**ADDENDUM NO.:** 002
**IFB NO.:** 698
Description: Furnish, Deliver & Install Audio Visual Equipment
Project: Queens College - Louis Armstrong Center
Bid Opening Date: May 17, 2021 at 2:30 p.m.

Specifics of the Addendum: Revision to the Scope of Work and Detailed Specifications

**Section A – Scope of Work & Detailed Specifications**

The Integrated Audiovisual Systems and Equipment Specification – Section 274116 was not included as part of the original Bid Documents under Section A.

The following clarifications should also be included as part of the Scope of Work and Detailed Specifications:

- All cables and wiring installation necessary to support a complete Audiovisual system is the responsibility of this contract.
- Infrastructure (conduit, backboxes and drag lines) are being provided by others.

All other terms and conditions of the original Invitation for Bids or Request for Proposals shall remain the same. This notice shall be signed and attached to the Invitation for Bids and shall form a part of your bid.

# SECTION 274116

# INTEGRATED AUDIOVISUAL SYSTEMS AND EQUIPMENT

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Provide complete systems in compliance with drawings, general provisions of contract, including General and Supplementary Conditions, Division 1 Specifications, and Instructions to Bidders.

B. System refers to the complete and functional assemblage of equipment required to achieve the specified functionality, performance, and design intent. This shall include, but not be limited to, ancillary items such as power supplies, interfaces, transformers, mounting hardware, cable, and connectors.

C. Scope of Work: This specification section defines certain audio and audiovisual systems to be installed in the Louis Armstrong House Museum Education Center in Corona Queens, New York.

### 1.2 SECTION INCLUDES:

A. Design, supply and install audiovisual systems as described herein, to include equipment and materials, whether specifically mentioned herein or not, for a complete and operating system.

B. Provide all system engineering and design necessary to develop the complete systems described herein. Engineering and design shall include preparation of all necessary electronic schematics, hardware drawings, systems diagrams, schedules and lists. These documents shall be printed in both hard copy (paper) and soft copy (URL web link and USB drive). Data file formats shall be agreed between all necessary persons.

C. Generate submittal information for the complete fabrication, installation and wiring of the system. Provide the on-site installation and wiring and provide on-going supervision and coordination during implementation.

D. Provide for the initial adjustment of the systems as herein described and provide test equipment for the system checkout and acceptance tests. Prior to the systems acceptance tests, submit an initial testing and tuning report showing methods and results for tests performed.

E. Provide on-the-job training in the operation and maintenance of the systems for personnel designated by the Owner.

F. Provide one-year warranty from date of system acceptance for systems installed.

### 1.3 RELATED DOCUMENTS AND SECTIONS, COMPLY WITH THE FOLLOWING:

A. Division 01 – General Requirements Sections.

B. Division 12 – Furnishings

C. Division 23 – Heating, Ventilation and Air Conditioning (HVAC)

D. Division 26 – Electrical

E. Division 27 - Communications

## 1.4 REFERENCES

A. Reference Standards: See Section 014200 – References. In addition to requirements shown or specified, comply with applicable provisions of the following for design, materials, fabrication, and installation of component parts:
   1. BICSI/InfoComm, Audiovisual Design Reference Manual.
   2. InfoComm, AV Installation Handbook.
   3. InfoComm, Audiovisual Best Practices.
   4. Maltese, AV 9000: Defining Quality in Engineered Audio Visual Systems, 2006.
   5. City and State or District Codes and/or Ordinances, as applicable to location.
   6. IEEE C2, National Electrical Safety Code®.
   7. NFPA-70, National Electrical Code®.
   8. NFPA-72, National Fire Alarm Code®.
   9. NFPA-101, Life Safety Code®.
   10. NFPA-255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   11. American National Standards Institute (ANSI).
   12. Federal Communications Commission (FCC).
   13. National Electrical Manufacturers Association (NEMA).
   14. Occupational Safety and Health Administration (OSHA).
   15. Uniform Building Code (UBC).

B. Work shall comply with the latest edition of applicable criteria, standards, and codes including subsequent addendums.

C. In the event of conflicts, the more stringent provisions shall be applied.

## 1.5 DEFINITIONS

A. Definitions: See Section 014200 – References for additional definitions.
   1. Code Requirements: Minimum requirements.
   2. Final Acceptance: Owner's Representative's acceptance of project from Contractor.
   3. Furnished by Others: Receive delivery at job site or where called for and install.
   4. Owner's Representative: Architect or Engineer having contracted directly with Owner for professional services.
   5. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready to use.
   6. Replace: Remove and provide new item.
   7. Rough-in: Pipe, duct, conduit, equipment layout and installation.
   8. Provide: Furnish and install.
   9. Authority Having Jurisdiction (AHJ): Federal, state, local, or other regional department, or individual having statutory authority.
   10. Systems Contract Documents: These specifications and drawings referred to herein are furnished with and are integral parts of this system construction document. The specifications and drawings shall remain the property of the Owner and shall be returned by unsuccessful bidders.
   11. Specification Information Requests: Direct requests for clarification, substitution, or changes in these specifications or drawings to the Owner.
   12. Custom: Indicates systems or components that shall be fabricated by the Contractor based on these specifications and drawings.

13. Owner Furnished Equipment (OFE): Coordinate the integration of existing components or new components, provided by the Owner into the audiovisual system. Provide required mounting hardware, rack panels, cable, connectors, etc. to incorporate the OFE systems as specified.
14. Not In Contract (NIC): Refers to work or equipment that is not in contract covered in this section.
15. Future: Indicates equipment that will be added to the systems by the Owner or Owner representative at a later date. Provisions shall be made for this equipment.
16. Or Equal: Indicates equal in materials, size, color, design, function, and performance of specified and conforming with base bid manufacturer/model.

B. Contractor Qualifications
1. Be a licensed dealer for equipment described in these documents and maintain a service department within 75 miles of the project site capable of maintaining those systems both on a component and a complete systems level.
2. Have direct experience on 5 recent projects of similar type and size.
3. Own and maintain the tools and equipment necessary for successful installation and testing of systems as detailed herein and have personnel who are adequately trained in the use of such tools and equipment.
4. Employ at least one control system programmer certified by the manufacturer of the control system utilized in the project.
5. Employ at least one engineer holding a current Certified Technology Specialist – Design (CTS-D) certification by InfoComm International. The engineer shall be assigned to oversee technical aspects of the project.
6. Employ at least one technician holding a current Certified Technology Specialist – Installation (CTS-I) certification by InfoComm International. The technician shall be assigned as the lead field technician overseeing the installation.

## 1.6 SUBMITTALS

A. Comply with section 013300 – Submittal Procedures and section 016000 Product Requirements

B. In addition to requirements specified in section 013300, submit electronic copies of submittals in PDF format.

C. Bid Submittal
1. Schedule of Values: Provide a Schedule of Values and quantities for equipment to be supplied. Each piece of equipment shall be individually priced. Equipment costs shall reflect required modifications and accessories. The equipment list provided shall not be considered complete; Contractor shall bear design responsibility for a detailed equipment list to ensure a complete and working system.
2. Add alternates – provide pricing for the following add alternates as described below. The Owner may elect at any time during construction to engage Contractor in any individual Add Alternate or a portion thereof based on pricing offered at the time of bid.
3. Non-Equipment Costs: Furnish the total non-equipment and Service cost, and a separate list of non-equipment costs for each area, by the following categories:
    a. Engineering: Including required design, drawings, run sheets, instruction manuals, etc.
    b. Pre-Installation: Including fabrication, modification, assembly, rack wiring, etc., performed on the Contractor's premises.
    c. Installation: Including on-site installation and wiring, coordination and supervision, testing, checkout, Owner training, etc., performed on the Owner's premises.

d. Software Development: Including required design, testing, debugging, documentation, etc.
e. Documentation: Including equipment manuals, as-built drawings, software instruction manuals and program listings, user instruction panels, etc.
f. Training: Including training sessions with owner staff as noted in this specification.
g. General and Administrative: Including G & A expenses, shipping, insurance, and guarantees.
h. Project Management: Including weekly written reports, project schedule management, and resource management.
i. Warranty and first years' service.
j. Taxes: Including applicable Local, State, and Federal taxes.

4. Service Contract:
   a. Submit cost for a separate one-year service contract for the second year maintenance, covering installed systems, new and Owner-furnished. Include in this contract quarterly site visits to inspect, repair, and adjust systems to restore them to as-new operation. Parts and shop labor are assumed to be additional charges beyond the scope of this contract. This service contract shall commence immediately after expiration of the warranty period. The cost for this service contract shall not be commingled with the costs for the systems base bid.
   b. Submit separate costs for "on-call" service, both in-house and in-shop.
5. Substitutions:
   a. Comply with Section 012500 – Substitution Procedures.
   b. Submit bids on the basis of the specified equipment. Submit proposals for substitutions with associated equipment costs, separate and apart from the costs of the equipment as specified.
   c. Proposals for substitutions will receive consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Owner.
   d. Proposals for substitutions shall be accompanied by full technical information, and specifications for the equipment so proposed.
   e. Under no circumstances shall the Owner's Representative be required to prove that an item proposed for substitution is not equal to the specified item. The Contractor shall submit to the Owner's Representative evidence to support the contention that the item proposed for substitution is equal to the contract specified item. The Owner's Representative's decision as to the equality of substitution shall be final.
6. System Enhancements:
   a. Submit recommendations that will enhance the performance of the system, or reduce costs without loss of performance, in the bid submission. Suggestions that are of value to the Owner will be taken into consideration in the evaluation of the bid returns.
   b. Such proposals shall be made as "alternates", with the appropriate cost modifications shown separate and apart from the costs of the system "as specified".
7. Project schedule including the following milestones:
   a. Submittal packages.
   b. Equipment procurement, indicate equipment with long lead times.
   c. Rack fabrication.
   d. Installation.
   e. Substantial completion.
   f. Acceptance testing.
   g. Owner/user training.

