

**SECTION 27 41 00 -AUDIOVISUAL SYSTEMS****PART 1 - GENERAL****1.1 SECTION INCLUDES**

- A. General: Comply with all Contract Documents, including, but not limited to, Divisions 0, 1, 26 and 27 of the general contract specifications.
- B. Statement of Work: Provide and install complete and operational Audiovisual System(s) as outlined in these specifications and related drawings at the Sterling Community Center located in Sterling, Virginia.
- C. It is the responsibility of the Contractor to provide all wiring, plates, connections, equipment, rigging, all support means and miscellaneous equipment for complete and operational System(s) if specified in this or other related documents or not.
- D. Provide for the coordination, provision, installation, inspection, testing, instruction, and warranties of the Audiovisual System(s).
- E. Provide all materials, equipment, transportation, and necessary labor for a complete and operational Audiovisual System(s).
- F. Additional section information:
  - 1. Required licenses, permits and low voltage permits including any required bonding or insurance requirements to comply with general conditions of specifications and contract documentation.
  - 2. Verification of the dimensions and conditions at the job site.
  - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturers' recommendations.
  - 4. Submittal information and provisions.
  - 5. Documented Audiovisual System(s) testing procedures.
  - 6. Instruction of operating personnel.
  - 7. Manuals and provisions thereof.
  - 8. Maintenance and warranties.
- G. Definitions:
  - 1. "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
  - 2. The term "shall" is mandatory, the term "will" is informative, and the term "should" is advisory.
  - 3. "Provide and install" – To supply, install, and connect up complete and ready for safe and regular operation.
  - 4. "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
  - 5. "Equivalent", "similar", or "equal" – Of base bid manufacturer, equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturers.
  - 6. "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner.
- H. "Professional grade" – Equipment that is intended for commercial, not residential, use and is rated for continuous duty.

1. “User-friendly controls” – Controls that are designed and laid out for ease of use in a logical, easily recognizable, format that utilizes industry standard symbols wherever applicable.
  2. “Labels” – All labels on audio-visual equipment and racks shall be self-adhering black laminate with white engraved letters as outlined in Section 3.04.
- I. Below is a listing of specification standards, tests, or recommended installation methods and procedures or applicable installation or safety codes.
1. National Electrical Code (NEC)
  2. National Electrical Manufacturer’s Association (NEMA)
  3. Underwriters Laboratories (UL)
  4. Electronics Industries Association (E.I.A.)
  5. American National Standards Institute (ANSI)
  6. Audiovisual System Engineering, by Davis and Davis Second Edition.
  7. Handbook for Sound Engineering Third Edition by Glen Ballou
  8. Video Engineering by Arch Luther, Andrew Inglis
  9. Basic Television and Video Systems Sixth Edition, by Bernard Grob, Charles Herndon
  10. BICSI/INFOCOMM AV Design Reference Manual

## 1.2 SCOPE OF WORK

- A. The Contractor shall provide Audiovisual System(s) compatible with the Owner’s communications systems (i.e. telephone, video, and computer systems) and operations.
- B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.
- C. The Contractor shall provide complete and operational system(s) configured and installed for user-friendly operation and low maintenance. Provide for reprogramming of the remote control software two (2) times, as directed by the Owner or Consultant, before Final Acceptance. Provide for two (2) level adjustments of the Audio System(s), as directed by the Owner or Consultant, before Final Acceptance. On-site factory technical support shall be provided, if necessary, to assure performance.
- D. The Contractor shall restore all finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes.
- E. Installation work shall be in compliance with all applicable standards and all governing codes and regulations of the authorities having jurisdiction and the Contract Documents.
- F. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems.
- G. All software affiliated with the equipment, including but not limited to, the audio DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs for archival purposes at project acceptance.
- H. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and “keys” or other associated control or programming items at no additional cost to the Owner at commissioning.

### 1.3 SYSTEM(S) DESCRIPTION AND REQUIREMENTS

- A. The following is a basic room type description and is not intended to be all-inclusive for proper installation or operation of systems. The AV specification and the AV Bid Set drawings need to be fully reviewed together to ensure that the design intent and list of design intent equipment is completely understood.
  - 1. Gaming Room
    - a. This entertainment area shall have a large flat panel display connected to a single wall input plate. The audio output of the display shall route to two wall mounted large format speakers. A small wall mounted touch control panel will allow selection of source, display power cycling and volume control.

### 1.4 RELATED WORK

- A. Conduits:
  - 1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
  - 2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

### 1.5 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
- C. The Contractor shall, without cost to the Owner/Consultant, replace any products damaged during storage, handling or during installation.

