve for F6 Series, F11 Series, and F59 Headend cable
2. Provide seal ring in all moisture intensive environments
3. Install with manufacturer recommended compression tool
4. Provide weatherized boots and seal covers for all antenna connections
5. Verify connector cable type, size and construction with manufacturer
6. Acceptable Product:
    a. Gilbert Engineering GF-US-6Q series, GF-US-11Q, and GF-US-59Q series respectively
    b. Gilbert Engineering Seal ring: G-SR-1/2

H. RJ45 Connectors:

1. UTP Category 6, 8-pin wiring inserts T568A/B jacks
2. Acceptable Products:
    a. Belden PN#AX101320 (color to match plate)

2.18 LOUDSPEAKER HARDWARE AND SUPPORT STRUCTURE

A. Provide a custom modular loudspeaker hardware system as required to mount and suspend loudspeakers in the arrangement as shown on the Drawings.

B. Attachment system to be supplied by vendor whose primary specialty is fabricating support systems for loudspeakers or similar devices over an audience.

C. Acceptable Manufacturers:
1. Adaptive Technologies Group
2. Polar Focus
3. Proprietary by loudspeaker manufacturer

D. Shoulder Type Machinery Eye Bolts:
1. Forged Steel – Shoulder, Quenched and Tempered
2. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles
3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements
4. Select size of product-based working load limits required
5. Acceptable Product:
    a. Crosby Group S-279 / M-279 Series
    b. Chicago Hardware Company 261 Series
    c. Approved equal

E. Forged Eye Nuts:
1. Forged Steel – Quenched and Tempered
2. Tapped with standard UNC class 2 threads after galvanizing
3. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements
4. Select size of product-based working load limits required.
5. Acceptable Product:
    a. Crosby Group G-400 Series
    b. Chicago Hardware Company 167 Series
    c. Approved equal

F. Anchor Shackles:
1. Forged - Quenched and tempered, with alloy pin
2. Working Load Limit permanently shown on every shackle
3. Hot Dip galvanized or Self-Colored
4. Product to meet the performance requirements of Federal Specification RR-C-271D Type IVA, Grade A, Class1
5. Select size of product-based working load limits required
6. Provide all screw pin type shackles with mouse wire
7. Acceptable Product:
    a. Crosby Group G-209 / S-209 Series Screw Pin
    b. Chicago Hardware Company 201 Series
    c. Approved equal

G. Turnbuckles:
1. Acceptable turnbuckle assembly combinations include: Eye and Eye, Jaw and Jaw, Jaw and Eye
2. End fittings are Quenched and Tempered, bodies heat treated by normalizing
3. Hot Dip galvanized

4. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements
5. Product to meet the performance requirements of Federal Specifications FF-T-791b, Type 1 Form 1 - CLASS 4, and ASTM F-1145
6. Select size of product-based working load limits required
7. All end fittings to be moused to the body with mousing cable
8. Acceptable Product:
    a. Eye and Eye:
        1) Crosby Group HG-226 Series
        2) Chicago Hardware Company 012/013 Series
        3) Approved equal
    b. Jaw and Eye:
        1) Crosby Group HG-227 Series
        2) Chicago Hardware Company 026 Series
        3) Approved equal
    c. Jaw and Jaw:
        1) Crosby Group HG-228 Series
        2) Chicago Hardware Company 030/031 Series
        3) Approved equal

H. Swivel Hoist Ring:
1. All components are Alloy Steel - Quenched and Tempered
2. Rated at 100% of Working Load Limit at 90° angle
3. 360 swivel and 180 pivot action
4. Product to meet or exceed all the requirements of ASME B30.26 including identification, ductility, design factor, proof load and temperature requirements
5. Bolt specification to be Grade 8 Alloy socket head cap screw to ASTM A 574
6. Fatigue rated at 1-1/2 times the Working Load Limit at 20,000 cycles
7. Zinc Plated (Yellow Chromate) finish for increased corrosion protection
8. Select size of product-based working load limits required
9. Acceptable Product:
    a. Crosby Group HR-125
    b. Chicago Hardware Company 860 Series
    c. Approved equal

I. Wire Rope Thimble:
1. Product to meet the performance requirements of Federal Specification FF-T-276b Type II
2. Hot Dip galvanized
3. Select size of product-based wire rope size required for suspended load
4. Acceptable Product:
    a. Crosby Group G-411 Series
    b. Chicago Hardware Company 224/225 Series
    c. Approved equal

J. Wire Rope:
1. Strands: 7 x 19 Utility Cable
2. Type: Galvanized
3. Select size of product-based working load limits required
4. Acceptable Product:
    a. WireCo World Group
    b. Approved equal

K. Wire Rope Sleeves:
1. Type: Copper Duplex
2. Select size of product-based wire rope size required for suspended load
3. Acceptable Product:
    a. WireCo World Group SW-740 Series

b. Approved equal

PART 3 - EXECUTION

3.1 GENERAL

A. Coordination of the Work specified herein with other project work so as to facilitate a cohesive final Product.

B. The installation recommendations contained within ASDI and Telecommunications Distribution Methods Manual are mandatory minimum standards and requirements.

