

SECTION 27 41 16 – ASSISTIVE LISTENING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 RESERVED

1.3 SECTION INCLUDES

- A. Project instruction for the Vendor, and Assistive Listening system description details
- B. Assistive Listening System product description
- C. Project completion instruction for the Vendor

1.4 RESPONSIBILITY

- A. Notwithstanding any detailed information in the Contract Documents, it is the responsibility of the Vendor to supply all materials, equipment, transportation, engineering and labor necessary to provide a fully working, tested, and calibrated 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, Vendor is to supply items and quantities according to the intent of the Specification and Drawings, without claim for additional payment.
- B. 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 Vendor by reason of his failure to have brought said discrepancies to the attention of the Owner.
- C. Execute all work in accordance with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), 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.
- D. Required licenses, insurance, and permits including payment of charges and fees.
- E. Verification of dimensions and conditions at the job site.
- F. Coordinate location and installation of equipment, power, grounding, and raceways with other building elements.

- G. Preparation of submittal information.
- H. Pick-up of Owner Furnished Equipment (OFE) and incorporation into the project if applicable.
- I. Installation in accordance with the contract document, manufacturer's recommendation, and in conformity with applicable codes and authority having jurisdiction (AHJ).
- J. Final tests and adjustments, written report, and documentation.
- K. Instruction of operating personnel.
- L. Provision of manuals.
- M. Maintenance services and warranty.

1.5 **RELATED WORK**

- A. Electrical
 1. The Vendor shall be responsible for the 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 Vendor 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 Audio System(s), are provided by the Vendor. Coordination between different disciplines is required to achieve a proper conduit system installation and power provisions for the Audio System(s). All electrical installations shall be in accordance with division 26 and the National Electric Code.
- B. Conduit and Cable Management
 1. Install signal cable in conduit as shown on 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 Vendor shall be responsible for design and structural engineering for the installation of the system antennas, and any related support equipment or equipment enclosures to the building structure. Mounting methods should be stamped and certified by an appropriate PE engineer, and shall confirm, among other things, appropriate mounting hardware for the installed equipment.
- D. Networks
 1. The Vendor is to connect any network enabled equipment to the appropriate network as directed by the Owner. This includes the WiFi option in ADD/ALT1 if purchased.

1.6 **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 Manufacturers 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. Davis and Davis, Sound System Engineering (3rd Edition) (SSE), Howard W. Sams, 2006
 13. Giddings, Audio System Design and Installation (ASDI), Howard W. Sams, 2013
 14. AV Installation Handbook Second Edition: The Best Practices for Quality Audiovisual Systems, Infocomm (AVIH), 2009
 15. Middle Atlantic – Thermal Management White Paper

1.7 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 the Vendor.
 3. Provide: To furnish and install.

1.8 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.
- B. The Work includes provision of a complete and working Assistive Listening System, providing coverage to all fixed spectator seating areas.
1. Reference complementary drawings
 2. The existing Assistive Listening System is located on the South lighting tower in the East end zone.
 - a. The Work includes demolition of the existing Assistive Listening System.
 - 1) Remove the existing Assistive Listening System with associated equipment housing, transmitter, and antenna.
 - 2) Coordinate disposal with the Owner.
 - 3) Remove cabling not intended for reuse.
 - b. Provide new weatherized equipment and/or equipment housings for the Assistive Listening Transmitter at all new transmitter locations.
 - 1) Coordinate a new location for the equipment housing with the Owner that maximizes airflow around the equipment housing and minimizes the cable length between the Assistive Listening Transmitter and the Antenna
 - 2) Provide conduit and signal cable extension from the existing equipment housing location to the new equipment housing location