8. Contractor Resume:
    a. A list of five recently completed projects of similar type and size with contact names and telephone numbers for each.
    b. A technical resume of experience for the Contractor's Engineer, Project Manager, Control System Programmer, Lead Field Technician and any other relevant personnel who will be assigned to this project.
    c. A list of technical product training attended by the Contractor's personnel that will install the systems.
    d. A list of subcontractors providing services under this scope of work. Provide description of work to be performed by each subcontractor and their qualifications.
9. Exceptions:
    a. Make exceptions to these specifications and related drawings with the bid submission. In the absence of exceptions, these specifications and related drawings shall be binding in letter and intent. It will further be assumed that the design, specifications, and existing conditions have been examined in detail, and full responsibility for the performance of the complete installation as specified is accepted.
10. Project Approach:
    a. An outline of the project approach and availability of resources.
    b. A scheduling plan with the bid return indicating the various pertinent terminal dates after award of contract for completion of design, pre-installation work, on-site installation work, and testing and acceptance.
    c. Test Equipment: A list of test equipment, giving make and model numbers to be used for tests and acceptance testing.

D. Installation Submittal
1. Provide after the award of contract, but prior to equipment procurement and installation
2. Shop drawings and data sheets shall be provided as a single comprehensive package. Partial submittals shall one be accepted with prior consent form the Owner's Representative.
3. Submittal shall include, but not be limited to, the following:
    a. System wiring diagrams for video, audio, and control systems showing manufacturer and model numbers, connectivity, cable types and cable identifiers including ancillary devices. Clearly label each item of equipment shown on the drawing with the manufacturer's terminal number or input/output designation.
    b. Algorithms and signal flow diagrams for configuration of digital signal processor equipment.
    c. Plate and Panel drawings showing finish, color, exact lettering, connectors and other pertinent fabrication instructions for all custom plates and panels in the systems. Include physical samples of engraving, finish and color.
    d. Rack Elevation drawings showing equipment layout within each rack, rack accessories, and power/grounding layout within each rack.
    e. Floor Plans, Reflected Ceiling Plans, Elevation and Sectional View drawings showing the layout for audiovisual devices within the facility.
    f. Run sheets or field wiring drawings: Clearly show at each terminal point the type of connector to be used and include typical wiring details of each connector. Note where shields are connected and where they will float to ensure the integrity of the grounding system. Call out wire types and color codes where appropriate. Assign wire numbers and patchbay locations to every wire and patch point in the drawing.
4. Detail drawings including:
    a. Custom furniture and millwork.

b. Custom components, assemblies and circuitry.
c. Custom equipment mounting, including structural attachment signed off by structural engineer.
d. Patch Panel Layout drawings.
e. Unusual equipment modifications
f. Drawing Index and Title Page
g. Symbols Legend

5. Binder containing product data sheets for equipment
   a. Should be organized logically by system
   b. Where a product data sheet includes more than one item, indicate model being proposed.
   c. Provide an index for reference
6. Provide structural loads and attachment methods to Project Structural Engineer for review.
7. Updates to project schedule
8. Test Equipment: Provide a list of test equipment, including manufacturer, description, and model number, of equipment that will be used to test and adjust the systems specified.
   a. Preliminary layouts of all remote control devices (touch panels, remote controls, etc.), submitted electronically and hardcopy.
   b. Touch Panel layouts must be done in software supplied by control system manufacturer, such as Vision Tools Pro-e. AutoCAD or similar graphics file formats are not acceptable.
   c. Descriptions of each button with functionality. Buttons with "trivial" functions, such as help buttons, may be omitted.
   d. For each piece of equipment, lists of functions under control of the remote control system.
   e. For each piece of equipment, a list of all inputs (feedback) to the remote control system.

E. Control System Submittal
1. Work with Owner and Owner's representative to review required control systems functions
2. Coordinate with Owner's network requirements and provide system interface to the local IP network (LAN).
3. Provide narrative description summarizing required functionality
4. Provide control panel operations in a manner that is consistent from page-to-page
5. Control system shall provide feedback that indicates the current equipment and/or system status where possible.
6. Provide and program software interface for Owner's technical staff, which shall allow advanced system control and monitoring functions using a PC connected to the control system LAN.
7. Submit GUI for review and signoff prior to finalization

F. Substantial Completion Submittal:
1. Shall be provided a minimum of 2 weeks prior to scheduled acceptance testing by the Owner's Representative and shall include the following:
2. A draft version of Record Drawings for systems depicting the current state of the systems to be tested.
3. A draft version of the Operation and Maintenance manuals which shall include the following:

a. Operating instructions for non-technical users. Include normal settings for equalizer, amplifier, signal processing, and user-operated controls. Include pictures of touch panel screens when appropriate.
b. A troubleshooting guide for the most common problems that might arise.
c. Equipment list for each room with manufacturer, model number, serial number, client tracking number (if applicable), and other unique equipment numbers for installed equipment in spreadsheet format.
d. A list of fixed or static IP addresses, ISDN numbers and telephone numbers used for audiovisual equipment.
e. A list of frequencies and/or channels used for wireless microphone and assistive listening systems.
f. Recommended maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, provide the information necessary for proper maintenance.
g. A list of necessary and recommended replacement parts for a normal maintenance period of one year.
h. Software files for graphical user interface, source code, DSP, and equipment settings on non-volatile electronic media. Provide electronic copies of compiled and un-compiled programming files.
i. Include the terms of the warranty and the appropriate contact phone numbers for service.
j. Equipment manufacturer’s operation and maintenance manuals for each piece of equipment.

4. Test and Measurement Data consisting of:
   a. Documentation of the performance test results. Comply with Section 3.12.
   b. Documentation of the tools and the manner in which the performance tests were taken.
   c. Documentation of the system settings prior to and after the system set-up.

G. Closeout Submittal
1. Comply with Section 017800 – Closeout Submittals.
2. The Closeout Submittal shall be provided within 30 days of systems acceptance and shall include:
   a. Final Project Record Drawings: Submit on URL weblink and USB stick in AutoCAD and PDF format.
   b. Final Project Record Drawings shall include drawings associated with the systems.
   c. The locations of installed conduits shall be shown on floor plan drawings.
   d. Two copies of the Final Operation and Maintenance manuals as described in Substantial Completion Submittal.
   e. A systems information packet shall be mounted in each equipment rack and shall consist of the system drawings associated with the rack, important telephone numbers and a list of equipment in the rack with serial numbers.
   f. Manufacturers’ instruction manuals for items of equipment, incorporating or followed by manufacturers’ warranty statements.
   g. Where manufacturer’s registration is required, register warranty in Owner’s name at an address determined by Owner. Provide copy of registration.

## 2.1 SYSTEMS DESCRIPTION

| Level | Room Name | Room Number |
|---|---|---|
| Cellar | Audio Control Room | [007] |
| 1 | Lobby Background Music | [012], [101], [101-4] |
| 1 | Jazz Room | [106] |
| 1 | Green Area | [107] |
| 1 | Green Room | [109] |
| 2 | Office | [204] |
| 2 | Reading Room | [206] |

A. CELLAR AUDIO CONTROL ROOM

1. Summary

   a. The Audio Control Room will support future program including but not limited to audio editing, recording, and/or engineering. At the time of this project, this room shall only receive infrastructure (NIC).

B. LOBBY BACKGROUND MUSIC

1. Summary

   a. The Background Music System is to be used for the following purposes: gathering space with background audio and presentation using wireless microphone system or portable equipment during events.

   b. The audiovisual system shall provide high quality playback of prerecorded audio, and audio content from portable systems.

2. Audio
   a. Sound System
      1) Provide ceiling loudspeakers and subwoofers on a 70V system with (3) audio zones for audio playback.
      2) Mount ceiling loudspeakers flush with finished ceiling. Mount ceiling flush with the finished ceiling. Coordinate exact locations with Architect.
      3) Provide program loudspeaker and subwoofers.
      4) Provide all required mounting hardware and amplification to support loudspeakers and subwoofers.

   b. Audio Routing and Processing
      1) Provide a rack-mounted modular digital signal processing (DSP) unit to be used for mixing, signal routing, EQ, delay, and other processing of multiple

audio sources to be located in equipment rack in Cellar AV Equipment Room [012].