### 1.6 SCHEDULING

- A. The Contractor shall submit a schedule to the Owner/Consultant for approval within 10 (ten) working days from notice to proceed. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off. This schedule shall be submitted in Microsoft Project (or similar program) in both paper and electronic format, with submittals.
- B. It is the responsibility of the Contractor to coordinate the installation of the system(s) to be compatible with the work of the other trades. The Contractor shall attend progress meetings and provide continuous on-site project management.
- C. It is the responsibility of the Contractor to arrange with the Owner/Consultant a mutually acceptable time and date(s) for Acceptance Testing, based upon project dates and schedule provided.
- D. The Contractor shall provide operating personnel with extensive training for each system type and/or room type as outlined in Section 1.03.

### 1.7 BID/TECHNICAL PROPOSALS

- A. The Contractor shall be experienced in the provision of systems similar in complexity to those required for this project and Contractor shall provide documentation demonstrating the below minimum criteria:

1. The primary business of the Contractor/Installer shall be the installation of audio or video systems.
  2. At least three (3) years experience with the specified equipment and systems.
  3. Be an authorized dealer and service facility for the products furnished.
  4. Maintain a technically trained installation crew and service crew for maintenance and installation of the specified system(s).
  5. Lead Installer shall have attended factory training in DSP and digital format for equipment specified in this specification.
    - a. Contractor shall demonstrate that the installation staff consists of 50% CTS-I trained personnel and have at least one (1) CTS-D on staff.
  6. Final Audiovisual System(s) shall be approved by the Consultant.
  7. Upon request of the Owner/Consultant, Contractor shall demonstrate that he has:
    - a. Sufficient facilities and equipment for this work.
    - b. Sufficient staff with the appropriate technical expertise and experience for this project.
  8. All Bid proposals shall be valid for ninety (90) days from date received.
  9. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment.
- B. Provide a list of five (5) references with locations, names of contacts, and contact phone and email information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old and be of similar size, type, and complexity as the system set forth.
- C. A detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This shall be generated from this document and related drawings.
- D. The Bid proposal will include all labor and cabling for all optional equipment listed in specification and AV Bid set drawings. Please list as separate budgetary items.

#### 1.8 SUBMITTALS

- A. Provide the following for approval no later than thirty (30) days after Notice to Proceed and prior to commencement of work:
1. A complete list of all products incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
  2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
  3. All shop drawings defined as required.
  4. Suspended loudspeaker rigging design/details with a Professional Engineer's certification as described in 3.05.
- B. Shop Drawings:
1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of system(s).
  2. Shall be scaled appropriately but not less than 1/8"=1'.
  3. Shall show detailed schematic wiring diagrams showing interconnection of Contractor-provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and

- use same designator throughout the project.
4. Shall show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling.
  5. Shall show all A.C. power outlet locations and terminal strip locations within each equipment rack including all sequencing as required for proper start-up and shut down.
  6. Shall show plans and sections of the building and adjacent grounds with the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
  7. Shall show patch panel layouts and labeling strips, including color schemes, as necessary.
  8. Shall show full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
  9. Shall show all speaker mounting details including hardware types and load capacity. Structural information with design calculations and a copy of the PE's certifications for each item/drawing.
  10. Shall provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate and sample plates per type.
  11. Shall show complete labeling schemes for all cabling and equipment components for project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
  12. Shall show a complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout coordination information.

#### 1.9 PROJECT CONDITIONS

- A. Verify conditions on the job site applicable to this work. Notify Owner's Representative/Consultant in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

#### 1.10 FINAL INSPECTION AND TESTING/COMMISSIONING

- A. Upon completion of installation and Contractor commissioning (as outlined in Section 3), the Consultant shall perform system(s) inspection and testing.
- B. To assist the Consultant, the Contractor shall provide a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the specified system(s).
- C. The process of testing the system(s) may necessitate moving and/or adjusting certain components such as speaker aiming, transformer tap values, software adjustments, DSP adjustments.
- D. Testing will include operation of each system and all components. The Contractor will provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.
- E. In the event that adjustments or work is required during testing, or to bring the systems into specification, the Contractor shall continue his work until the system(s) are acceptable with no addition to the contract price. If approval is delayed due to defective equipment, and/or failure of equipment or installation that meets the requirements of this specification, the Contractor

shall pay for additional time and expenses to the Owner at the rate specified by the Owner.

- F. All Control Systems shall be fully tested prior to commissioning. Once the Control Programming is finalized all source code (compiled and raw), programming, and touch panel software shall be burned on to a CD ROM and delivered to the Owner. All Control System programming (including source, files, touch panel design), and DSP shall become the property of the Owner.
- G. Contractor shall supply to Consultant all DSP and control layouts for review and comment and authorization prior to installation. Contractor shall provide any necessary adjustments to software as deemed by the Consultant.