- a) Test existing signal cable before and after relocation to verify operation
- 3) Coordinate relocation of electrical power from the existing equipment housing location to the new equipment housing location
- 4) Locate new transmitter on the lighting tower in a manner that provides Assistive Listening coverage to all fixed exterior spectator seats.
3. Provide equipment housing, transmitter, antenna, cabling, pathways, and coordinate electric power at four locations to cover the lower bowl
 - a. Quadrant A, Quadrant C, and Quadrant D are new equipment locations
 - 1) Coordinate equipment housing locations with the Owner
 - 2) Coordinate electrical power needed at each equipment housing location
 - 3) Provide pathway and cabling between the new equipment housing locations and respective Quadrant Amplifier Rooms on the lower suite level
 - b. Quadrant B transmitter location is in the existing Video Production rack room
 - 1) Coordinate space for the transmitter and connection to electrical power with the Owner
 - c. Locate the antennas as shown on drawings, maintaining the shortest cable distance possible
4. The signal source for each of the five transmitters will be analog outputs from the existing house sound system DSP
 - a. Programming to the DSP GUI will be done by Sound and Video Works if required. Include this programming as part of your base bid. Sound and Video Works can be reached via email at sales@svworks.net or through their website at <http://svworks.net/>
 - 1) Coordinate which DSP analog outputs are used with Sound and Video Works.
5. Unpackage Receivers, Charging/Carry cases, Neck-loops, and Earbuds
 - a. Apply an inventory sticker provided by the Owner for each Receiver stating "Property of the Maryland Stadium Authority"
 - b. Pair one set of Earbuds with each Receiver
 - 1) Each pair of Earbuds to be provided with a heat-shrink label stating "Property of the Maryland Stadium Authority"
 - 2) Each pair of Earbuds to be provided with a captive hook and loop tie-strip to keep the cable coiled when not in use
 - c. Load Receivers with Earbuds into Charging/Carry cases
 - 1) Coordinate a storage/charging location for the Charging/Carry cases with the Owner
 - d. Provide a portable utility storage case for the Neck-loops and replacement earbud cushions
 - 1) Each Neck-loop to be provided with a heat-shrink label stating "Property of the Maryland Stadium Authority"
 - 2) Each Neck-loop to be provided with a captive hook and loop tie-strip to keep cable coiled when not in use
6. Provide a sample of ADA signage for public display to Owner for approval. Once approved, coordinate install with Owner at each of three (3) Ticket Windows and two (2) Guest Services locations.
7. Testing
 - a. Verify operation of each Receiver and Earbud combination
 - b. Verify operation of each Neck-loop
 - c. Verify interrupt and messaging from the Fire Alarm interface is operational through the Assistive Listening System
 - d. Test all ticketed seating bowl seats to confirm reception from the Assistive Listening System. Provide test results to the Owner. Provide the Owner with a seating map of M&T Bank Stadium that confirms signal strength and coverage area.

8. Provide the Owner with a record of all serial numbers, in the Owner's preferred format (Excel).

1.9 ADDITIVE ALTERNATES (ADD/ALT)

- A. Provide breakout pricing for each ADD/ALT
- B. ADD/ALT 1 – Assistive Listening WiFi based system
 1. Provide per-server pricing, to include associated network infrastructure needs
 2. See equipment specification in Part 2.

1.10 SUBMITTALS

- A. Provide submittals in accordance with Conditions of the Contract and Division 1, Submittal Procedures section unless otherwise indicated.
- B. Supplementary submittal requirements:
 1. Provide the following for review within thirty days of issuance of Notice to Proceed (NTP) and prior to commencement of the Work.
 2. Each submittal is to include 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. Complete schedule of submittals.
 - e. Chronological schedule of the Work in bar chart form.
 - f. Product Data Submittal (PD):
 - 1) Provide product data submittal in a single combined PDF file.
 - 2) Provide an indexed list of products to be incorporated in the Work.
 - 3) Manufacturer's data/specification sheets to be incorporated within the Work.
 - 4) In the index provide clickable hyperlinks that lead to the page of the submittal for the item.
 - 5) Organize index and data sheets in specification order. Provide a specification reference for each product (i.e. 2.6, A, 1). For data/specification sheets provide this in the upper right-hand corner of the page.
 - 6) Remove any pages with non-English language text.
 - 7) When multiple products are shown on a data sheet, indicate which product(s) are to be provided with an arrow, highlight or note.
 - 8) Submittal shall not include user/operating manuals, service/installation manuals, marketing brochures.
 - 9) For items to be installed in areas visible to the public, prior to submittal, coordinate with the Owner the desired color. Include color selection in submittal.
 - 10) Submissions that do not follow the format and configuration described above will be returned without review.
 - g. Shop Drawing Submittal (SD):
 - 1) Functional Diagrams/Schematics:
 - a) Detailed, redrawn wiring diagrams showing interconnection of devices, wiring and cabling diagrams depicting cable types and unique designators/labels, and device designators for each system. Provide connector type and terminal strip identification, along with

color codes for cables connecting to these devices. Give each device a unique designator and use this designator consistently throughout the project.