2) Network audio routes from (2) FB3 floorbox locations in the lobby & east lobby to include (2) line level inputs and (2) line level outputs to support a portable mixing console and/or portable loudspeakers for events.
3) Levels shall be set according to the following scenarios:

a) Background Music – Level should default to a comfortable background volume associated with 50% on the control system. 100% should be very loud while maintaining adequate system overhead. 0% should be effectively inaudible.

b) Event Mode (Portable Equipment) – Line level inputs & outputs should default to a comfortable background volume associated with 50% gain in the DSP software. 0% should read 0 signal on mixing console.

c) Event Mode (Wireless Microphone) – Wireless Microphone gain and ceiling loudspeaker gain should default to a comfortable volume associated with 65% on the control system. 100% should be loud while not producing feedback when microphone heald at a reasonable distance.

c. Audio Sources
1) Network audio inputs from within facility
2) Provide DJ / Aux inputs (XLR-F, RCA & 3.5mm) in floorbox locations (FB3) as shown on AV drawings.
3) Provide a four-channel wireless microphone system with one (1) ceiling mounted diversity antenna (AN).

3. Control
a. Provide an integrated control system to control, monitor and manage AV functions.
b. Provide one (1) 7” wired touch panel to be placed upon reception desk table top in the lobby. This touch panel shall act as the main user interface. Provide graphical layout and programming required to integrate control of systems as described herein.
c. Graphical user interface (GUI) shall present users with pre-programmed configurations and functionality for the AV system as described below. All control system GUI pages shall be approved by consultants and owner.
1) System on/off
2) Control of background music audio levels
3) Control of individual wireless microphone gain levels
4) Overall audio gain levels
5) Control/mute/route audio zones
d. Provide rack mounted network switch capable of supporting Dante and AES67 audio transport within space. Coordinate network requirements with telecom structured cabling contractor and owner to allow for uplink from audio network switch to Facility LAN.
e. Provide and program digital signal processing equipment such that a low voltage GPIO control signal from fire alarm system (by others), shall trigger global mute of audio system in event of emergency.

4. Infrastructure and Accessories
   a. Provide all required infrastructure and accessory components, including but not limited to the following:
      1) Custom plates/panels
      2) Equipment mounting brackets
      3) Power controllers and sequencers
      4) Equipment racks and any/all seismic bracing

         a) The AV Rack Room [C012] shall be used as the rack room containing audiovisual equipment racks and all rack-mounted equipment.
      5) AV systems shall be served by conduit to device locations.
   b. Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

C. JAZZ ROOM

1. Summary

   a. The Jazz Room is to be used for the following purposes: Playback of Orientation Film (provided by Exhibit Fabricator), amplified live music performance, special events produced by third parties, and banquet-style events. A dedicated production/control room is provided for in-house event production, including camera control, video playback, audio/video recording capabilities.

   b. The audiovisual system shall provide high quality playback of prerecorded audio, speech reinforcement, and display of video content.

2. Audio
   a. Sound System:
      1) Provide (3) individually addressed point source loudspeaker enclosures and (1) subwoofer for speech reinforcement and audio/video playback. Provide loudspeaker types and mounting details as indicated in Attachment A – Audiovisual Equipment List.
      2) Hang Loudspeakers & Subwoofer from finished ceiling. Coordinate exact locations with Architect.
      3) Provide all required mounting hardware and amplification to support loudspeakers and subwoofers.
   b. Audio Processing and Routing:
      1) Provide network audio input/output plates within (W1) and (FB2) locations for routing of line level digital audio signals.
      2) Provide Cat6 ethernet connection within (FB2) floorboxes to rack mounted network switch for connection of network audio stage box to support 16 inputs and 8 outputs for live performances.
      3) Provide digital signal processing (DSP) unit with equalization, auto-mixing and signal routing of network and analog audio channels.
      4) Audio routing to each loudspeaker to be as follows to achieve a clear and full range mix throughout the space and varying source type modes:

         a) Orientation Film – Film stereo audio to be routed through audio DSP to provide mono mix output to each loudspeaker/subwoofer above stage.

b) Live Performance (House Equipment) – Stereo output from (W1) converted into network audio and compiled as mono mix in audio dsp for output to each loudspeaker/subwoofer above stage.

(1) All subwoofers shall be Left/Right mix

c) Background Music – Selected input source to be routed through audio DSP to provide mono mix output to each loudspeaker/subwoofer above stage.

5) Delays shall be applied such that all loudspeaker set with equivalent delay as required for uniform sound across the area.

6) Levels shall be set according to the following scenarios:

a) Background Audio – Level should default to a comfortable background volume associated with 50% on the control iPad. 100% should be very loud while maintaining adequate system overhead. 0% should be effectively inaudible.

b) Program Audio (follows video sources) – level should default to a comfortable background volume associated with 50% on the control touch panel. 100% should be very loud while maintaining adequate system overhead. 0% should be effectively inaudible.

c) Live Performance (House Equipment) – Program audio output gain to be set and locked to allow for proper gain structure and control through audio mixing console.

c. Audio Sources:

1) Provide stereo audio from the following sources:

a) Audio from the video via the video matrix switcher, including but not limited to:

(1) Exhibit Film CMS player (provided by others)

(2) User video sources (laptop, phone, tablet, etc.) via control room wall plate (W1) or video transmitters within floorboxes (FB2)

2) Provide a four-channel wireless microphone system with four (2) beltpack and two (2) handheld transmitters.

3) Provide network audio (Dante) tielines at floorbox locations (FB2) as shown on AV drawings.

4) Provide a Dante-enabled mixing console in the AV production/control room. Provide portable Dante-enabled stage box for connection and mixing of the Jazz Room live sources Provide local stereo monitors in AV control room for live mixing.

d. Assistive Listening:

1) Provide inductive loop Assistive Listening System with ADA compliant quantity of receivers. Refer to section 27 41 16.01 for further details.

3. Video

a. Video Displays and Outputs

1) Provide (1) 4K 6000lumen laser projector with lens as specified in Attachment A.
2) Provide (1) ceiling mounted motorized projection screen as indicated in section 11 52 13.
3) Provide HDMI output to control room desk (D2) for 27" 4K video monitor.
4) Provide HDMI output to (2) rack mounted studio broadcast recording decks.
5) Provide HDBT outputs to (2) displays in the Green Room & Green Area.

b. Video Routing and Processing:
1) Provide a video matrix switcher for video routing/scaling of sources.

c. Video sources shall include:
1) Wall mounted camera (C1) for room monitoring and video-recording
2) Wall-mounted video input location within control room (W1) DM HDBT connection.
3) CMS video playback devices with 4K HDMI video output (provided by others) for Exhibit Orientation Film playback

4. Control
a. Provide integrated control system to control, monitor and manage AV & room environmental functions.
b. Provide one (1) wired 10" touch panel control surface that shall act as the main user interface. Provide graphical layout and programming required to integrate control of systems as described herein.
c. Graphical user interface (GUI) shall present user with pre-programmed configurations and functionality for the AV system as described herein. Any controls related to the LED Wall shall be on a password-protected page. All control system GUI pages to be approved by consultants and the owner:

a) System on/off

b) Audio/Video source selection

c) Control of video source devices

d) Recall of system audio presets

e) Control of program audio levels

f) Overall audio gain level

d. Provide and program digital signal processing equipment such that a low voltage GPIO control signal from fire alarm system (by others), shall trigger global mute of audio system in event of emergency.

5. Infrastructure and Accessories
a. Provide hang points for mounting production equipment during events. Coordinate exact locations with Architect.
b. Provide two (1) full-height equipment racks to be housed within Jazz Room Control Room Support Area [106-2] as shown on AV drawings.
c. Provide one (1) 16RU height, rolling equipment rack to be housed within the AV production/control room [106-1] as shown on AV drawings.
d. All required infrastructure and accessory components shall be provided, including but not limited to the following:

1) Custom plates/panels
2) Equipment mounting brackets
3) Power controllers and sequencers
4) Equipment racks with accessories including rack shelves, fans, lacing bars, etc.

5) Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

D. GREEN AREA

1. Summary

a. The Green Area is to be used for Jazz room video feed monitoring.

b. The audiovisual system shall provide high quality display of video content via integrated AV devices.

2. Video
   a. Video Displays and Outputs
      1) Provide one (1) HD 40" LCD flat panel display and swing arm wall mount
      2) Provide one (1) HDBT wall plate receiver connected to Jazz Room video matrix switcher located within equipment rack in [106-2]
   b. Video Routing and Processing
      1) Overflow video will be routed from the Jazz Room matrix switcher and selectable as a video destination on the Jazz Room 10" touch panel.
   c. Video sources shall include:
      1) Jazz Room PTZ camera
      2) Mirror output from Jazz Room video projector

3. Control
   a. Provide video wall plate receiver with room controller function to allow Jazz Room touch panel GUI to control the following functions:

      a) Display on/off

      b) Video Source Selection

4. Infrastructure and Accessories
   a. Provide all required infrastructure and accessory components, including but not limited to the following:
      1) Custom plates/panels
      2) Equipment mounting brackets
      3) Power controllers and sequencers
   b. AV systems shall be served by conduit to device locations.
   c. Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

E. GREEN ROOM

1. Summary

a. The Green Room is to be used for Jazz room audio and video feed monitoring.

b. The audiovisual system shall provide high quality display of video content via integrated AV devices.