#### 1.11 WARRANTY

- A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial two year service contract.
- B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.
- C. The Contractor shall respond with a remedy to a trouble call within twenty-four (24) hours upon receipt of such a call, and shall provide a 24-hour service phone number. Downtime for system(s) shall be no longer than a 24-hour period. All replacement parts/components shall be of equal or higher level of service.
- D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
- E. At least two routine inspections and adjustment visits will be scheduled for the first year, coordinated with Owner and the findings reported.
- F. Provide a separate price for an optional yearly service contract for three (3) and five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.
- G. The Contractor shall be present at the first use of the system (scheduled by the Owner), and one (1) additional event as requested by the Owner for no additional charge.

#### 1.12 INSTRUCTION OF OWNER PERSONNEL

- A. After final inspection and completion, provide instruction to Owner-designated personnel on the operation and maintenance of the system(s).
- B. Develop an instructional course based on the use of the system(s) and manufacturers' recommendations. Provide a minimum of three (3) hours of instruction, per system type, on two (2) separate occasions separated by a length of time established by the Owner. Total training time shall not be less than a total of six (6) hours. Arrange the course so that operational and maintenance classes are separate. Each instruction time shall be video recorded and provided to the Owner.
- C. Submit an outline of the course with sample instructional aids for approval one (1) week prior to scheduled instruction sessions.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Electronic component models shall be commercially available for a least one (1) year prior to bid, or be approved by the Consultant.

- B. All equipment and material shall be new unless specified in this specification.

- C. All equipment must be UL listed or built to UL standards, where required.

## 2.2 GENERAL

- A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied, unless a variance (exemption document) is submitted and approved by the Consultant.

- B. System(s) shall be installed and configured for simplicity of operation, with user-friendly controls.

- C. Product quantity is as required for complete and operable system(s). If any quantities are given, the Contractor shall provide at least the given amount. Some of the products listed under this section may not be required to fulfill the work as outlined.

- D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

- E. Remove all manufacturer's nameplates or logos from product, such as found on speaker(s), within the public sight lines or spaces when applicable.

- F. Paint all wall and ceiling mounted speaker grilles and enclosures as directed by the Consultant/Architect.

- G. The Contractor is responsible for providing a fully operational turnkey system. The following equipment list and attached drawings are for final design intent purposes.

- H. The Contractor shall program no less than five (5) presets on the audio console such that the first preset will reset the console to a default "cleared" setup and each of the other presets will be for various levels of user group activities. Additionally, settings that are not needed for everyday use will be locked out and the password will be given to Owner. Additionally, no less than three (3) user groups will be programmed and password protected.

## 2.3 AUDIO MIXING & AMPLIFICATION

- A. Audio Amplifier – Type 1

1. Single (70v) output channel
2. 35watt power output per channel
3. Frequency Response: 50 Hz-20 kHz
4. Ultra-small form factor
5. Acceptable Product:
  - a. RDL FP-PA35A

## 2.4 AUDIO OUTPUTS

- A. In-Wall Mounted Loudspeakers

1. 70v input
2. Flush-ceiling mount
3. 6.5-inch woofer
4. 1-inch tweeter

5. Nominal Coverage Angle: 90 degrees
6. Frequency Response: 75 Hz-20 kHz
7. Sensitivity Rating: 91 dB
8. Directivity Factor: 5.6
9. Directivity Index: 6.5
10. Acceptable Product:
  - a. Tannoy IW 6TDC

## 2.5 CONTROL SYSTEMS

### A. Control System – Type 2

1. Modular programming architecture
2. Onboard 256MB RAM & 4GB Flash memory
3. Support for external USB flash memory and mass storage devices
4. Industry-standard Ethernet wired communications
5. iPhone, iPad, and Android control app support
6. SNMP remote management support
7. One RS-232/422/485 COM port with hardware and software handshaking
8. Two IR/serial, two relay, and two digital input ports
9. Programmable event scheduling with astronomical time clock
10. C#, symbol based, and drag-and-drop programming environments
11. Full Unicode (multi-language) support
12. Hardware level security using 802.1X authentication
13. TLS, SSL, SSH, and SFTP network security protocols
14. FIPS 140-2 compliant encryption
15. Built-in Web Server
16. IPv6 ready
17. PoE network powered
18. Compact, stackable "IFE micro" form factor
19. Surface or DIN rail mountable
20. Acceptable Product:
  - a. Crestron RMC3