- h. Coordination Drawings:
 - 1) Coordination drawings – as appropriate and relevant to this system - showing major elements, components, raceway, cabling and devices of the systems in relationship with other building components on:
 - a) Floor plans
 - b) Reflected ceiling plans
 - c) Elevations
 - d) Sections
 - e) Rack elevations, front and rear, including non-rack mounted equipment within racks; AC power outlet and terminal strip locations; wire routing and cabling within housings.
 - f) Patch panel layouts and designation (labeling) strips, including color schemes.
 - g) Transmitter and equipment enclosure mounting details, include hardware types and load capacity.
 - h) Fabricated Plates and Panels: 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.
 - i) Full fabrication details of any custom enclosures and millwork indicating size, material, finish and openings for equipment.
 - j) Labeling: Equipment and cabling labeling scheme. Include font sizes and styles, explanation of scheme, and designator schedule.
 - k) Schedules: 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 the remainder of wiring diagrams.
 - l) Consultant's project documents in electronic format will not be supplied to the Vendor for their use as part of submittals.
 - m) Detail drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
 - n) Submissions that do not follow the format and configuration described above will be returned without review.
 - o) Any other pertinent data which is necessary to provide the Work.
- i. Structural rigging and mounting details:
 - 1) All transmitter and equipment enclosure structural rigging 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) Attachment method to building structure for transmitter and equipment enclosures.
 - b) Detail the product manufacturer, part numbers and load capacity of the hardware fittings and materials selected.
 - c) A copy of the design calculations.
 - d) Any secondary steel required for attachment to the building structure. All fittings, hardware, materials, and cable used for suspended transmitters and equipment enclosures.

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.

3. Approval of Submittals: The submittal information will be reviewed by the general Vendor, owner, Owners, engineers, and consultants. Each submittal package will be returned, stamped as follows:
 - a. "No Exceptions Taken" proceed with construction, all job site coordination will be at the direction of the general Vendor.
 - b. "Make Corrections Noted: No Resubmission Required" submittals have been returned with conditional approval. Corrections, as indicated on the returned drawings and/or specifications, must be made before construction can begin.
 - c. "Make Corrections Noted: Submit Corrected Copy" submittals have been returned with conditional approval. Corrections, as indicated on the returned drawings and/or specifications, must be made in writing and returned to the consultant before construction can begin.
 - d. "REJECTED, Submit Specified Item" a specified item in the submittal has been rejected for the reasons noted. Re-submit in compliance with the specifications.
 - e. "REJECTED, Revise and Resubmit" submittal has been rejected for the reasons noted. Re-submit in compliance with the specifications.
 - f. "No Review Action Required" all information provided was for information or coordination purposes only. Review is not required.

1.11 **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:
 - a. Equipment Lists: In an Excel spreadsheet, list all provided equipment make/model/description/serial number/MSA tag numbers.
 - b. Equipment Manuals:
 - 1) Manufacturer's owner/instruction manual for each type of Product by manufacturer and model or part number unless specified otherwise herein
 - 2) Supply manufacturer's serial numbers for each Product
 - 3) For custom circuits or modifications, a description of the purpose, capabilities, and operation of each item
 - 4) List by manufacturer and model or part number of Products incorporated within the Work, arranged in alphanumeric order.
 - 5) When applicable, bind Manufacturer's warranty statements separately.
 - c. Test Reports: Recorded findings of Commissioning.
 - 1) Provide commissioning test results to the Owner.
 - 2) Provide the Owner with a seating map of M&T Bank Stadium that confirms signal strength and coverage area.
 - d. System Operation and Instructions: Prepare a complete and typical procedure for the operation of the equipment as a system, organized by subsystem or activity.
 - 1) This procedure should describe the operation of system capabilities.
 - 2) Assume the intended reader of the manual to be technically inexperienced but unfamiliar with the components and the facility.
 - e. 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.
 - f. Any other pertinent data generated during the Project or required for future service.
 - g. 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:

- 1) Record drawings: Final rendition of Shop Drawings depicting what is actually incorporated within the Work.
- 2) 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.
- 3) One set of signed proof-of-training documents.
- h. Submittal Format:
 - 1) Record Drawings: Drawings executed at an appropriate scale, but not smaller than 1/8 inch = 1'-0".
 - 2) 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.
 - 3) Project Record Manual
 - a) Provide product data submittal in a single PDF file.
 - b) Provide an indexed list of major groupings.
 - c) In the index, provide clickable hyperlinks that lead to the page of that major grouping.
 - d) Organize index and major groupings in logical signal-flow order.
 - 4) 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.