C. Mount equipment and enclosures plumb and level.

D. Permanently installed equipment to be firmly and safely held in place. Design equipment supports to support loads imposed with a safety factor of at least five. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.

E. Verify all locations of equipment in all rooms with Owner's Representative, Owner, and Consultant.

3.2 INSTALLATION

A. Installation of cable and wiring
   1. Cabling and Wiring:
      a. Install cable in a manner to adhere to manufacturer's specifications for maximum cable pulling tension, minimum bend radius, and any other restrictions.
      b. Provide appropriate support at all horizontal-to-vertical transitions in order to keep the weight of the cable from degrading at the point of transition.
      c. If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at a maximum of 48-inch (1.2 meter) intervals. At no point shall the cables rest on light fixtures, acoustic ceiling grids, panels, conduits, sprinkler pipe, water pipe and/or HVAC system ducting.
      d. Horizontal distribution cables shall be bundled in groups of no more than 50 cables when being supported by J-Hook or trapeze systems. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance. An exception to this rule is when cable is installed in cable tray systems.
      e. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
      f. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.
      g. Any cable damaged or exceeding recommended installation parameters during installation shall be replaced prior to final acceptance at no cost to the Owner.
      h. Cables shall be identified by a self-adhesive machine label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606-A. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.
      i. Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.
      j. Provide splice free wiring and cabling from origination to destination. Cables shall be installed in continuous lengths from origin to destination (no splices). Properly designed transition points, or consolidation points are not considered 'splice' points.

k. Make joints and connections with rosin-core 60/40 solder or with mechanical connectors specifically intended for the type and class of cable being used. Where spade lugs are used, crimp properly with ratchet type tool.
l. Take precaution to prevent and guard against electromagnetic and electrostatic hum. For line-level audio signal, float cable shield at one end. Shield(s) that are not connected are to be folded back over the cable jacket and covered with heat-shrink tubing. Do not cut off unused shield.
m. Isolate cables and wires of different signals or different levels are to be separated, organized, and routed in order to restrict channel crosstalk, or create feedback oscillation in any amplifier section. Keep wiring separated into groups for microphone level circuits, line level circuits, loudspeaker circuits, and power circuits.
n. Connect cable to active components through XLR connections whenever multiple formats are available. Make connections to speaker transformers with properly sized closed-end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.
o. Cover edges of cable and wire pass-through holes in chassis, housings, boxes, etc., with rubber grommets or Brady GRNY nylon grommetting.
p. Execute wiring in strict adherence to:
1) Phillip Giddings. Audio System Design and Installation. Indianapolis: Howard W. Sams & Co., 1990.
2) Don Davis and Carolyn Davis. Appendix II, Recommended Wiring Practices. Sound System Engineering, 2nd Edition. Indianapolis: Howard W. Sams & Co., 1989.
3) AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm, 2009

2. Equipment Housing Cabling and Wiring:
a. Lace, tie, or harness wire or cable as required herein, and in accordance with accepted professional practice. Dress, lace, or harness all wire or cable to prevent mechanical stress on electrical connections; no wire or cable shall be supported by a connection point. Install cable and wire neatly tied in manageable bundles with cable lengths cut to minimize excess cable slack but still allow for service and testing. Provide horizontal support bars if cable bundles sag.
b. Provide adequate service loops so that equipment mounted on rack slides may be pulled fully out to their locked position without straining cable.
c. Neatly bundle excess AC power cable from housing mounted equipment with plastic cable ties.
d. Provide plastic cable ties or Velcro straps to bundle cabling and wiring. Electrical tape and adhesive backed cable tie anchors are not acceptable.
e. Install with connections completely visible and labeled.
f. Provide termination resistors, if required, of 5 percent tolerance. Mount the termination resistors fully visible.

B. Installation of connectors, plates & panels:
1. Install panel mounted connectors rigidly attached to panels, plumb and level.
2. Custom rack panels shall be flanged standard EIA sizes, brushed black anodized finish unless otherwise noted.
3. Custom connector plates (loudspeaker, microphone, etc.lamicoi) are typically stainless steel, unless otherwise noted or specified. However, verify plate finish with the Owner.
4. Install XLR type connectors in accordance with IEC-268 standard, with a wiring scheme of pin 2 hot (high), pin 3 (low), and pin 1 screen (shield).
5. Other Plates and Panels may be required to satisfy the requirements of the Work.