### B. Control Panel

1. 4.3" widescreen active-matrix color touch screen
2. 800 x 480 WVGA display resolution
3. High-performance H.264 streaming video
4. IP intercom
5. Customizable audio feedback
6. Built-in microphone and speaker
7. Built-in proximity sensor
8. 10 optional "hard key" pushbuttons
9. White LED button backlighting and feedback
10. Custom engravable button text
11. Room occupancy sensor option
12. Single-wire Ethernet connectivity
13. PoE network powered
14. Acceptable Product:
  - a. Crestron TPMC-4SMD-B-S



## 2.6 EQUIPMENT RACKS AND HARDWARE

- A. PoE Network Switch – Type 2
  - 1. 5-port unmanaged Ethernet switch
  - 2. All ports support 1000Base-T Gigabit Ethernet
  - 3. Provides PoE (802.3af) on 4 ports
  - 4. Auto-negotiating and auto MDI/MDIX
  - 5. Rugged metal enclosure
  - 6. Surface or rack-rail mountable
  - 7. Acceptable Product:
    - a. Crestron CEN-SW-POE-5

## 2.7 PLATES AND PANELS/FLOOR BOXES

- A. Provide plates and panels as described/detailed in the drawings and as required for fully operable system(s).
- B. Custom plates shall be 1/8" thick aluminum, standard EIA sizes, sized to cover rough-in/boxes behind plates.
- C. Plastic plates are not allowed or accepted.
- D. Lettering shall be in all caps and numbers engraved with black or white lettering to the base material with a minimum size of 0.25".
  - 1. Font Size shall be 1/8"
    - a. Font Style shall be Helvetica
- E. Acceptable manufacturer of custom plates and panels shall be:
  - 1. RCI Custom – AL/ALOS series Aluminum Wall Plates

## 2.8 CABLES AND WIRING

- A. All audio cable shall be stranded copper conductors.
- B. Shielded cables located in raceways shall have aluminum foil shield with drain wire.
- C. Where cables run exposed in a return plenum space, provide plenum rated cable.
- D. Where cables are routed through cable tray, provide tray rated cable of equal gauge.
- E. Provide the following as required for fully operable system(s).
  - 1. Microphone/Line Level cable: 22/2 shielded jacket.
    - a. Plenum - West Penn 25291B
    - b. Non Plenum – West Penn 452
  - 2. Speaker Level cable: 14/2 unshielded.
    - a. Plenum – West Penn 25226B
    - b. Non Plenum – West Penn 226
  - 3. Speaker Level cable: 16/2 unshielded.
    - a. Plenum – West Penn 25225B
    - b. Non Plenum – West Penn 225
  - 4. Loudspeaker cable: 10/2 unshielded.

- a. Plenum – West Penn 25210
  - b. Non Plenum – West Penn HA210
- 5. Communications cable: 22/9 shielded.
  - a. Plenum – West Penn D253653
  - b. Non Plenum – West Penn D3653
- 6. Communications cable: 24/9 shielded.
  - a. Plenum – West Penn D252404
  - b. Non Plenum – West Penn D2404
- 7. Control cable: 22/10 shielded jacket.
  - a. Plenum – West Penn 253272B
  - b. Non Plenum – West Penn 3272
- 8. Ethernet cable: Cat5e UTP unshielded.
  - a. Plenum – West Penn 254245
  - b. Non Plenum – West Penn 4245
- 9. Ethernet cable: Cat5e F/UTP shielded.
  - a. Plenum – West Penn 254245F
  - b. Non Plenum – West Penn 4245F
- 10. Ethernet cable: Cat6 F/UTP shielded.
  - a. Plenum – West Penn 254246F
  - b. Non Plenum – West Penn 4246F
- 11. RGBHV cable: 25/5 shielded.
  - a. Plenum – West Penn 255CRGB
  - b. Non Plenum – West Penn 5CRGB
- 12. HD/SDI cable: 18/1 braided
  - a. Plenum - West Penn 256350
  - b. Non Plenum - 6350
- 13. CATV cable: 18/1 braided
  - a. Plenum – West Penn 25841
  - b. Non Plenum – West Penn 841
- 14. Hybrid HDMI/Fiber cable:
  - a. Plenum – FSR DR-PCB-H###
- 15. Fiber Optic cable – OM3
  - a. Plenum – West Penn M9C014
  - b. Non Plenum – West Penn M9C006

## 2.9 PROPOSED SUBSTITUTIONS

- A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.
- B. The Owner/Consultant requires manufacturer's original specification tests. The Owner/Consultant will evaluate and approve/disapprove all substitutions.
- C. Items designated "no substitutions" will be specified items only. Submission of items other than specified shall not be considered and will disqualify RFP submission.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Follow ANSI standards as a minimum.
- B. Provide shaft locks or security covers on non-user operated equipment having front panel access.
- C. Install XLR-type connectors wired as follows: Pin 2 High, Pin 3 Low, and Pin 1 Shield.
- D. Mount all equipment, speakers, plates and panels, plumb and level.
- E. Permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.
- F. Validate bracing or blocking for proper mounting and safety.