1.12 CUSTOM SOFTWARE

A. Introduction:

1. Proprietary software provided for the Technical Systems shall be subject to this software license between the Vendor and the Owner as an essential element of the system as defined in the system specification and associated documents, drawings and agreement.
2. Vendor shall agree that 3rd party proprietary software provided with the system shall be subject to this agreement.
3. Vendor 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 Vendor'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 the 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. Vendor 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 Vendor. 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 Vendor and accepted by the Owner.
2. Except as expressly set forth in this agreement, Vendor 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 the Vendor or allow the Vendor 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 the Vendor. All such intellectual property shall remain the exclusive property of Owner and shall not be used by Vendor 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. The 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. The 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 Vendor.
- D. Warranties and Representations:
1. Vendor 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 the Owner.
 - b. The goods and services provided by Vendor under this Software License, including the software and all intellectual property provided hereunder, are original to Vendor 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. Vendor 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.

1.13 QUALITY ASSURANCE

- A. Qualifications: Vendor 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 of 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 AVIXA.
 7. Adequate plant capacity and equipment to complete the Work.
 8. Adequate staff with commensurate technical experience.
 9. Suitable financial status (i.e.; bonding and materials purchase capacity) to meet the obligations of the Work.
 10. Adequate regional service organization to meet warranty response requirements of the Project.
 11. Provide listing with appropriate explanation regarding the status of Vendor's resolved or unresolved legal disputes within the last six calendar years.
 12. Provide listing with appropriate explanation regarding any projects within the last 3 years where the Vendor has failed to meet construction schedules due to Vendor's cause.
 13. Completed current version of the American Institute of Owners (AIA) Vendor's Qualification Form.
- B. Subcontractors: at the time of bid, the Vendor shall provide a list of structural, electrical, sound, or any other subcontractor 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 Vendor.
- 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 Owner.

1.14 **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 the 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.

1.15 **PROJECT CONDITIONS**

- A. Verify conditions on the job site applicable to this work. Notify the Owner 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 Owner for approval, showing how the work may be installed.

1.16 **WARRANTY**

- A. Warrant labor and equipment for one (1) 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 observation visit with the Owner.

PART 2 - **PRODUCTS**

2.1 **GENERAL**

- A. Product quantity is as required. If a quantity is given, provide at least the given amount. Some products 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 transmitters 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.
- F. Paint all transmitters, equipment enclosures and conduit or cabling to match surroundings if required by Owner. Painting requirement is dependent upon final equipment location. Confirm color selection with Owner during the submittal phase.

2.2 **ACCEPTABLE MANUFACTURERS**

- A. Model numbers and manufacturers included in this specification are listed as standard of function, performance, and quality.
- 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 a manufacturer's rack mount adapter or one manufactured by Middle Atlantic or Winstead unless specified elsewhere.

2.3 ASSISTIVE LISTENING SYSTEM

- A. Provide Assistive Listening Signage, Receiver, Neck-loop, and Earphone quantities based on current ADA regulations.
- B. Provide line-item unit pricing for additional Receivers, Charger/Carry Cases, Earbuds, and Earbud replacement cushions.
- C. Quantities shown are complementary to the quantities purchased recently by MSA for Orioles Park at Camden Yards.
1. Acceptable Product to include the following:
 - a. Listen Technologies LT-800-216-01 Wireless Transmitter (Quantity: 5)
 - b. Listen Technologies LA-326 Rack Mount Kit (Quantity: 5)
 - c. Listen Technologies LA-117 Weatherized Antenna (Quantity: 5)
 - d. Listen Technologies LA-390 Terminated RG-8 cable (Length as required to span distance between Transmitter and Antenna. Minimize length to the extent possible, 100-foot is the maximum ideal length.)
 - e. Listen Technologies LR-5200-216 Receiver (Quantity: 260)
 - f. Listen Technologies LA-380 12-unit charger and carry case (Quantity: 22)
 - g. Listen Technologies LA-405 Stereo Earbuds (Quantity: 260)
 - h. Listen Technologies LA-163 Earbud replacement cushions, 20 count (Quantity: 10)
 - i. Listen Technologies LA-166 Neck loop (Quantity: 65)
 - j. Listen Technologies LA-304 Notification Signage (Quantity: 3)
 - k. Listen Technologies LW-100P-02 WiFi Server (ADD/ALT 1)