C. Installation power and grounding:
1. Coordinate final connection of power and ground wiring to housings.

2. Hardwire power wiring directly to internal AC receptacles to ensure uninterrupted operation.
3. Provide 3-conductor, isolated ground, 120 VAC outlets as required within each housing. Provide a minimum of two spare outlets in each rack.
4. Provide a copper ground buss top to bottom in each housing, insulated from the housing. Ground equipment chassis not having a three wire power cord to these busses using 6/32 nuts, bolts and lock-washers with No. 12 wire. Connect green ground wire from each AC outlet in housing to this buss bar.
5. Replace manufacturers supplied 18 gauge IEC power cords with UL listed 18 gauge pre-molded 6”, 12”, 18”, or 24”. Use minimum length required. No looped or cable tied IEC power cords will be permitted within the equipment rack.
6. Replace manufacturers supplied 14 gauge IEC power cords with UL listed 14 gauge pre-molded 18” or 36” folamr all equipment IEC capable. Use minimum length required and minimize looped or cable tied IEC power cords present in the equipment rack.

D. Installation of electronic equipment:
1. Take appropriate precautions against electrostatic discharge (ESD). Establish a personal ground before handling electronic equipment through the use of a grounded wrist wrap and/or an anti-static floor pad.
2. Take appropriate precautions to protect the equipment from damage during installation. Equipment to be installed free of damages, scratches, dents, etc.
3. Mount trim potentiometers, custom circuit cards, relays, and transformers (except large 70V units) in shielded enclosures, and mark their function and connections with engraved lamicoid labels.
4. Mount equipment plumb and level, firmly and safely held in place.

E. Installation of equipment housing:
1. Mount equipment in racks or other project specific equipment housing apparatus. Fully wire and test before delivery to job site. If field conditions prevent prior assembly of racks, notify Owner in writing that racks will be fabricated on site and the reasons for the change.
2. Provide rear support for housing mounted equipment greater than 15 inches deep.
3. Provide blank panels to fill unused panel space within the equipment housing.
4. If Key door locks are required, key each housing type alike.
5. Looking at the rack from the rear, locate AC power and speaker wiring on the left; line level audio, video, and RF wiring on the right.
6. Provide shaft locks or security covers on non-user operated equipment having front panel controls. These panels are to be installed at the conclusion of testing.
7. If forced-air active thermal management is used, provide ventilation blocking material on the front, sides, and rear of the equipment rack as needed. Reference Middle Atlantic Products “Controlling the Temperature Inside Equipment Racks”. Air temperature inside of the rack is not to exceed 90 degrees Fahrenheit.
8. Panels, or equipment mounted on the rear rack rails, shall not block access to any front mounted components.
9. If equipment rack is not equipped with casters, provide two inch high wood base to isolate equipment rack from floor. Wood base should be capable of supporting the load.

F. Installation of loudspeakers:
1. The Contractor is responsible for final design and engineering of loudspeaker rigging, attachments, brackets, and hoisting.
2. Loudspeakers shall be mounted at the operating position in a safe, secure, and permanent manner.
3. Provide custom rigging as needed.
4. Suspension and Mounting:
    a. Static and dynamic equipment loads shall be suspended or mounted in compliance with the following ANSI/ESTA standards, using the latest available versions of the standards:

1) ANSI E1.4-2-2021 Statically Suspended Rigging Systems
2) ANSI E1.56-2018 Rigging Support Points
3) ANSI E1.6-1-2021 Powered Hoist Systems
4) ANSI E1.8-2012 Loudspeaker Enclosures Intended for Overhead Suspension

b. Rigging, mounting, and support systems for overhead suspended loudspeakers shall be reviewed and certified by a registered Professional Engineer (PE), in the employ of the Contractor, licensed to practice in the State in which the project is located. Documentation shall be included as a submittal item. Once the systems are installed, the PE shall physically inspect, at the Contractor's cost, the methods and means used to verify compliance with the original design.

5. General Guidelines:
   a. Paint loudspeakers, supports, and related hardware color as directed by the Owner.
   b. The aiming direction of all loudspeakers shall be adjustable by no less than ±5 degrees horizontally and vertically.
   c. Loudspeakers are to be oriented parallel to their mounting surface unless otherwise noted.
   d. Provide a safety cable connected to a secondary location for each loudspeaker.
   e. All loudspeakers located in ceiling tiles shall be located in the center of the tile unless noted otherwise.
   f. Paint loudspeakers to match surroundings. Confirm color selection with the Architect during the submittal phase.
   g. Exterior loudspeaker cabinets shall be constructed of materials designed for permanent outdoor exposure conditions with a minimum IP 54 rating, and a minimum expected 10-year life span. Exterior and interior surfaces of the cabinets shall be protected from the effects of water, moisture, and humidity. The exterior surface shall also be protected from the effects of ultraviolet radiation to prevent fading and color change. The cabinets shall be shaped and oriented in a manner that minimizes the possibility of water pooling on any cabinet surface. Associated hardware shall be inherently non-corrosive, performing to the standards of 304 Stainless Steel or higher.

G. Installation of projectors:
   1. Confirm distance of specified projection lens before mounting projector.
   2. Projectors shall be mounted plumb and level at the operating position in a safe, secure, and permanent manner.
   3. All hardware required to locate the mount and projector at the required location shall be provided.
   4. Projectors shall be mounted using tamper proof secure hardware.
   5. Contractor may be required to adjust projection screen, projection screen upper and lower limit switches, and lifts specified elsewhere not installed as part of this Contract.