2. Audio
   a. Sound System
      1) Provide ceiling loudspeakers on a 70V system for audio playback.
      2) Mount ceiling loudspeakers flush with finished ceiling. Coordinate exact locations with Architect.
      3) Provide all required mounting hardware and amplification to support loudspeakers and subwoofers.

   b. Audio Routing and Processing
      1) Provide a compact audio amplifier to be mounted behind display (D1)
      2) Amplifier input to be taken from unbalanced audio output of video monitor display (D1)

   c. Audio Sources
      1) Audio following video when mirror of Jazz Room video source is selected

3. Video
   a. Video Displays and Outputs
      1) Provide one (1) HD 49” LCD flat panel display and swing arm wall mount
      2) Provide one (1) HDBT wall plate receiver connected to Jazz Room video matrix switcher located within equipment rack in [106-2]
   b. Video Routing and Processing
      1) Overflow video will be routed from the Jazz Room matrix switcher and selectable as a video destination on the Jazz Room 10” touch panel.
   c. Video sources shall include:
      1) Jazz Room PTZ camera
      2) Mirror output from Jazz Room video projector

4. Control
   a. Provide video wall plate receiver with room controller function to allow Jazz Room touch panel GUI to control the following functions:

      a) Display on/off

      b) Audio mute/unmute

      c) Video Source Selection

5. Infrastructure and Accessories
   a. Provide all required infrastructure and accessory components, including but not limited to the following:
      1) Custom plates/panels
      2) Equipment mounting brackets
      3) Power controllers and sequencers
   b. AV systems shall be served by conduit to device locations.

c. Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

F. OFFICE

1. Summary

a. The Office is to be used for single input video presentation

b. The audiovisual system shall provide high quality display of video content via integrated AV devices.

2. Audio
   a. Sound System
      1) Provide custom width powered loudspeaker mounted below flat panel display for stereo audio playback.
      2) Provide all required mounting hardware to support loudspeakers.

   b. Audio Routing and Processing
      1) Powered loudspeaker input to be taken from unbalanced audio output of video monitor display (D1)

   c. Audio Sources
      1) Audio following video from HDMI wall plate input (W2).

3. Video
   a. Video Displays and Outputs
      1) Provide one (1) HD 49” LCD flat panel display and swing arm wall mount
      2) Provide one (1) HDBT wall plate receiver within (D1) connected to HDMI wall plate transmitter (W2) in the office.
   b. Video sources shall include:
      1) HDMI over HDBT wall plate (W2)

4. Control
   a. Provide wall mounted Media Presentation Controller with touch button control panel (CP2) with integrated control system within.
   b. Provide video wall plate receiver with room controller function to allow Office touch panel to control the following functions:

      a) Display on/off

      b) Audio volume control

      c) Audio mute/unmute

5. Infrastructure and Accessories
   a. Provide all required infrastructure and accessory components, including but not limited to the following:
      1) Custom plates/panels
      2) Equipment mounting brackets
      3) Power controllers and sequencers

b. AV systems shall be served by conduit to device locations.
c. Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

G. READING ROOM

1. Summary

a. The Reading Room is to be used for single input video presentation

b. The audiovisual system shall provide high quality display of video content via integrated AV devices.

2. Audio
   a. Sound System
      1) Provide custom width powered loudspeaker mounted below flat panel display for stereo audio playback.
      2) Provide all required mounting hardware to support loudspeakers.

   b. Audio Routing and Processing
      1) Powered loudspeaker input to be taken from unbalanced audio output of video monitor display (D1)

   c. Audio Sources
      1) Audio following video from HDMI wall plate input (W2).

3. Video
   a. Video Displays and Outputs
      1) Provide one (1) HD 49” LCD flat panel display and swing arm wall mount
      2) Provide one (1) HDBT wall plate receiver within (D1) connected to HDMI wall plate transmitter (W2) in the Reading Room.
   b. Video sources shall include:
      1) HDMI over HDBT wall plate (W2)

4. Control
   a. Provide wall mounted Media Presentation Controller with touch button control panel (CP2) with integrated control system within.
   b. Provide video wall plate receiver with room controller function to allow Reading Room touch panel to control the following functions:

      a) Display on/off

      b) Audio volume control

      c) Audio mute/unmute

5. Infrastructure and Accessories
   a. Provide all required infrastructure and accessory components, including but not limited to the following:
      1) Custom plates/panels
      2) Equipment mounting brackets

3) Power controllers and sequencers

b. AV systems shall be served by conduit to device locations.

c. Coordinate wall and floor boxes with architect, electrical contractor, and structured cabling systems contractor.

## 2.2 PERFORMANCE STANDARDS

A. Meet the following performance standards with each system, unless restricted by the published specifications of a particular piece of equipment:

B. Audio Signal:
1. Signal-to-Noise Ratio (including crosstalk): 55 dB minimum.
2. Total Harmonic Distortion: 0.1% maximum from 20 Hz to 20,000 Hz.
3. Frequency Response: +/- 1.0 dB, 20 Hz to 20,000 Hz.

C. Audio Reproduction:
1. Signal to Noise Ratio (including crosstalk): 55 dB minimum.
2. Total Harmonic Distortion: 1% maximum from 30 Hz to 15,000 Hz.
3. Hum and Noise: Hum and noise across all systems shall be inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.

D. Video Signal:
1. Signal-to-Noise Ratio (peak to RMS) Unweighted DC to 4.2 MHZ: 55 dB minimum
2. Crosstalk: Crosstalk (unweighted DC to 4.2 MHz): 45 dB minimum
3. Frequency Response: Within plus-or-minus 0.5 dB to 4.2 MHz
4. Line and Field Tilt: 2% minimum
5. Differential Gain: 3% maximum
6. Differential Phase: $2^{o}$ maximum

E. Video Timing:
1. System Timing: Sync coincidence within 50 nanoseconds
2. Color Timing: Within $2^{o}$ at 3.58 MHz

## 2.3 DELIVERY, STORAGE AND HANDLING

A. Bear costs of shipping to the site, and of unusual storage requirements. Make appropriate arrangements, and coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

## 2.4 ADDITIONAL ENGINEERING SERVICES

A. In the event that the Owner's Representative is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor, or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Owner's Representative is required to examine and evaluate changes proposed by the Contractor for the convenience of the Contractor, then the Owner's Representative's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

B. In the event that the Owner's Representative is required to provide additional engineering services as a result of Contractor's errors, omissions or failure to conform to the requirements of the Contract Documents, or if the Owner's Representative is required to examine and evaluate changes proposed by the Contractor solely for the convenience of the Contractor, then the

Owner's Representative's expense in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

C. In the event that the Owner's Representative is scheduled to visit the project site to validate proper system performance before the Contractor has tested and setup all systems in accordance with this document, then the Owner's Representative's expense in connection with such additional services shall be paid by the Contractor and may be deducted from monies owed to the Contractor.

### 2.5 WARRANTY

A. Comply with Section 017800 – Closeout Submittals.

B. Include costs anticipated to comply with the requirements of this section in the bid.

C. For a period of one year from completion of the project, affect replacement or substitutions of equipment within 24 hours of first notification. Complete repairs to equipment within 72 hours. If repairs cannot be completed during this time period, or if ordering of parts is required, forward to the Owner every 72 hours documentation of progress of repairs. This repair capability is mandatory.

D. Contractor shall be responsible for and make good, without expense to the Owner defects arising during this warranty period that are due to imperfect materials, equipment, improper installation or poor workmanship.

E. Activate manufacturer's equipment warranties in Owner's name to commence on the date of acceptance. In the case of Contractor- modified equipment, the manufacturer's warranty is normally voided. In such cases, provide the Owner with a warranty equivalent to that of the original manufacturer.

F. Provide and include in the warranty quarterly site visits to check and adjust equipment and restore systems to original performance standards.

G. Provide a service visit one month prior to the warranty expiration to confirm the correct working condition of the system and to make necessary adjustments to bring the system back to optimal working condition.

## PART 3 - PRODUCTS

### 3.1 GENERAL

A. Potential discrepancies among the contract documents shall be highlighted and described to the Owner's Representative during the bid phase, or the most stringent case shall be applied.

B. This section presents the major components of the systems to be installed. Provide additional equipment and accessories as required to produce a complete and functional system consistent with the design intent.

C. At the time of installation supply the latest model of the product which is available for each piece of equipment.

D. Materials: Supply materials and equipment that shall be new and shall meet or exceed the latest published specifications of the manufacturer.

### 3.2 CABLES

A. Cables must be manufactured and installed in compliance with local and state codes.

B. Cable Passing through two or more floors: Rated, listed and marked for use in riser application.
   1. Riser Cable: CMR or OFNR rated per NEC and comply with other applicable codes.

C. Cable in Plenums: Rated, listed and marked for use in plenum application.
   1. Plenum Cable: CMP rated per NEC and comply with other applicable codes.

D. Contractor shall verify all spaces as plenum or non-plenum with the architect/mechanical engineer prior to purchasing or installing any cable. Contractor shall be aware of any owner or AHJ requirements for plenum cable or other cable types.