2.4 POWER CONDITIONING

- A. Power Protection if not already provided in existing rack Owner rack:
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
- B. Backup Power, if not already provided in existing rack Owner rack:
1. Provide UPS systems for:
 - a. Computer CPU's and associated video monitors.
 - b. DSP units and DSP hubs.
 - c. Audio related network equipment.
 - d. Mixing Console(s)
 - e. 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. Tripp Lite SM2200RMXL2UP

- C. Rack Lighting and Power Strip (if not already provided in existing rack):
 - 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. 1-U Rack Mountable
 - 7. Acceptable product:
 - a. Furman PL-Pro C
 - b. Middle Atlantic PDLT-815RVA

2.5 NETWORK EQUIPMENT

- A. Ethernet Switch:
 - 1. Compatible and approved by DSP and amplifier system manufacturer
 - 2. Compliant with Maryland Stadium Authority IT Standards
 - 3. Provide Fiber Optic adaptors as required
 - 4. Acceptable product:
 - a. Hewlett Packard Aruba 2930F series
 - b. Hewlett Packard Aruba 2930M series
- B. Fiber Patch:
 - 1. Rack Mountable Modular System designed for Fiber Optic Termination
 - 2. Acceptable products:
 - a. Panduit LGX compatible enclosures as required
 - b. Panduit LGX adaptor plates as required
 - c. Approved Equivalent

2.6 MISCELLANEOUS EQUIPMENT

- A. Line Level Isolator:
 - 1. Two channel isolator
 - 2. XLR input and output
 - 3. Maximum Signal Handling: +19dBu
 - 4. Acceptable Product:
 - a. Jensen Iso-Max PI2XX
- B. Portable Media Interface Cable:
 - 1. 1/8-inch TRS to Two 1/4-inch TS cable
 - 2. 6-foot length
 - 3. Each cable to be provided with a heat-shrink label identifying facility name and cable length.
 - 4. Each cable to be provided with a hook and loop tie strip to keep the cable coiled.
 - 5. Acceptable Product:
 - a. Whirlwind MST2TS
- C. Ethercon Feed-through Coupler:
 - 1. Ethercon/RJ-45 coupler
 - 2. Acceptable Product:
 - a. Neutrik NE8FF
- D. Ethercon to RJ-45 adaptor:
 - 1. 1-foot Ethercon to RJ-45

2. Acceptable Product:
 - a. Lex RJ45-RJ45E

- E. Transformers:
 1. Frequency response ± 0.25 dB, 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

- F. Dante to Analog Converter
 1. Two channels of analog from Dante
 2. Female RJ45 to male XLR
 3. Acceptable Product:
 - a. Amphenol Amphe-Dante RJD1212-0050

2.7 EQUIPMENT HOUSING & ACCESSORIES

- A. Audio Equipment Racks:
 1. Type: Frame and panel with locking rear door.
 2. Size: 32-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 WRK series

- B. 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

- C. 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

- D. Outdoor Equipment Rack:
 - 1. Type: Pad, Wall, or Pole mountable
 - 2. Size: 24-inches deep
 - 3. Aluminum construction with stainless steel external hardware and hinges
 - 4. Powder coated finish, with custom color options
 - 5. Venting system with reusable filter
 - 6. Top solar shield
 - 7. Optional HVAC climate controls
 - 8. Optional electrical and cable entry solutions
 - 9. Configure as required
 - 10. Acceptable Product:
 - a. DDB Unlimited SOD-302420

- E. Waterproof Utility Case
 - 1. Type: rolling utility case with retractable pull-handle
 - 2. Interior size: 19-inch X 14.38-inch X 8-inch
 - 3. Construction: Molded polypropylene copolymer resin
 - 4. Black finish
 - 5. Acceptable Product:
 - a. SKB 3i-1914-8B-E