H. Installation of flat panel monitors:
   1. Confirm location before mounting.
   2. Monitors shall be mounted plumb and level at the operating position in a safe, secure, and permanent manner.
   3. All hardware required to locate the mount and monitor at the required position shall be provided.
   4. Locate monitor on the center line of the room unless noted otherwise.

I. Outdoor mounting of equipment
   1. Objects mounted outdoors and within the building bowl structure shall be properly treated for exposure to moisture and temperature extremes.
   2. Mounting hardware shall be non-corrosive or be coated with a corrosion inhibiting layer.
   3. Structural supports for loudspeakers, or other equipment, shall have inherent corrosion resistance, or be covered with a corrosion inhibiting layer.

4. Speaker components mounted in exterior environments shall be rigidly connected to the structure to prevent movement caused by wind gusts.
5. Speaker and microphone enclosures to include grille capable of breaking up direct water sprays or rain.
6. Seal all exposed electrical connections on speaker enclosure with waterproof silicone sealant.
7. Treat paper cones of outdoor speakers with silicone based moisture repellent if not factory treated.
8. Provide screened cover over all openings in horn type speakers to keep out birds, insects, or small animals. Screened covering to be stretched with no visible wrinkles.

3.3 FIRESTOP

A. A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Fire-stop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.

B. All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire-stopped.

C. Fire-stop systems shall be reviewed by a Professional Engineer (PE) licensed to practice in the State in which the project is located. Stamped drawings showing the fire stop systems shall be included as a submittal item. Once the systems are installed, the engineer of record for the firestop system shall physically inspect the methods and means used to verify compliance with the original design.

D. A drawing showing the proposed fire-stop system, stamped/embossed by the PE shall be provided to the Owner’s Technical Representative prior to installing the fire-stop system(s).

E. All fire-stop systems shall be installed in accordance with the manufacturer’s recommendations and shall be completely installed and available for observation by the local authorities prior to cable system acceptance.

3.4 CONTROL SYSTEM PROGRAMMING

A. Transport Control
1. Provide standard Stop, Play, Pause, Fast Forward, and Rewind for each playback device and menu control for DVD players. Buttons should be arranged in a conventional fashion that will be familiar to the normal user.
2. The selected control function should be displayed by showing the appropriate button “pressed”. It should remain this way until another function is selected.
3. For devices that will go into a standby mode after a period of time, the control system shall sense this mode and restore normal operating mode once a transport function has been selected. This may require the use of current sensors to determine the state of the unit. No direct user action should be required at the playback device to restore the normal operating mode.

B. Screen/Shade Control
1. In addition to up-down functions, provide a Stop function to allow the movement to be halted. Once movement has been stopped, the up or down buttons should resume travel in the selected direction.
2. Control system shall not prevent screen/shade wall controls from being used as well.
3. Touch panel controls should be readily accessible to the user to permit direct control of shades or screen with having to navigate through multiple control pages.

C. Room Combining
   1. Combining of adjacent areas shall be done through a graphical representation of the physical areas to be combined. Use of a floor plan metaphor is recommended with the graphic oriented correctly with respect to control panel location.
   2. Use buttons or other appropriate objects placed along the common wall to enable the combining function.
   3. When spaces are combined, the graphic appearance of those areas shall change to reflect this configuration. Once an area is separated from a combination, the color of its area should revert to the normal room color.
   4. Common control functions between combined rooms shall be linked, allowing control of the combined area from any one of the touch panels. Examples of common functions include:
      a. Background music selection
      b. Background music volume
      c. Background music muting
      d. Lighting preset recall
      e. Master volume (not individual channel volume)
   5. When combining adjacent rooms, the control system shall force the common functions to a predetermined default configuration so all rooms have the same configuration.
   6. To avoid unintentional changes, a control panel will not be able to operate a function in a remote location without also operating that same function in the room where the panel is located.

D. Level Control
   1. Objects requiring level adjustment such as volume or tone controls shall be through Up/Down buttons with a graphical representation of the actual level.
   2. Increment of level change to be adjusted for reasonable range without the need to push the Up or Down buttons needlessly.

E. Volume Mute
   1. Where the ability to mute the sound is needed, the button shall use the label “Vol On” and “VOL OFF” instead of Mute and Unmute. When in a “VOL OFF” mode, pushing the “VOL UP” button shall restore the sound and bring the system out of the muted mode.
   2. VOL ON/OFF buttons shall change color to indicate the status of the button.

F. Standard Colors
   1. Control functions shall be color coded to add clarity and show relationships between different groups of controls.
   2. The color Red shall be reserved to indicate a fault or abnormal condition.
   3. Green may be used to indicate normal operation, but may be used for standard control colors as well.
   4. Similar controls should maintain the same color scheme across all control pages.
   5. When a function is selected, the graphical depiction of that button should appear to be pressed and its color change to a darker shade of the regular button color.
   6. Color schemes used for background and foreground objects should be selected to be complimentary and provide a consistent theme throughout the control pages.