### 3.2 EQUIPMENT HOUSING

- A. Locate operator useable equipment and patch panels at an appropriate operating height.

### 3.3 LABELING

- A. Provide engraved label over each user-operated control that describes the function or purpose of the control. Adjust size of label to appropriate size for location.
- B. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
- C. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
- D. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
- E. Wiring designator shall be alphanumeric code, unique for each cable.
- F. Each cable type shall be labeled starting with different destinations (i.e. mic series "Mxxx", speaker series "Sxxx", etc.).
- G. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

### 3.4 CONTRACTOR COMMISSIONING

- A. Prior to energizing or testing the system(s), ensure the following:
  - 1. All products are installed in a proper and safe manner per the manufacturers' instructions.
  - 2. Insulation and shrink tubing are present where required.
  - 3. Dust, debris, solder, splatter, etc. is removed.
  - 4. Cable is dressed, routed, and labels and all connections are consistent with regard to polarity.
  - 5. All labeling has been provided and installed.
  - 6. All products are neat, clean, unmarred and securely fastened.
  - 7. All debris has been cleaned and removed from the site.

8. All electronic devices are properly grounded.
- B. Perform the following test. Record all results in the final project manual.
  1. Test each AC power outlet for proper connections for hot, neutral and ground.
  2. Measure and record the DC resistance for the technical ground in the equipment racks and console. Resistance should be 0.15 ohms or less.
  3. Measure the impedance of each speaker line from the amplifier rack.
- C. Speaker Verification Test:
  1. Provide a low level distinctive tone to each amplifier input.
  2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.
- D. Constant Voltage Speaker test:
  1. Provide a low level distinctive tone to each amplifier input.
  2. Systematically turn on each amplifier, one by one, and verify that the correct speaker is being driven. Correct wiring as required for proper operation.
  3. Walk the areas covered by the speakers and check for even level volume coverage. Adjust any speakers that are not correct by changing tap values as required for even volume level.
- E. Speaker Polarity:
  1. Use an electronic polarity checker to test each reinforcement speaker. All speakers should have the same relative polarity.
- F. System(s) Gain Adjustment:
  1. Adjust each active device to have unity gain from the console output to the input of the amplifiers.
  2. With all amplifiers turned off, connect a sine wave and pink noise to an input of the console. Using a RMS voltmeter, adjust the scale to an output between -10 and 0dBu. Once level has been established, it should remain unchanged throughout the testing.
- G. Amplifier Level Adjustment:
  1. Adjust the gain of each amplifier to provide consistent and appropriate levels throughout the seating areas/facilities.
  2. With the console and other electronic devices feeding the amplifiers adjusted as described above, adjust the output of the console to be -10dB on the output VU meter.
  3. Adjust the appropriate amplifiers to achieve 85dBA in the area covered by one of the speakers. Use a calibrated sound level meter to make the adjustments.
  4. If the speaker is utilizing an active crossover, mute the individual bandpass sections to adjust each section independently.
  5. Start with the speaker closest to the stage area or the booth location as appropriate. Once that speaker has been adjusted to the above criteria, repeat this procedure for each speaker cabinet.
  6. Amplifiers should be set to provide an average of 85dBA plus or minus 1.5dB throughout each seating section.
- H. Amplifier Level Adjustment 70 volt System:
  1. Adjust the level of the 70 volt systems to achieve a volume level appropriate for their location and intended use.
  2. After initial amplifier adjustment, walk all areas utilizing the 70 volt systems and check

for volume uniformity. If any changes of 3dB or more occur, adjust that specific area or speaker as required for even coverage.

I. Input Verification Test:

1. Using a microphone, portable signal generator, or CD player, send signal from every microphone input to the console. Check every connection location in the facility.
2. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
3. Verify that the receptacle under test appears at the correct position on the patch bay and is operating properly.
4. In a similar manner, check any other inputs or tie lines, as appropriate.

J. Impedance:

1. Measure absolute impedance value of each loudspeaker line at 250, 500, 1000, and 2000 Hz without the amplifier connected but with all speakers connected. Record the impedance levels versus frequency for each loudspeaker line.
2. Impedance must not be below the rated load impedance of respective amplifier and may be any value equal to or above that.
3. Check the resistance of the lines for loudspeaker, line level, and microphone receptacles with the receptacles opened and shorted. Document and repair any shorts or discontinuities found.