- F. Rack Drawer:
 - 1. Spring loaded latch
 - 2. Black textured finish
 - 3. Acceptable Product:
 - a. Middle Atlantic TD series

- G. Low Profile Keyboard Shelf:
 - 1. Sliding black laminate shelf
 - 2. Single rack space
 - 3. Acceptable Product:
 - a. Middle Atlantic SSL

- H. Computer Shelf:
 - 1. Flanged construction
 - 2. 16 Gauge steel
 - 3. Black powder coat finish
 - 4. Acceptable Product:
 - a. Middle Atlantic U4

- I. Universal Rack Shelf:
 - 1. Black textured powder coat finish
 - 2. Acceptable Product:
 - a. Middle Atlantic RSU-129

- J. Universal Mounting Trays:
 - 1. Multiple Devices
 - a. Acceptable Product:
 - 1) Extron RSU 126
 - 2. Single Device
 - a. Acceptable Product:
 - 1) Extron RSB 126

- K. Blank Rack Panels:
 - 1. Flanged construction

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2. 16 Gauge steel
 3. Black powder coat finish
 4. Acceptable Product:
 - a. Middle Atlantic SB series
- L. Vent Rack Panels:
1. Flanged construction
 2. 16 Gauge steel
 3. Black powder coat finish
 4. Acceptable Product:
 - a. Middle Atlantic VTF series
- M. Brush Grommet Panel
1. Flanged construction
 2. 16 Gauge steel
 3. Black powder coat finish
 4. Acceptable Product:
 - a. Middle Atlantic BR1
- N. Rack Fan:
1. 10-inch or four 4.5-inch, 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 the 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, electrical
 2. Acceptable Product:
 - a. Wiremold 4000 Series

2.8 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 Owner. 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
- 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

2.9 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 the jacket of cable.
- C. Where cables are routed through ladder or tray, provide ladder or tray rated cable of equal specification.
- D. Where cables are run exposed through a return air plenum, provide plenum rated cable of equal specification.
- E. Shielded cables located in raceways shall have aluminum foil shields with drain wire.
- F. 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 a version of cable that meets required rating. Cables from Liberty, Commscope, Gepco, and West Penn are also acceptable provided they meet the performance specifications of the approved listed cables.
- G. Microphone and Line Level Cable: Belden 1696A - Single Pair twisted, 22 gauge, shielded, jacketed, 110 Ohm cable. Conductor to conductor cable capacitance to be less than 13 pF/ft.
- H. Antenna Cable: Belden 9258 - RG8/X, 16-gauge stranded center conductor, 95% braided shield.
- I. Ethernet Cable: White Belden 2412 - 4 pair, enhanced Category 6 nonbonded pairs.
- J. Digital Audio Fiber Optic Cable: Belden B9W241 Single-mode, 12 strand.

2.10 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

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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 rings 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)

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. 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 the 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 a 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 shields.
 - 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, 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 grommets.
 - 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.

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- 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 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 the 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" for 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 lamacoid 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 the 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 other 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".
 8. Panels, or equipment mounted on the rear rack rails, shall not block access to any front mounted components.

9. If the equipment rack is not equipped with casters, provide a two-inch-high wood base to isolate the equipment rack from the floor. Wood base should be capable of supporting the load.
- F. Installation of transmitters and equipment enclosures:
1. Transmitters and equipment enclosures shall be mounted at the operating position in a safe, secure, and permanent manner.
 2. Rigging, mounting, and support systems for transmitters and equipment enclosures shall be reviewed and certified by a registered Professional Engineer (PE) 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 the methods and means used to verify compliance with the original design.
 3. Paint transmitters and equipment enclosures, supports, and related hardware as required by the Owner. Color as directed by the Owner, reviewed at Shop Drawing submittals.
 4. Structural support members to have a safety factor of at least five. Mounting hardware and wire rope to have a safety factor of eight. All fasteners are to be graded and certified for use in the intended applications. Overhead suspension hardware shall comply with ASME B30.20 standards and all applicable local building and safety codes. Overhead suspension hardware must be of a type that includes product traceability controls.
 5. Provide safety cable on all bracket mounted transmitters and equipment enclosures.
- G. 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. Objects mounted outdoors shall be inherently corrosion resistant and perform to the standards of 304 or 316 stainless steel.
 3. Objects mounted outdoors shall be painted with UV resistant paint to avoid color fade.
 4. Structural supports for equipment, shall have inherent corrosion resistance, or be covered with a corrosion inhibiting layer.
 5. Transmitters and equipment enclosures mounted in exterior environments shall be rigidly connected to the structure to prevent movement caused by wind gusts.
 6. Seal all exposed electrical connections on the transmitters and equipment enclosures enclosure with waterproof silicone sealant.
 7. Provide screened cover over all openings in transmitters and equipment enclosures 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 UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed.