G. Minimum Button Size and Placement
   1. Minimum visual size of a button is 3/8” wide by 1/4” high.
   2. Spacing between buttons should be no less than 1/16”.
   3. Where buttons are immediately adjacent, the active selection area of the button should be reduced to 80% of the visual area of the button.

H. Button Actions
   1. When a function on a control page is selected, that button or visual object associated with that function should change to reflect what has been chosen.
   2. For functions that are momentary selections (i.e., VOL UP), the change of state is visible for as long as the button is being pressed.

3. For function that are maintained selections (i.e., PLAY), the change of state remains visible until another function is selected and resets the previous function.
4. The state change of a button or visible object should depict real-world objects as much as possible including the appearance of the button be pressed inward, change in shade of the original color, but not a change in hue.

I. Labels
1. Use of simple words or titles are preferred to indicate functionality, navigation and system status.
2. Use of stylish symbols should be avoided unless their identity is commonly recognized by the general public. Standard symbols for transport functions are acceptable.
3. Labels should be presented in a clear, sans serif type face that will remain legible on lower resolution touch panels.
4. Where physical buttons are present along the side of a touch panel, these buttons should be engraved and filled with a contrasting color.

J. Power On/Off
1. For panels requiring an ON/OFF control, these functions should be linked through current sensors or other methods for the control system to detect the power on condition of the component being controlled.
2. Powering off a system should not interfere with the ability of a projector to complete its cool down cycle.

K. Look & Feel
1. Control pages should utilize a clean, elegant but stylish appearance.
2. Use a common graphical template across all control pages for a consistent look.
3. The touch screen layout should utilize graphical elements such as drop shadows, gradient fills and transparency to provide a pleasing overall appearance.
4. Utilize graphical representations of floor plans to convey location information.
5. Include company logos, icons or watermarks to portray the corporate identity.
6. Provide clear navigation tools for moving between control pages.
7. Each sub-page should have a “BACK” button to return to the previous page. This button should appear in the same location on each page.
8. Provide a “HELP” button or icon on each user page to provide clear, non-technical instructions on how to use the functions available to regular users.

L. Security
1. Provide password access to control pages not intended to be accessed by the general public.
2. Unless otherwise noted, provide a minimum of three levels of access
   a. General User
   b. Non-Technical Employee
   c. AV Technician
3. Segregate the control functions to only allow authorized individuals access to more sophisticated control pages.
4. Provide a timeout feature to automatically return the control panel back to the default opening screen after 30 seconds of inactivity. After this reset, passwords must be reentered to return to a previous control page.

M. Presets
1. For systems that have different operating modes or configurations, provide the ability to store and recall preset combinations of system settings.
2. Provide a “Preset” page that permits a minimum of five presets to be recalled. Each button to include a label describing the function or configuration associated with that button.
3. Provide the ability for new presets to be stored over previous settings. New preset to be able to change the label to reflect the new or revised configuration.

4. When a preset has been recalled, the control page should indicate the active configuration.

3.5 LABELING OF EQUIPMENT

A. Provide each terminal strip with a unique descriptor and a numerical designator for each terminal. Show terminal strip descriptor and designator on system schematic drawing.

B. Provide logical and legible cable and wiring label permanently affixed for easy identification.
1. Labels on cables to be adhesive strip type covered with clear heat-shrink tubing. Factory stamped heat shrink tubing may be used in lieu of the adhesive strip style.
2. Wiring designator to be an alpha-numeric code unique for each cable. Actual cable designation assignments to be determined by Contractor. Add cable designation codes to system schematic drawings.
3. Locate the cable designator at the origination and destination of each circuit within 3 inches of the point of termination or connection. Provide cable designator on circuits with intermediate splice points with an additional suffix to indicate each segment.

3.6 ENGRAVING

A. Text font: 1/8-inch block sans serif characters unless noted otherwise.

B. On dark materials, provide white characters; on stainless steel or brushed natural aluminum plates, or light-colored materials, provide black characters.

C. Provide at least two lines of text with first line listing the general device name, e.g., amplifier. Second line to include schematic reference of the device, e.g., AMP-1.

D. Equipment label: black with white characters except where indicated.

3.7 COMMISSIONING

A. Prior to energizing or testing the system, ensure the following:
1. All products are installed in proper and safe manner according to manufacturer’s instructions.
2. Insulation and heat shrink tubing are present where required.
3. Dust, debris, wire trimmings, etc. is removed.
4. Cable is dressed, routed, and labeled; connections are consistent with regard to polarity.
5. Labeling has been provided.
6. Temporary facilities and utilities have been properly disconnected and removed.
7. Products are neat, clean, and unmarred. Parts securely attached.
8. Broken work, including glass, raised flooring and supports, ceiling tiles and supports, walls, doors, etc. have been replaced or properly repaired.