E. Comply with communications specification section for copper horizontal cabling, coaxial horizontal cabling, and fiber cabling

F. Unless otherwise called for in these specifications and drawing the following cables, or their approved equals, shall be used in these systems:

| **Signal** | **Cable Description** | **Part Number** |
|---|---|---|
| Audio Microphone and Line Level Audio | Single pair, twisted, shielded, 22 AWG stranded | Belden 9451 |
| Multi Microphone and Line Level Audio | Double pair, twisted, shielded, 24 AWG stranded | Belden 1411R |
| Intercom | Single pair, twisted, shielded, 22 AWG stranded | Belden 9451 |
| Low-Impedance Loudspeaker | Single pair, twisted, unshielded, 12 AWG stranded | Belden 8477 |
| 70 Volt (High-Impedance) Loudspeaker | Single pair, twisted, unshielded, 18 AWG stranded | Belden 8461 |
| Subwoofer | Single pair, twisted, unshielded, 10 AWG stranded | Belden 8477 |
| DC Power Cables | Single pair, twisted, unshielded, 16 AWG | |
| Control Cables | Single pair, twisted, unshielded, 18 AWG stranded | Belden 9156 |
| Wireless microphone antennae | RG-58U. 20 AWG, coaxial, 50 Ohm | Belden 9310 |
| UTP Tie Line | Cat 6a UTP | See specification section 27 |
| Single Mode Fiber | 125 µm, 1310/1550 nm, broadcast rating, single-mode fiber | See specification section 27 |
| Video Cables (50 feet or less) | RG-59U, 22 AWG, coaxial, 75 Ohm, solid, foil and braid shield | Belden |
| Video Cables (0 to 150 feet) | RG-6U, 18 AWG, coaxial, 75 Ohm, solid, foil and braid shield | Belden |
| Video Cables (0 to 300 feet) | RG-11U, 14 AWG, coaxial, 75 Ohm, solid, foil and braid shield | Belden |

## 3.3 CONNECTORS

A. Acceptable manufacturers: Switchcraft, Neutrik, Canare.

B. Cabling - Unless otherwise detailed herein, use the following types of cabling connectors:

1. Audio connectors of XLR, 1/4 inch, and RCA types shall be solder type and incorporate metal shells and bodies.
2. Video connectors of BNC and RCA shall be:
   a. Dual crimp or compression style nickel plated brass connector utilizing a gold plated center contact.
   b. Connector and pin appropriately selected based on the specified cable as part of a manufacturer's approved assembly.
   c. Crimp or compression tool and die sets utilized shall be approved by the manufacturer for the assembly.
3. Data – Cat 6a & Fiber
   a. Comply with Division 27
   b. Provide ruggedized, locking connectors.
   c. Neutrik Ethercon and Opticalcon

C. Receptacle Plate Connectors – Unless otherwise detailed herein, use the following types of panel receptacles on connection boxes, panels, plates, and wireways:
1. Audio (microphone): XLR (female) type with locking tab, such as Neutrik DL-Series or equivalent
2. Audio (line-level): XLR (male) with locking tab, such as Neutrik DL-Series
3. Audio (line-level): XLR combo (female) type, such as Neutrik A-Series or equivalent. Insulate from panel.
4. Audio (loudspeaker level): Neutrik NL-2 or NL-4 Speak-on type or equivalent. Insulate from panel.
5. Video: BNC type, such as Canare DCJ-RU or equivalent. Insulate from panel.
6. Camera: BNC type, such as Canare DCJ-RU or equivalent. Insulate from panel.
7. Fiber: LC, such as Neutrik opticalCON N02-4FDW-1 or equivalent.
8. UTP and AV Network: RJ45 with locking tab, such as Neutrik etherCON CAT 6 NE8FDY-C6-B or equivalent.
9. RF: F type. Insulate from panel

D. Use only rosin core solder or approved mechanical connectors for joints and connections within the system. Twist-on wire-nuts are not acceptable.

E. UTP & Fiber Optic Connectors: Refer to Specification Division 27

## 3.4 EQUIPMENT RACKS

A. Locate equipment to allow proper airflow and ventilation. At the rack, provide ventilation to ensure rack temperatures do not exceed 100 degree Fahrenheit after 5 hours of continuous operation.

B. Provide low-noise ventilation when racks are open to work areas.

C. Cable lacing bars shall be used for horizontal cable management.

D. Use only rack screws with nylon anti-scuff washers.

E. Key lock doors identically.

F. Fill empty rack spaces with flanged, 0.125 inch thick aluminum, standard rack size, brushed black anodized finish blank panels, unless otherwise noted.

G. Provide and install security covers to restrict access to equipment with front panel controls that do not require adjustment by the end user.

H. Project Information Label: Permanently mount, at the top facing edge of each equipment rack, an engraved plastic laminate plate, with filled lettering on contrasting background. Plate shall identify "Design by Arup. Installation by: Contractor, City, ST."

I. Panels mounted on the rear rack rails shall not block access to front mounted components or conflict with vertical cable management.

J. Provide power receptacle strips, with "U" ground outlets. Power receptacle strips shall be mounted on the rear interior of the rack space on the left side as viewed from the rear. Insulate power receptacle strips from the rack.

K. Provide UL-approved LED work light mounted on the upper left interior panel of each equipment rack.

L. Provide the appropriate factory or custom rack mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not.

M. Provide security covers for equalizers, crossovers, signal delays, and other adjustable signal processors.

N. Provide rack shelves for ancillary equipment.

## 3.5 INTERFACES

A. Audio: Provide line level interfaces for sources not having nominal plus 4dBu, balanced inputs and outputs.

B. Auxiliary Interfaces:
1. Provide one cable with molded connectors for each auxiliary audio, video, and control interface location provided as specified herein, unless noted otherwise on the Drawings.
2. Cables shall be flexible.
3. Where multiple formats are typically utilized together cables shall include all formats within a single jacket, included but not limited to, VGA with mini-TRS, Composite Video with Stereo Audio, and Component Video with Stereo Audio.
4. Provide the following length cables, unless noted otherwise on the Drawings:
    a. Rack Mounted Interface: 12 feet.
    b. Wall Mounted Interface: 12 feet.
    c. Floor Mounted Interface: 12 feet.
    d. Table Mounted Interface: 6 feet.
5. Provide manufacturer's adapter plates for pass-through connections as indicated on the Drawings.
6. Extra Materials:
    a. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    b. Provide one of each type for every ten required, but not less than one.

## 3.6 OPEN-TOP CABLE SUPPORT (J-SUPPORT)

A. Comply with Section 270528.29 – Hanger and Supports for Communications Systems

## 3.7 MISCELLANEOUS EQUIPMENT

A. Provide screws, anchors, clamps, tie wraps, wire molding, miscellaneous grounding and support hardware necessary to facilitate installation of the system.

B. Provide specialized tools not readily available on commercial tool market for assembly, adjustment, or maintenance of systems components.

C. Furnish special installation equipment or tools necessary to properly complete system. This may include, but is not limited to, tools for terminating cables, test equipment for audiovisual devices, jack stands for cable reels, and cable winches.

D. Furnish scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.

E. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall be able to withstand handling conditions that might be encountered, such as rapid lowering and braking of load, without bending or distortion of shape.

F. Electrical Power Connections: Electrical power junction boxes and circuits will be provided by others. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.

G. Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended of audio transformers specified in the system.

H. Networks and Pads: Provide networks and pads as shown on the drawings or as required to achieve proper impedance matching and levels. Networks and pads shall be balanced. 0.5 watt, 5% composition resistors shall be soldered to fixed connection points at each end.

I. Loudspeaker Enclosures: Loosely fill with glass fiber to 2 lbs/cu. ft. density prior to installing loudspeakers.

J. Seismic Safety: Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Physically bolt audiovisual equipment rack base or bottom rails to the floor to prevent toppling. Brace hanging equipment such as loudspeakers, et cetera both to minimize sway and to prevent detachment from the overhead structure.

K. Owner-Furnished Equipment (OFE): Accept equipment upon removal, perform a general cleaning, test for proper operation, and install in accordance with project guidelines.

L. Coordinate return or recycling of removed and/or replaced equipment with Owner. Existing equipment not reused shall be returned to the Owner. The Contractor is required to properly recycle or dispose of equipment at no additional charge at Owner's request.

## PART 4 - EXECUTION

### 4.1 GENERAL

A. Installation shall include:
   1. Delivery, unloading and setting in place of equipment.
   2. Fastening equipment to walls, floors, ceilings, or other structure as required.
   3. Interconnecting wiring of the system components.
   4. Equipment alignment and adjustment.
   5. Other work required to result in complete and operational systems.

B. If in the opinion of the Contractor, an installation practice is desired or required, which is contrary to these specifications or drawings, a request for modification shall be made in writing

to the Owner's Representative. Modifications shall not commence without written approval from the Owner's Representative.

C. Prevent and guard against electromagnetic and electrostatic interference, and install the equipment to provide safety for the operator.

D. Coordinate ordering and installation of equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the schedule.

E. Provide access to equipment and components requiring operation, service or maintenance within the life of the system.

F. Verify correctness of parts list and equipment model numbers and conformance of each component with manufacturer's specifications.

G. No equipment shall be hidden or covered up prior to inspection by the Owner's Representative. Work that is determined to be unsatisfactory shall be corrected immediately.

H. The contractor shall be responsible for damage to surface or work disrupted as a result of contractor's work. Repair of surfaces, including painting, and patching, shall be included as necessary.

I. Edges of holes which cables pass through shall be covered with rubber or nylon grommets.

J. Equipment and enclosures shall be mounted plumb and square.

## 4.2 WORKMANSHIP

A. Materials and standards shall meet or exceed industry standards and be fully guaranteed for one full year from final acceptance.

B. Cable integrity and associated terminations shall be thoroughly inspected, fully tested and guaranteed as free from defects, transpositions, opens-shorts, tight kinks, and damaged jacket insulation.