K. Polarity:

1. Verify the polarity of each device in the shop to obtain true polarity throughout the system.
2. Verify and document that polarity is kept throughout the system after wiring from inputs through output devices or receptacles.

L. Gain Structure:

1. Turn off amplifiers and set equalizers and filter controls to flat response. Do not bypass any equalizers or filters.
2. Adjust compressors and limiters to a 1:1 compression ratio and a +10 dBu limiting threshold. Do not bypass these processors.
3. Insert pink noise into the mixer or mixing console and adjust levels to obtain a 0 dBu reading for the mixer or mixing console output. Distribute this output to all systems and subsystems.
4. Adjust the output of line level electronics and signal processors to obtain a 0 dBu output at the output terminals. For equipment with input level controls, adjust the input controls so that input levels peak at -10 dB. For equipment not capable of providing 0 dBu output, adjust to achieve as close to 0 dBu as possible.
5. Turn amplifier gain controls to minimum and turn on the power amplifiers. Adjust the gain controls to achieve a +4 dBu output level for low impedance amplifiers and a +18 dBu output level for high impedance or constant voltage amplifiers.

M. Hum and Noise Level:

1. Without changing the gain, terminate microphone and line level inputs with proper shielded resistors of 150 and 600 ohms respectively.
2. Measure and record overall hum and noise levels for each power amplifier output from each input and with all inputs simultaneously. Hum and noise shall be at least 50 dBA below rated power output levels with amplifier controls set for optimum signal-to-noise, using input from line level and microphone sources.

## N. Electrical Distortion:

1. Load amplifier outputs with appropriate resistors matching the nominal impedance of the output terminals in place of the actual loudspeaker loads.
2. Adjust gain controls as for hum and noise level test.
3. Apply 250 Hz, 500 Hz, 1 kHz, and 2 kHz sine wave signal from an oscillator with less than 0.01% Total Harmonic Distortion to one input, such that a level of 0 dBu is obtained on the mixer.
4. Measure and record the electrical distortion at each power amplifier output. Distortion shall be less than 0.5%.

## O. Parasitic Oscillation and Radio Frequency Pick-up:

1. Set up system for each specified mode of operation.
2. Using a 5 MHz bandwidth oscilloscope and loudspeaker monitoring.
3. Ensure that the system is free from spurious oscillation and RF pick-up with the absence of any input signal and with a 160 Hz signal at a 0 dBu level on the mixer or mixing console.
4. Repeat this test for each mode of operation of the lighting dimmers (incandescent, neon, and fluorescent).

## P. Background Noise:

1. Using a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, determine the average ambient noise level in the room. Record the level derived. The average background noise shall be 60 dBA or below during performance of the following tests. If noise level exceeds this criterion, promptly notify the Consultant before proceeding further.

## Q. Buzzes and Rattles:

1. Apply a 1 kHz sine wave signal such that a 0 dBu level is obtained on the mixer or mixing console.
2. Sweep loudspeaker systems from 50 Hz to 5 kHz at 6dB below full amplifier power. Listen for buzzes, rattles, vibrations or resonance. Locate and correct problems.
3. If the cause is outside the system, promptly notify the Consultant, indicating the cause and recommended corrections.

## R. Coverage:

1. Using pink noise as an input, adjust loudspeakers and output levels to provide  $\pm 6$  dB coverage in the octave band centered at 1 kHz throughout the areas served by the system.
2. Measure and record results.

## S. Equalization:

1. Equalize the sound systems in order to provide uniform seat-to-seat response, raise the threshold of feedback, suppress ring modes, and insure natural, pleasing sound in equal and adequate amplitude with maximum degree of intelligibility, and provide performance conforming to the requirements specified under "Acceptance Testing."
2. Turn off systems except the speaker system under test.
3. Using pink noise as an input and with system equalizers set to bypass operation, determine the average frequency response of the loudspeaker system in the room using a 1/3 octave real time analyzer.
4. Record the frequency response derived.
5. Locate the analyzer microphone approximately 1 m above the floor at a point which

- approximates the average frequency response, within  $\pm 3$  dB from 50 Hz to 16 kHz.
6. Record the frequency response at this location.
  7. Using pink noise as an input and with system equalizers set to normal operation, set low and high pass filters at 63 Hz and 16 kHz respectively.
  8. Adjust the 1/3 octave filter settings to obtain the following response curves, minimizing the variation ( $\pm 3$  dB) between adjacent filter settings:
    - a. Roll off -6 dB per octave below 125 Hz.
    - b. Maintain  $\pm 3$  dB, 125 Hz to 4 kHz.
    - c. Roll off -3 dB per octave from 4 kHz to 12 kHz.
    - d. Roll off sharply above 12 kHz.
    - e. With any system microphone open, make minor adjustments to maximize gain before feedback. No more than 3 filter settings shall be adjusted.
    - f. Record the frequency response derived.