B. Prior to energizing the System, verify and perform the following tests and adjustments in compliance with applicable EIA standards.
1. Electronic devices are properly grounded.
2. Test each AC power receptacle with a circuit checker for proper hot, neutral, and ground connections.
3. Verify each individual component is operating properly.
4. Verify each individual component’s performance meets the manufacturer’s published performance for this unit.
5. Measure and record the DC resistance between the technical ground in any equipment rack or console and the main building ground. Resistance should be 0.15 ohms or less.

C. Loudspeaker Circuit Verification Test
1. Measure the impedance of each loudspeaker line leaving the equipment racks.

2. For constant voltage systems measure the impedance at 100 (or 250) Hz, 1 KHz and 8 (or 10) KHz of each line leaving the equipment rack with the line disconnected from the driving source. For band limited devices, use a frequency appropriate for the operating range of the transducer.
3. When documenting the results of these tests, include the calculated impedance based on number of units on a line and the size and distance of the run. Correct any field readings that differ more than 20% from the calculated impedance.
4. Include the results of the tests in the Project Record Manual.

D. Loudspeaker Polarity Verification Test
1. Use an electronic polarity checker, SysTune, SMAART, or other two-channel FFT measurement system to test each loudspeaker. All loudspeakers should have the same relative polarity.
2. Follow manufacturer's recommendations in conducting the tests.
3. Include the results of the tests in the Project Record Manual.

E. Audio Signal Paths
1. Verify operation from each source device through all switching, amplification, and distribution devices.

F. System Gain Adjustment
1. Adjust each active device to have proper gain structure from the mixer output to the input of the amplifier.
2. With all amplifiers turned off, connect a sine wave or pink noise generator to the input of the mixer. Using an RMS AC voltmeter with a dB scale, adjust the mixer to an output between -10 and 0 dBu. Note the dBfs level should be -18dB for digital outputs. Once the level has been established, it should remain unchanged throughout the test. All equalizers should be set flat for this test.
3. Follow the signal flow from the mixer to each subsequent component. Measure the input level and output level of each device at the point of connection to the device. The input level reading should differ no more than 0.25 dB from the level recorded for the preceding device. Diagnose and correct the wiring or equipment when any readings exceed this range.
4. Adjust the output of each component to achieve the proper output level.
5. Record the output levels of each device in the Project Record Manual.

G. Signal Delay Adjustment
1. Adjust the delay to each subsystem to ensure proper synchronization between the main speakers and delayed speakers.
2. Using SysTune, SMAART, or other two-channel FFT measurement system, measure the arrival time of the distant signal and then measure the arrival of the local signal.
3. Based on the arrival times measured, adjust the delay applied to the local speakers to synchronize them with the distant speakers. Repeat the test to verify the delay has been set to within 1 ms of the arrival of the distant signal. Once the precise delay time has been determined, provide an additional 10 ms of Haas effect delay to maintain directional orientation toward the original sound source.
4. Continue to test and adjust each separate subsystem with a dedicated delay channel.
5. Provide hard-copy printout of each delay adjustment showing first the arrival times with no delay set and then the result after the delay has been adjusted. Record the settings of each delay in the Project Record Manual.

H. Remote Input Verification Test
1. Using a microphone or portable signal generator, connect to each microphone/line level receptacle throughout the facility.
2. Verify that the receptacle under test appears at the correct input and is operating properly.
3. In a similar manner, check all remote tielines and media related lines for correct wiring and labeling.

I. System Equalization
   1. Using SysTune, SMAART, or other two-channel FFT measurement system, equalize all loudspeaker systems to provide a suitable frequency response as follows:
      a. Speech Reinforcement Systems: flat response from 125 Hz to 2.5 KHz, with 2 dB roll off above. Adjust initial settings as necessary for best intelligibility
      b. Program Reproduction Systems: flat response from 65 Hz to 8 KHz, with 2 dB per octave roll off above. Adjust subwoofer level to +6dB above man speakers from 35Hz to Hz. Adjust initial settings to optimize audio quality.
   2. Verify system gain and amplifier levels.
   3. Provide program levels of at least 95 dB and speech reinforcement levels of at least 70 dB in the seating area without objectionable distortion, buzzes, or rattles.
   4. Provide hard copy printouts of the spectral response with the test data.

J. RFI and Parasitic Oscillation
   1. With systems operating, check to ensure that all systems are free from spurious oscillation and radio frequency interference in the absence of audio signal.

K. Buzzes, Rattles, and other Distortions
   1. Adjust the system for normal operating level in the space. Apply a slow sine wave sweep from 60 Hz to 3 KHz and listen carefully for buzzes, rattles, and other objectionable distortions.
   2. Correct the cause of the defect. If the cause is not from the system, bring the cause to the attention of the Owner, indicating cause and suggestive corrective actions.