C. Work shall be executed in strict accordance with the best practices of the trade.

D. Installation shall be done in conformance with the manufacturers' design and installation guidelines. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation.

## 4.3 EXAMINATION

A. General: Examine conditions and proceed with work in accordance with Section 014000 – Quality Requirements.

B. Examination of Premises: Visit Site to become familiar with existing systems and local conditions under which work is to be performed and correlate observations with requirements of Contract Documents. No allowance shall be made for claims for concealed conditions which Contractor, in exercise of reasonable diligence in observations of site and local conditions, should have learned of.

C. Verify that electrical requirements including junction boxes, floor boxes, ceiling loudspeaker enclosures, empty conduit and power circuits and receptacles are in place as shown on the drawings and required for systems installation. Coordinate with General Contractor and Electrical Contractor.

D. Inspect and review related electrical work to verify correct voltage, polarity, and grounding prior to interfacing power with audiovisual equipment.

E. Before ordering materials or doing work, verify measurements and be responsible for correctness of same.
   1. No extra charge or compensation allowed for duplicate work or material required because of unverified difference between actual dimension and measurement indicated on Drawings.
   2. Submit discrepancies found in writing to Owner's Representative for consideration before proceeding with Work.

F. Prior to start of installation, meet at project site with Owner's Representative and other trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with work.

G. The Drawings are diagrammatic in nature and, unless explicitly dimensioned, indicate approximate locations of equipment and components. Changes in the location, and offsets of equipment and components which are not shown on the Drawings but are necessary in order to accommodate building conditions and coordination with the work of other trades, shall be made prior to installation, without additional cost.

## 4.4 ROUGH-IN

A. Before construction work commences, visit site and identify exact routing for pathways. Coordinate requirements with other trades.

B. Equipment Locations: Coordinate with other trades, other renovation projects, and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections.
   1. Provide code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation. If it is determined that ample maintenance and passage space has not been provided, rearrange work and/or provide other equipment as required for maintenance space.
   2. Coordinate work with other trades and existing conditions to determine exact routing of cable tray, hangers, conduit, etc., before fabrication and installation. Where more than one trade is involved in area, space, or chase, coordinate to utilize space appropriately in relation to their individual requirements.
   3. Coordinate work in open ceilings. Where cable tray, hangers, conduits, cables are exposed route infrastructure perpendicular to finishes and other building systems. Route infrastructure to reduce locations where trade work transition from/to exposed areas.
   4. Bring changes in size or location of material or equipment necessary in order to avoid conflicts between trades to immediate attention of Owner's Representative before such alterations are made.
   5. Verify with Owner's Representative exact location and mounting height of equipment in finished areas, such as equipment racks, communication, and electrical devices.

## 4.5 MOUNTING REQUIREMENTS

A. Work shall be installed level and plumb, parallel and perpendicular to other building systems and components.

B. Permanently attach equipment to the building structure with a minimum safety factor of 5 Suspended components that move or are otherwise subjected to continuous wear or friction shall be supported with a minimum safety factor of 8. When a higher safety factor is

recommended by an equipment manufacturer or required by the AHJ, the more stringent requirement shall be met.

C. Do not attach equipment in a manner that weakens or overloads the building structure.

D. Audiovisual Contractor is responsible for structural engineering of mounts and attachments.

E. Obtain the stamped approval of a licensed Structural Professional Engineer for equipment that is attached in a manner or location that could impact the integrity of the building structure or cause personal injury. This list shall include but not be limited to all loudspeaker attachments.

F. Provide structural loads and attachment methods to Project Structural Engineer for review.

G. Install equipment with the ability for minor adjustment as required for optimization.

H. Loudspeaker enclosures shall be supported from the building structure, or from the ceiling suspension system in acoustical tile ceilings with a safety wire fastened to the building structure.

I. Seismic bracing shall be installed on appropriate equipment where local codes require such installation.

## 4.6 LABELLING

A. Equipment: Provide permanently mounted 1/32" thick by 1/4" high black lamicoid or anodized, brushed aluminum labels with 1/8" engraved lettering for each piece of equipment and every user-adjustable control and input on the audiovisual equipment.

B. System Functional Diagrams: Provide reduced-size as-built functional diagram for the control, audio, video, intercom, and tie line system. Frame with acrylic cover, or laminate drawing, and mount adjacent to equipment rack.

C. Receptacle Plate Designation: Engrave wall-mounted receptacle plates with alphanumeric identification of input type (i.e., mic, line, speaker, video etc.) and corresponding audio or video patch field designation.

D. Patch Panel Assignments: Wire patch panels so that signal "sources" (outputs from) appear on the upper row of a row pair; and "loads" (inputs to) appear on the lower row of a row pair.

E. Patch Panel Designation Strips: Utilize alphanumeric identifications and descriptive information on audio and video patch panel designation strips. Number the jack positions in each horizontal row sequentially from left to right. Letter the horizontal jack rows sequentially from top to bottom. Include the alphanumeric identification of each jack on the functional block drawings, as well as on reproductions of these drawings which shall be mounted in an appropriate location near the patch bays. Alphanumeric identification shall consist of tie line panels, signal/use, and numbering.

F. All labelling across the project shall be logical, consistent, and agreed with Owner’s Representative.

## 4.7 PENETRATIONS

A. Conduit and Sleeve Openings: Shall be waterproofed and fireproofed in compliance with applicable codes and regulations.

B. Firestopping: Fire-stop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 - Firestopping.
   1. Fire-stop System Inside of Conduits:

a. Use only dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with appropriate damming or backer materials.
b. Use sealant capable of being removed and reinstalled.
c. Sealant shall adhere to penetrants and common construction materials and be capable of allowing normal wire/cable movement without being displaced.

2. Add fire-stop pillows rated for sealing existing cable tray penetrations through firewall.
3. Patch openings remaining around and inside conduit, sleeves, and cable penetrations to maintain integrity of fire rated assembly, and to maintain acoustical separation performance.

## 4.8 ELECTRICAL POWER, GROUNDING AND BONDING

A. Provide a ground bus bar bonded to each equipment rack. Terminate the bus bar to the audiovisual technical ground. Ground the chassis of each piece of equipment not utilizing a 3-prong power cord to the bus bar.

B. For active equipment, float the ground wire at the output side of balanced audio lines other than microphone lines or intercom and where required by manufacturer.

C. Carry audio shields straight through passive devices such as patch panels and terminal strips.

D. Arrange inner-rack power distribution so that no circuit exceeds 80% of full power.

E. When the electrical service to a rack is hardwired, the Contractor shall terminate inner-rack power wiring to a j-box at the top or bottom of the rack for field connection of the electrical service.

F. Ground control lines in compliance with the manufacturer's specification for the appropriate equipment.

G. No power cord from equipment shall have its third prong (ground) removed or defeated.

H. Label each outlet within each rack to reflect which circuit is feeding it.

I. Establish only one ground connection path between equipment in the system.

J. Do not place audiovisual distribution cabling alongside power lines or share the same conduit, channel or sleeve with electrical apparatus.

K. Provide cable service loops at devices for inspection, minor adjustment, and future flexibility.

L. Grounding Procedures: In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, adhere to the following grounding procedures:
1. General: Because of the great number of possible variations in grounding systems, follow good engineering practice, as outlined above, and deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.
2. System Grounds: Establish a single primary "system ground" for the systems in each particular area. Connect grounding conductors in that area to this primary system ground. Provide the system ground in the audio equipment rack for the area. The ground shall consist of a copper bar of sufficient size to accommodate secondary ground conductors.
3. Rack Ground:
   a. Connect the No.6 insulated copper wire connected to the earth ground to the primary system ground busbar in the Equipment Rack.
   b. Bond a No.12 TW stranded wire from the Equipment Rack frame to the primary system ground bus bar.

4. Equipment Grounds: Grounding methods used will be dependent upon individual equipment interconnection of chassis ground, circuit common, and power supply common within the units. Provide ground method for equipment types as follows:
   a. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis (Signal common is not internally connected to chassis): Make no connection from chassis ground to primary systems ground busbar in Equipment Rack.
   b. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis: Make no connection from chassis ground to primary system busbar, but do make connection with 14AWG insulated wire from circuit common to primary system ground busbar in Equipment Rack. Separate circuit common from chassis ground.
   c. Equipment having a 2-wire power cord, no green wire, neutral is not tied to chassis, and circuit common is tied to chassis: Make connection from chassis to primary system ground busbar using 14AWG insulated wire.
5. Audio Cable Shields: Ground audio cable shields at one point only. There are no exceptions. For inter- and intra-rack wiring connect the shield at one end only, this shall be at the input to a device. The shield shall be lifted at the device output. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
6. Video Receptacles: Insulate video receptacles from the panel, outlet box, or wireway. Unless otherwise detailed herein, use insulated-from-panel type receptacles.

## 4.9 NETWORK REQUIREMENTS

**A. The AV contractor is solely responsible for providing, installing, and configuring network switches to owner requirements.**

**B. Lead discussions on network requirements to coordinate with owner network and security requirements and to support the requirements of the specified AV system. Provide network documentation.**

C. Coordinate WiFi requirements for wireless control of AV systems.

D. Set up equipment and network interfaces specified to conform to owner's network requirements. Coordinate these requirements and IP addresses with owner.