T. System Input and Output Levels

1. Using pink noise source material and a calibrated ANSI S1.4-1983 (1997) Type 1 or IEC 60651-01-1994, precision sound level meter, perform the following:
  - a. For microphone level inputs: locate a pink noise source at a distance of 300 mm from the corresponding system microphone. Adjust the pink noise source to provide a level of 75 dBA at the microphone and set mixer levels to achieve a 0 dBu level at the mixer output.
  - b. For line level inputs: use system program source equipment, with pink noise playback media, as a direct input to the mixer or mixing console and set mixer levels to achieve a 0 dBu level at the mixer output. Repeat for each system input individually where mixer inputs vary in input sensitivity. Settings for equivalent sensitivity inputs may be duplicated.
  - c. With any input set as specified above, adjust audio distribution amplifiers to provide levels of -10 dBu at each output.
2. Measure and record results.

U. Feedback Stability:

1. With required output levels set, measure and record the available gain before feedback. Feedback stability margin shall be 6 dB, minimum.

V. Intelligibility:

1. Using a TEF analyzer, measure the percent articulation loss of consonants (% ALcons) for at least 4 various locations in the room in the 2000 Hz octave band.
2. % ALcons shall be less than 10 for each location.
3. Record results.

W. Notification:

1. Once all of the above is complete, the system(s) is (are) ready for inspection. Formally notify the Owner/Consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and equalization will be conducted at the time of inspection.

### 3.5 CONTRACTOR MEDIA TESTING AND COMMISSIONING

A. Audio Video Switching

1. The AV switching system shall support at least 6.75gbps of data transfer on each input and output to support 1080p 36-bit (deep) color video resolutions without compression.
2. The AV switching system shall support 8 channel audio.

3. The AV switching system shall support audio breakaway from video.
4. The AV switching system shall have less than 5us of latency from av input to av output.
5. The AV switching system shall support the HDMI specification of less than 1 in 1x10-9 bit errors at 1080p 36-bit (deep) color.
6. The AV switching system shall downmix multi-channel audio into 2-channel audio so that the same audio content may be routed to both multi-channel and 2-channel sinks.
7. The AV switching system shall be able to dither between standard and deep color video signals on each input and output.
8. The AV switching system shall support the following av signal inputs:
  - a. HDMI 1.3a (high definition multimedia interface)
  - b. DVI 1.1 (digital visual interface)
  - c. Displayport multimode 1.1
  - d. Analog RGB
  - e. YPBPR
  - f. SPDIF
  - g. Analog stereo audio
9. The AV switching system shall transcode the AV signals to a single signal type for distribution.

B. Audio Video Distribution

1. The AV distribution system shall use multimode fiber or shielded twisted pair for AV signal distribution.
2. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.
3. The twisted pair structured cabling used to carry the AV signals shall be shielded.
4. The twisted pair structured cabling used to carry the AV signals shall be specified to 1.2ghz of bandwidth or greater.
5. The AV distribution system shall not require extra cabling to transmit the following control signals for AV sources and sinks:
  - a. RS-232
  - b. Infrared
  - c. Ethernet
  - d. USB human interface device-class devices
  - e. Contact closure

C. EDID Management

1. The AV switching system shall allow configuration of the EDID presented to sources on each AV input.
2. Each input on the AV switching system shall be configured independently.
3. The AV switching system shall by default present an EDID to each input that includes only the video timings and audio formats common all sinks connected to the outputs.
4. The AV switching system shall allow the user to enter each input's EDID video timings individually.
5. The AV switching system shall allow the user to enable and disable support for the following items in each:
  - a. Deep color
  - b. 3D support

D. HDCP Management

1. The AV switching system shall support HDCP 1.1 or greater.
2. The AV switching system shall detect the number of keys supported by each source.