L. Video Systems Test
   1. Projected images and screen must be plumb with respect to ceiling line.

M. Video System Tests. Verify performance of all video equipment, components, and systems, as specified herein.
   1. Video (signal):
      a. S/N (peak to RMS), unweighted DC to 4.2 MHz: 55 dB minimum.
      b. Crosstalk, unweighted DC to 4.2 MHz: 45 dB minimum.
      c. Frequency Response: Within plus to minus 0.5 dB to 4.2 MHz.
      d. Line and Field Tilt: 2% maximum.
      e. Differential Gain: 2% maximum.
      f. Differential Phase: 2 degrees maximum.
      g. Frequency Response: DC to 4.2 MHz within plus or minus 0.5 dB.

N. Video Signal Paths
   1. Verify operation from each source device through all switching, amplification, and distribution devices.

O. Video Test Report shall include the following:
   1. Test Failures and Notices
      a. Sink Device EDID Test – Open items or failures shall not be accepted.
      b. Cable Length Test – Open items or failures shall not be accepted.
      c. HDCP KSV Limitations – Limitations shall not be accepted.
      d. Cable Limitations - Limitations shall not be accepted.
      e. EDID Limitations - Limitations shall not be accepted.
      f. Cable Length Limits exceeded – Failing cables shall not be accepted.
   2. Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
   3. Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
   4. EDID – Input Resolution and 3D support status for each input.
   5. EDID – Supported Output Resolution and 3D support status for devices connected to each output.
   6. EDID – Supported Audio formats for each input.
   7. EDID – Supported Audio formats for devices connected to each output.

P. Control Systems
1. Verify operational functions of the control system and all interfaced devices.
2. Verify operational functionality of any wireless user devices.

3.8 CAT5E/CAT6 CABLE CERTIFICATION

A. General Field Test Requirements
1. All CAT5E/CAT6 cabling links installed as part of this scope shall be tested for the following, in accordance with the field test specifications defines in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard.” This document will be referred to as the “Category 5e Standard”:
   a. Wire Map
   b. Length
   c. Insertion Loss
   d. NEXT loss
   e. PS NEXT Loss
   f. ACR-F Loss
   g. PS ACR-F Loss
   h. Return Loss
   i. Propagation Loss
   j. Delay Skew
2. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the “Permanent Link” performance specification as defined in the Category 5e Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the Category 5e standard mentioned above and as further detailed in Section B below. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. The test equipment (tester) shall comply with the accuracy requirements for level IIe field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 2 of ANSI/TIA-1152 (Table 2 in this TIA document also specifies the accuracy requirements for the channel configuration).
5. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
6. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
7. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
8. The Pass or Fail condition of the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass.
9. A Pass or Fail result for each parameter is determined by comparing the measured values with the specifies test limits for that parameter.

B. Performance Test Parameters

1. The test parameters are defined by the Category 6A Standard. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 100 MHz) must meet or exceed the limit value determined in the above mentioned standard.
2. Wire Map - Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct.
3. Length – The field tester shall be capable of measuring length of all pairs of a basic link or channel based on the propagation delay measurement and the average value for NVP. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the Permanent Link configuration (90 meters – 295 feet) plus 10% to allow for the variation and uncertainty of NVP.
4. Insertion Loss (Attenuation) – Insertion Loss is a measure of signal loss in the permanent link or channel. The term “Attenuation” has been used to designate “Insertion Loss.” Insertion Loss shall be tested from 1 MHz through 100 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk Ratio (ACR) parameter. Minimum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results of the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which the worst case value occurs, and the test limit value at this frequency.
5. NEXT Loss – Pair-to-pair near end crosstalk loss (abbreviated as NEXT loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations).This parameter is to be measured from 1 through 100 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. The maximum step size for NEXT loss measurements shall not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
6. Table 1 – Maximum frequency step size as defined in ANSI/TIA-1152

Frequency Range (MHz)	Maximum Step Size (MHz)
1-31.25	0.15
31.26-100	0.25

7. NEXT Loss – Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 100 MHz and the step size may not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Maximum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS next. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
8. ACR-F Loss, pair to pair – Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and

reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured 1 through 100 MHz and the maximum step size for FEXT loss measurements shall not exceed the maximum step size defined as the standard as in Table 1. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst value for ACR-F. There wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

9. PS ACR-F Loss – Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs of the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
10. Return Loss – Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured from 1 through 100 MHz in frequency increments that do not exceed the maximum step size defined in the Category 5e Standard as shown in Table 1. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst value of Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.
11. Propagation Delay – Propagation delay is the time required for the signal to travel from one of the links to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst propagation delay. The report shall include the propagation delay value measured as well as the test limit value.
12. Delay Skew – [as defined in the Category 5e Standard; Section 6.2.19] This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

C. Test Result Documentation
1. The test results/measurements shall be transferred into a Windows based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.
2. The database for the completed job shall be stored and delivered electronically, including the software tools required to view, inspect, and print any selection of test reports.
3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
   a. The identification of the link in accordance with the naming convention defined in the overall system documentation.
   b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number.
   c. The date and time the test results were saved in the memory of the tester.
4. General information to be provided in the electronic data base with the test results information for each link:
   a. The identification of the customer site as specified by the end-user.

b. The identification of the link in accordance with the naming convention defined in the overall system documentation.
c. The overall Pass/Fail evaluation of the link-under-test
d. The name of the test limit selected to execute the stored test results
e. The cable type and value of NVP used for length calculations
f. The date and time the test results were saved in the memory of the tester
g. The brand name, model, and serial number of the tester.
h. The identification of the tester interface
i. The revision of the tester software and the revision of the test limits database in the tester
j. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5.

5. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
6. The detailed test results data to be provided in the electronic database must contain the following information:
   a. Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m330 and test limit value.
   b. Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
   c. Delay Skew: Identify the pair with the largest value for delay skew, the value measured in nanoseconds (ns) and the test limit value.
   d. Insertion Loss (Attenuation): Minimum test results documentation as explained in Section B for the worst pair.
   e. Return Loss: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link.
   f. NEXT, ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.
   g. PS NEXT and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link.

3.9 FINAL OBSERVATION & TESTING

A. Upon completion of installation, initial adjustments, tests, and measurements specified in Part 3, and submission and review of the results, a final observation and test will be performed by the Owner or Owner’s representative no earlier than two weeks after receipt of the written results.

B. Provide a minimum of one (1) person for observation and testing familiar with aspects of the System to assist the Owner.

C. The process of testing the System may necessitate moving and adjusting certain components.

D. Testing includes operation of each major system and any other components deemed necessary. Perform tests and provide required test equipment, tools and material required to make any necessary repairs, corrections, or adjustments.

E. The following procedures will be performed on each System:
   1. Observation of the methods and means employed to incorporate the System within the facility.
   2. Verification of proper operation, from controlling devices to controlled devices.
   3. Verification of proper adjustment, balance, and alignment of equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark

normal settings for each level control, and appropriately record these settings within the Record Documents.

4. Other tests on equipment or systems deemed appropriate.

F. In the event the need for further adjustment or work becomes evident during testing, the Contractor is to continue their work until the System is acceptable at no addition to the contract price. If approval is delayed because of defective equipment, or failure of equipment or installation to meet the requirements of these specifications and any extension of the observation and testing period is required, the Contractor shall pay for additional time and expenses of the Owner at the standard rate in effect at that time.

3.10 TEST EQUIPMENT

A. Thirty days prior to start of testing, provide a list to the Owner of test equipment make, model numbers, and calibration dates that will be used.

B. The following equipment shall be available on site for the entire test period through final system testing.

1. Sound Level Meter: ANSI S1.4-1971 Type S1A with digital or analog display. Meter to provide ranges of 40 to 120 dBA.
2. Pink Noise Source - Equal energy per octave bandwidth 20 Hz to 20,000 Hz, ±1 dB (long-term average) at 0 dBm output. Stability: ±2 dB per day.
3. Impedance Meter - Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 5k Hz. Measurement Range: 1 ohm to 100 kohms.
4. Audio Oscillator: bandwidth 20 Hz to 20k Hz ±.5 dB at 0 dBm output. Output to be balanced. Oscillator to include adjustable output level over the range from –30 dBu to +10 dBu.
5. Multimeter - Measurement range, DC to 20k Hz, 100 mV to 300 V, 10 ma to 10 A, dB.
6. NTSC Test generator
7. Sound system measurement and alignment system
   a. SysTune, SMAART, or other two-channel FFT measurement system, with industry standard measurement microphones. Provide adequate microphone cabling for the venue size, or a wireless microphone system qualified for use with a test measurement system. Provide one microphone stand with each microphone.
8. Video (analog) test generator capable of generating signal up to 1920 x 1200 with audio.
9. Video (digital) test generator capable of generating signal up to 1920 x 1200 with audio.
10. Two-way radios to connect personnel in the equipment room(s) with personnel in other areas of the site for coordinated systems test and setup.
11. Ladders and scaffolding necessary to inspect elevated equipment, junction boxes, etc.

3.11 INSTRUCTION OF OWNER PERSONNEL

A. Provide 8 hours instruction to Owner designated personnel focusing on the use, operation, and maintenance of the systems, scheduled as a minimum of two separate sessions, by an instructor fully knowledgeable and qualified in system operation. The System Reference Manuals should be complete and on site at the time of this instruction. Coordinate schedule of demonstration with Owner’s Representative.

B. Video record all training sessions and compile a training video to be provided to the Owner electronically.

C. Provide sign in sheet to document the attendee’s presence.

D. If Contractor is not properly equipped to conduct Owner training on particular equipment, arrange for factory representatives of the equipment to be present to provide training at no additional cost to the Owner.

E. Provide on-site event support for 4 events, chosen at the discretion of the Owner, by a technician fully knowledgeable and qualified in sound system operation, programming, and troubleshooting.

3.12 CLEANUP AND REPAIR

A. Upon completion of the work, remove refuse and rubbish from and about the premises. Leave areas and equipment clean and in an operational state. Repair any damage caused to the premises by the installation of systems at no cost to the Owner.

END OF SECTION 27 41 16