## 4.10 WIRELESS FREQUENCY COORDINATION

A. Provide wireless frequency survey to identify unused wireless frequencies.

B. Coordinate wireless microphone and ALS frequencies with site conditions and owner's wireless frequency channel lineup.

## 4.11 CABLE INSTALLATION

A. Comply with Division 27 and requirements specified herein.

B. Mark cables, regardless of length, with permanent, non-handwritten number or letter cable markers within six inches of both ends. There shall be no unmarked cables in the system. Marking codes used on cables shall correspond to codes shown on drawings and run sheets.

C. Furnish screw-type terminal blocks, boards, strips, or connectors, for cables which interface with racks, cabinets, consoles, or equipment modules. Terminate wires terminating at

screw-type terminals with crimp-on lugs. "Telephone-style" punch-down blocks are not acceptable for signal or data wiring.

D. Group cables according to the signals being carried. In order to reduce signal contamination, form separate groups for the following cables:
   1. Power cables
   2. Control cables
   3. Video cables
   4. Camera cables
   5. Audio cables carrying signals less than minus 20 dBm.
   6. Audio cables carrying signals between minus 20 dBm and plus 30 dBm.
   7. Audio cables carrying signals above plus 30 dBm.
   8. Broadband RF cables.
   9. CAT-6 Data Cables
   10. Fiber cables

E. All cables shall be routed in an orderly manner. Where cables are of the same type, these shall be tie-wrapped for neatness.

F. Cut cables (except video and camera cables that must be cut to an electrical length) to the length dictated by the run. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of appropriate length.

G. Install cable with a bend radius not less than that recommended by the cable manufacturer.

H. Clearly identify cable terminated at panels with permanent, indelible labels within 6" of the cable connector. Provide strain relief for cables. Provide connectors with metal shell/casing. Provide a minimum of 3’ of free cable coiled in the junction box. Use spiral wrap to group similar cable types.

## 4.12 EQUIPMENT RACKS

A. Perform rack fabrication before delivering the racks to the job site. Only wiring and terminations dependent on external devices shall be done at the job site.

B. Test equipment power and functionality prior to delivering the racks to the job site.

C. Equip the rack with sufficient AC power distribution to support equipment as well as two spare, non-switched, convenience outlets. One convenience outlet is to be readily accessible from the front and one readily accessible from the rear of the rack.

D. Provide service loops within the equipment rack for cables connected to external devices.

E. Locate equipment in racks to comply with ADA guidelines.

F. Install equipment racks level and plumb with the room and with adjacent racks.

G. Organize inner-rack cables in an orthogonal manner and organized into neat harnesses by cable type. The rear of equipment shall be fully visible without an array of cables in the way.

H. As a general practice, run power cables, control cables, and high level cables on the left side of an equipment rack as viewed from the rear. Run other cables on the right side of an equipment rack, as viewed from the rear.

I. Horizontal cable management in rack shall be tied in bundles with cable lengths cut to minimize excessive cable slack, but allowing for service and testing.

J. Provide horizontal support bars.

K. Adhesive backed cable tie anchors shall not be used.

L. Velcro style cable wraps shall be used in vertical wire management. Plastic cable ties shall not be acceptable.

M. Arrange unlike signal types in separate harnesses maintaining adequate separation distances to avoid interference.

N. Package spare parts for each device in a clear plastic pouch and attach it to the rear of that device.

O. Allow the Owner's Representative to inspect the racks for approval prior to delivery to the job site.

P. Receptacle Plate Designation: Engrave wall-mounted receptacle plates with alphanumeric identification of input type (i.e., mic, line, speaker, video etc.) and corresponding audio or video patch field designation.

Q. Patch Panel Assignments: Wire patch panels so that signal "sources" (outputs from) appear on the upper row of a row pair; and "loads" (inputs to) appear on the lower row of a row pair.

R. Patch Panel Designation Strips: Utilize alphanumeric identifications and descriptive information on audio and video patch panel designation strips. Number the jack positions in each horizontal row sequentially from left to right. Letter the horizontal jack rows sequentially from top to bottom. Include the alphanumeric identification of each jack on the functional block drawings, as well as on reproductions of these drawings which shall be mounted in an appropriate location near the patch bays.

## 4.13 SYSTEM SETUP AND PERFORMANCE VERIFICATION

A. Preparation:
1. Interior finishes and furnishings shall be in place for these tests.
2. HVAC system is to be balanced and in operation.
3. Confirm complete and proper labeling of system components.
4. Attach reduced-size Block Drawings to a rack in each location.
5. Remove boxes and debris from the project site.
6. Deliver portable and spare equipment to the premises, tested and stored as directed.
7. Tests and adjustments shall be performed in the sequence specified herein.

B. General Setup:
1. Verify that audiovisual related components are free from rough or jagged edges.
2. Verify that rack ventilation is working properly.
3. Test uninterruptible power supply units to verify proper operation.
4. Verify that systems are free from oscillation and stray RF interference.
5. Connect and test television feeds.
6. Test and verify continuity and proper termination of every cable in the system. Provide test sheets with results of tests below for verification.
7. Following final acceptance of system set-up and performance, equipment with front panel controls, not normally adjusted by the operator shall have the controls disabled or be mounted behind blank panels or be furnished with security panels.

C. Audio System Setup and Testing:
1. Impedance
    a. Measure and document the impedance of each loudspeaker circuit at 63 Hz, 250 Hz, 1 kHz and 4 kHz.
    b. Measure at the circuit's entry point to the equipment rack.

c. Measurement shall be taken prior to the loudspeaker circuit being connected to the amplifier.
d. Reject and correct measurements that differ significantly from calculated values or fall outside of amplifier specifications.
e. Measure and document the magnitude of impedance at 1 kHz.

2. Polarity
   a. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color-coding.
   b. Test polarity of the loudspeakers using a sine-wave test signal warbled about 500 Hz. The listener shall be located on axis of the loudspeaker. Switch the loudspeakers from nominally in polarity to nominally out of polarity with respect to the selected loudspeaker. With the loudspeakers in proper polarity, the quality and clarity of the music or speech should be greater, and the warble test signal should clearly come to the surrounding space from the loudspeaker.
3. Ambient Noise
   a. Measure and document the ambient noise level in each loudspeaker zone in the system.
   b. Ensure that the minimal loudspeaker level is at least 25 dB above the ambient noise level at the furthest listener. At the direction of the Owner's Representative, make additional level adjustments that the space requires.
4. Hum and Noise Level:
   a. Measure the hum and noise levels of the overall system for each microphone input channel and line-level input channel.
   b. Adjust gain controls for optimum signal-to-noise ratio so that full amplifier output will be achieved with 0 dBm at a line-level input.
   c. Terminate line-level inputs with shielded resistors of 150 and 600 ohms, respectively, for these measurements.
   d. Disconnect the loudspeaker lines and terminate the power-amplifier outputs with power resistors for these measurements. The value of the load resistor shall be within 5% of the nominal load impedance of the amplifier under test. The power rating of the resistor shall equal the power rating of the amplifier.
5. Wireless Microphones and Accessories:
   a. Arrange wireless microphone antennas to provide drop-out free performance over the entire area being served.
   b. Set wireless microphone channels for minimum interference from external RF sources and maintain proper channel separation to eliminate adjacent channel interference.
6. Unity Gain:
   a. Bring the system to a unity gain level of plus 4 dBu.
   b. Verify proper gain structure throughout system.
7. Delay:
   a. Using an impulse response measure the arrival time for each loudspeaker zone.
   b. Set-up delay as required providing localization based on the Haas effect. Realizing localization based on level differences will not be accepted.
8. Uniform Coverage: Using pink noise at the nominal operating level as the source and measuring in dBA with a sound pressure level meter at the typical listening height, verify that variance complies with performance requirements.
9. Frequency Response:
   a. Using a dual channel FFT with boundary-plane measurement, adjust equalizers to achieve a system frequency response described in PART 1.

b. Take an average of measurements performed at a variety of locations in the space.
c. Perform this measurement and setup only after seats and floor, wall, and ceiling treatments have been installed.
d. Smooth out and adjust the room curve to achieve a desirable response for the most typical source material.
e. Avoid equalizer settings that result in a 6 dB or greater change from either adjacent band.
f. Re-take the uniform coverage test and make adjustments as required.
g. Document both the un-equalized and equalized average frequency response curves of the room and include the graphs in the Project Record documentation.
h. Properly adjust processing equipment, such as compressors, limiters and feedback eliminators for typical operation.