- 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. 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.
- B. 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.
- C. 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 changed to a darker shade of the regular button color.
 - 6. Color schemes used for background and foreground objects should be selected to be complementary and provide a consistent theme throughout the control pages.
- D. 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.
- E. 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 being pressed inward, change in shade of the original color, but not a change in hue.
- F. 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 typeface 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.
- G. 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.
- H. 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.
- I. 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.
- J. 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 Vendor. 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 the 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 a proper and safe manner according to manufacturer's instructions.
 - 2. Insulation and heat shrink tubing are present where required.
 - 3. Dust, debris, solder splatter, 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, removed and disposed of off-site.
 - 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. All debris has been cleaned up and discarded.
- 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. Audio Signal Paths:

1. Verify operation from each source device through all switching, amplification, and distribution devices.
- D. 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 a RMS AC voltmeter with a dB scale, adjust the mixer to an output between -10 and 0 dBu. 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.
- E. Signal Delay Adjustment:
1. Adjust the delay to each subsystem to ensure proper synchronization between the main speakers and delayed speakers.
 2. Using a TEF 20, SYSID, 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 printouts 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.
- F. 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.
- G. System Equalization:
1. Using a TEF 20, SYSID, SysTune, SMAART, or other two-channel FFT measurement system, equalize all loudspeaker systems to provide a suitable frequency response as coordinated with the Consultant.
 2. Verify system gain and amplifier levels.
 3. Provide program levels of at least 85 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.
- H. 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.

-
- I. 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.

 - J. Video Systems Test:
 - 1. Projected images and screen must be plumb with respect to ceiling line.

 - K. 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.

 - L. Video Signal Paths:
 - 1. Verify operation from each source device through all switching, amplification and distribution devices.

 - M. 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.

 - N. 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 **CAT6 CABLE CERTIFICATION**

- A. General Field Test Requirements:
 - 1. All CAT6 cabling links installed as part of this scope shall be tested for the following, in accordance with the field test specifications defined in ANSI/TIA-568-C.2 “Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard.” This document will be referred to as the “Category 6 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 6 Standard.
 3. One hundred percent of the installed cabling links must pass the requirements of the Category 6 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 specified test limits for that parameter.
- B. Performance Test Parameters:
1. The test parameters are defined by the Category 6 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 6 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.

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

6. 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 6 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.
7. 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.

8. 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.
 9. 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 6 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.
 10. 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.
 11. Delay Skew – [as defined in the Category 6 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 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 database 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 Vendor is to continue his 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 Vendor 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 the 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. Dual-trace oscilloscope - 100 MHz bandwidth, 1 mV/cm sensitivity.
 - 4. Impedance Meter - Capable of testing audio lines at three frequencies, minimum, between 250 Hz and 5k Hz. Measurement Range: 1 ohm to 100 kohms.
 - 5. 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.
 - 6. Multimeter - Measurement range, DC to 20k Hz, 100 mV to 300 V, 10 ma to 10 A, dB.
 - 7. NTSC Test generator
 - 8. Real time analyzer with LED or CRT display. The unit shall meet the filter requirements of ANSI S1.11 Class III for one third octave filters.
 - 9. Video (analog) test generator capable of generating signals up to 1920 x 1200 with audio.
 - 10. Video (digital) test generator capable of generating signals up to 1920 x 1200 with audio.
 - 11. Ladders and scaffolding necessary to inspect elevated equipment, junction boxes, etc.
- C. Provide three portable VHF or UHF business band radios for use during acceptance testing with transmission range sufficient to cover the entire project. Include rechargeable batteries and recharger along with a holster for wearing on the belt. Radios to be available for the duration of the testing process, including any follow-up visits required prior to final acceptance.

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 a sign in sheet to document the attendee's presence.
- D. If the Vendor 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