10. Spurious Noises:
    a. Verify that the system is free from pops, crackle, hum, and other distortion when active controls are operated, in the absence of audio input signal and when the system is driven to full output at 100 Hz.
    b. Using an electronic audio oscillator, slowly sweep through the usable frequency band of the sound system at a level of 6 dB below rated power-amplifier output voltage to each system in order to verify that the system and other building elements are free from buzzes or rattles.
    c. Correct causes of these defects unless the cause is clearly from other than the sound amplification system's equipment and installation, in which case bring the cause to the attention of the General Contractor.
11. THD+N:
    a. Measure and document the THD+N at 15 dB above nominal operating level for entire audio system signal chain. Test from output of all line level input device and end with amplifier input cable.
    b. Reject and correct measurements that exceed 0.5 % between 40 Hz and 20 kHz.
12. Assistive Listening Systems:
    a. Set gain so that normal speech or music does not over modulate the transmitter.
    b. Adjust emitter panels or antennas to provide even coverage throughout the space.
13. Power-Output and Signal-Level Adjustment within System:
    a. Measure the electrical distortion of the overall system for each line-level input channel.
    b. Adjust gain control as for the tests specified herein.
    c. Apply a 1-kHz sine-wave signal from an oscillator having less than 0.5% total harmonic distortion at the input tested, at a level required to produce full amplifier output. Note that a pad with 150-ohm output impedance is required for driving the microphone-level input in accordance with the EIA standard.
    d. Use a distortion analyzer to measure the output level and the total harmonic distortion of the amplification and control equipment. In the absence of a distortion analyzer, a high input impedance-measuring device such as a DMM may be used to measure the output level. Lack of clipping or apparent deformation of a sine-wave input signal at the power-amplifier output, as seen on the oscilloscope, may serve as evidence that distortion of amplification and control equipment is within acceptable limits.
    e. Make measurements with loads actually incurred in the system operation. Power-amplifier loads shall be power resistors equal to the nominal load impedance of the output terminals used in the system.

14. Audio Test Signal Paths: Verify operation from source inputs (for microphones, audio tape units, video tape units, etc.) through ADAs, mixers, switchers, etc., to signal destinations.

D. Video System Setup and Testing:
   1. Video Displays:
      a. Allow video display to warm up for a minimum of thirty minutes with moving images prior to testing and adjustments.
      b. Video display adjustments shall be performed using the native resolution at each utilized input of the display.
      c. Image sizing:
         1) Using a crosshair or crosshatch pattern, adjust the display devices to show a full image at the system resolution.
      d. Clock Setting:
         1) Using an alternating pixel test pattern, adjust the clock setting until the pixels appear to stand still.
         2) Document the value of the onscreen display.
      e. Black Level:
         1) Properly adjust using a picture line up generating equipment (PLUGE) test pattern.
         2) Adjust the brightness control slowly until the black than black bar is just fully extinguished, the remaining vertical bar should be dimly visible.
         3) Document the appropriate value of the onscreen display.
      f. Gain:
         1) Properly adjust using a PLUGE test pattern on the display to be adjusted.
         2) Adjust the contrast control until the 100% white bar is at the threshold of maximum brightness without blooming.
         3) Document the value of the onscreen display.
         4) Perform Black Level and System Gain tests until there is no additional interaction between contrast and brightness control adjustments and document the final onscreen values for contrast and brightness. Document the values of the onscreen display.
      g. Color Level:
         1) Properly adjust using a SMPTE color bars test pattern.
         2) While viewing the blue information only, adjust the color level until the first and last large bar blends with the small patch underneath.
         3) Document the onscreen value for color level.
      h. Color Phase:
         1) Use a signal generator to provide a SMPTE color bars test pattern on the display to be adjusted.
         2) While viewing the blue channel information only, adjust the tint control until the large internal bars blend with their patch below.
         3) Perform Color Level and Color Phase tests until there is no additional color or tint control interaction and document the final onscreen values for color and tint.
      i. Gray Scale:
         1) Set the proper black level (bias) and gain settings for each of the three color channels independently using the “window” test patterns.
   2. Cameras and camera equipment:
      a. Adjust and set reference black.
      b. Adjust and set white balance.

c. Adjust and set chroma level and phase.
d. Camera images shall be free of visible vibration.
e. Adjust and set pan/tilt limit switches.
f. Set camera presets in accordance with the design intent and Owner's requirements.

3. Timing: Properly calibrate video timing and genlock to ensure seamless switching and alignment.
4. Signal Processing Equipment:
   a. Configure and adjust signal processing equipment to produce a properly aligned and centered image at the native resolution of the relative display for each potential source resolution.
5. Computer Interfaces:
   a. Adjust gain.
   b. Adjust peaking using H pattern.
   c. Adjust horizontal and vertical position for the native resolution of the relative display.
6. System Calibration:
   a. Properly calibrate individual system components. Verify signal continuity and quality throughout the signal path.
   b. Document adjusted values of individual components.
   c. Video images shall be free of anomalies, including, but not limited to, banding, bending, ghosting, reflections, video roll, visible jitter and double images.

E. Control Equipment Setup and Testing:
1. Test all hardwired and wireless network connections connected to the audiovisual system.
2. Verify proper operation of all equipment and devices connected to the audiovisual control system.
3. Verify correct function of all control system operations, including, but not limited to:
   a. Equipment powers on and off correctly and in the proper order.
   b. User is locked out of the system during system start-up and shutdown, timers are provided if this is an excessive period.
   c. When system is "shutdown" all appropriate audio and video has stopped playing.
   d. Gauges and feedback are registering correctly.
   e. Automated functions are sequencing properly.
   f. Interfaces are registering the same feedback.
   g. Devices are being controlled using the most robust control method available
4. Verify installed GUI complies with approved design.
5. Provide and verify system password protection and backdoor password.

## 4.14 ACCEPTANCE TESTING

A. Before Acceptance Tests are scheduled, perform a system checkout. Furnish all required test equipment and perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification. This work shall include the following:
1. Submission of the test and measurement data.
2. Test all audio, video and related systems for compliance with the System Setup and Performance Verification as specified herein.
3. Check all control functions, from all controlling devices to all controlled devices, for proper operation.
4. Adjust, balance, and align all equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for all level controls, and document these settings in the Operation and Maintenance Manual.

5. Unless otherwise specified, use tamper-proof security covers on all controls affecting overall system level balance and signal-to-noise ratio, such as power amplifier input level control, and input-output level controls for equalizers, mixers, amplifiers, etc. Some controls may require re-adjustment as the result of Acceptance Testing.
6. Maintain documentation of all performance tests for reference by the Owner's Representative during the System Acceptance Tests.
    a. Upon completion of the tests and necessary adjustments, submit a digital copy of a written report presenting test results, including numerical values of all measurements, for review by the Owner's Representative prior to demonstration and System Acceptance testing.
    b. With the above report, submit written certification that the installation conforms to specifications, is complete, and is ready for inspection and testing by the Owner's Representative.
7. Meet with the Owner and the Owner's Representative and make system changes as directed.

B. Upon completion of the Contractor's system checkout and performance verification, demonstrate the proper operation of all audiovisual systems in the project to the Owner's Representative.

C. Provide a qualified technician knowledgeable with the system and the installation to assist the Owner's Representative with the acceptance procedure.

D. Provide qualified technician with extensive knowledge of sound system tuning, setup, and optimization for review of sounds system setup, EQ, delay with Owner's Representative. Provide necessary test equipment.

E. The Contractor shall provide all labor, materials, tools, and measurement equipment necessary for these demonstrations, tests and adjustments.

F. System Acceptance Tests will not be performed until the Contractor's system checkout has been completed. The System Acceptance Tests will be supervised by the Owner's Representative and will consist of the following:
1. A physical inventory will be taken of all equipment on site.
2. The operation of all system equipment shall be demonstrated by the Contractor.
3. Both subjective and objective tests will be required to determine compliance with the specifications.
4. Acceptance Tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various operating conditions, using speech, music, and live or recorded effects material. Acceptance tests shall include viewing of monitor images for sharpness, contrast, brightness, and color.
5. Measurement of frequency response, distortion, noise, wave form, color vector, or other characteristics may be performed (or a demonstration test requested) by the Owner's Representative on any item, or group of items, deemed necessary to determine conformity with criteria.
6. All final Record Drawings, run sheets, manuals, and other required documents, as detailed herein, shall be on hand. Two complete sets of these documents shall be delivered to the Owner's Representative at this time. (One complete set shall have been delivered to the Owner's Representative prior to the scheduling of Acceptance Tests).
7. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner's Representative.

a. If the need for further adjustments becomes evident during the demonstration and testing, continue work until the installation operates properly. Included in the continued work shall include, but not be limited to, changes to or installation of resistive pads, readjustment of loudspeaker aiming, adjustment of system equalizers, programming changes to the control system, convergence of the video projector, if these adjustments are required.
b. If acceptance of the system is delayed because of defective equipment or because the equipment does not fulfill this specification, reimburse the Owner for time and expenses for these tests during extensions of the acceptance-testing period.

## 4.15 DEMONSTRATION AND INSTRUCTION

A. Upon completion of the system installation and acceptance procedure, provide 24 hours of system training and orientation for the Owner's personnel. An individual intimately familiar with the equipment in the system and qualified to explain it in detail should conduct the training. When an employee capable of providing such training is not available, retain the services of someone qualified to do so at no additional fee.

B. Conduct the training prior to the owner using the system for the first time to ensure proper usage. If necessary, conduct the training at a time outside of normal business hours at no additional fee.

C. Shall include, but not be limited to:
1. Physical review of installed systems.
2. Operations of equipment covering all potential use cases
3. Review of systems documentation and test results.
4. Instructions on standard care and maintenance methods to enable Owner's personnel to successfully maintain system.
5. Additional Owner requirements defined during project.

## 4.16 CLEANUP AND REPAIR

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

## 4.17 PROTECTION OF WORK

A. During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the Owner.

**SEE ATTACHMENT A – AUDIOVISUAL EQUIPMENT LIST**