3. The AV switching system shall not send a source more keys than it supports.
  4. The AV switching system shall cache the keys from each connected sink.
  5. The AV switching system shall authenticate all cached keys with each source up to the source's key limit, so that authentication does not need to be re-started each time content is routed to a new output.
- E. Signal Detection
1. The AV switching system shall report the following incoming signal information to an AV control system:
    - a. Signal detect
    - b. Horizontal and vertical resolution
    - c. Signal refresh rate
    - d. Presence of HDCP
  2. The AV switching system shall report the following information to an AV control system:
    - a. HDCP authentication status for each source and sink
    - b. EDID preferred video timing for each sink
    - c. Maximum number of keys supported by each source
- F. Troubleshooting
1. The AV switching system shall report the following information for troubleshooting:
    - a. Maximum number of keys supported by each source
    - b. The number of keys sent to each source
    - c. EDID indicated video timings and audio formats supported for each sink
    - d. EDID presented to each source
  2. The AV switching system shall support off-site remote troubleshooting via Ethernet.
- G. System Design
1. The contractor shall provide AV source equipment with support for enough keys so that it can be routed to all sinks simultaneously.
  2. If a particular AV source cannot be found to support enough keys to route to all sinks simultaneously, the contractor shall:
    - a. Notify the engineer
    - b. Configure the AV switching equipment so that it shall not send an AV source more keys than it supports.
  3. The contractor shall configure the EDID presented to each AV source to indicate only the video timings supported by all sinks used for viewing and distributing video.
  4. The contractor shall configure the EDID presented to each AV source to indicate support for only the audio formats actually supported by all the sinks used for distributing audio.
  5. The contractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.
  6. The contractor shall provide display equipment that does not overscan the video signal when full-pixel sources are routed.
- H. Demonstration and Acceptance Testing
1. The demonstration and acceptance tests shall be done by an Extron DTP certified engineer.
  2. The contractor shall provide a copy of the following information in electronic format in order to verify the AV switching equipment has been installed and configured correctly:
  3. The number of HDCP keys supported by each source.
    - a. The video timing, HDCP use and audio format of each source when operating (not

- needed for walk-in equipment).
- b. The video timings and supported audio formats for each connected sink.
- c. The video timings and supported audio formats presented in the EDID to each source– the preferred video timing shall be indicated.
- d. The length of cable used on all shielded twisted pair cable used for AV distribution.
- e. The data rate supported by each shielded twisted pair cable used for AV distribution.

### 3.6 GENERAL VIDEO SYSTEMS

- A. Video signals shall be scaled or scan converted as necessary to provide the native resolution signal to display and video capture devices.
- B. Whenever possible a common native resolution shall be determined for each space and shall be provided to every display in the system.

### 3.7 COMPUTER INTERFACES

- A. Review all locations with the Owner prior to installation and provide according to Approval of the Owner. Low voltage power shall be provided at the interface.
- B. Provide audio and video breakout cables for each computer interface provided as specified herein unless noted otherwise.
- C. Provide manufacturer's adapter plates for pass-through connections as specified herein unless noted otherwise.
- D. Adjust peaking, horizontal and vertical position for system native resolution.

### 3.8 SIGNAL PROCESSING EQUIPMENT

- A. Signal processing equipment shall be mounted in the equipment racks and/or control consoles, as specified herein unless noted otherwise.
- B. Configure and adjust signal processing equipment to produce the native resolution of the primary display devices within each separate system for each potential source resolution, unless specified otherwise herein. RGBHV sources shall be tested from 640 x 480 at 60 Hz through 1600 x 1200 at 60 Hz. NTSC composite video and NTSC S-video shall also be tested.

### 3.9 VIDEO MONITORS/RECEIVERS AND ASSOCIATED EQUIPMENT:

- A. Video monitors/receivers shall be selected to match the native resolution of the system, unless otherwise specified herein.
- B. Configure monitors to provide full images at the monitor's native resolution. Verify color timing.
- C. Review all locations with the Owner prior to installation and provide according to Approval of the Owner.

### 3.10 VIDEO SYSTEMS

#### A. General

1. Adjust, balance, and align equipment for optimum quality and to meet the manufacturer's published specifications.

#### B. Performance Standards

1. Unless restricted by the published specifications of a particular piece of equipment, or unless specified otherwise herein, the following performance standards shall be met by each system.

#### C. Video images shall be:

1. Free from banding where bands of the video image are at incorrect intensities.
2. Free from bending at the corners due to synchronization problems.
3. Free from outlining due to timing issues and component signals being out of convergence.
4. Free from ghosting or reflections due to improper termination and impedance mismatching.
5. Free from video roll due to ground loops and improper grounding.
6. Free from visible jitter due to an instable synchronization signal.
7. Free from double images due to improper scan rates.

#### D. Video, Signals

1. S/N (peak-to-rms) unweighted dc to 4.2 MHz: 55 dB minimum.
2. Crosstalk, unweighted dc to 4.2 MHz: 55 dB minimum.

#### E. Video Signal Strength

1. Composite video: 1V peak-to-peak, nominal.
2. S-video: 0.7V peak-to-peak, nominal.
3. Component video: 0.7V peak-to-peak, nominal.
4. Computer (RGBHV) color timing shall be within 1 pixel at system resolution.
5. Receptacle voltage level for RF signal outlets: 6.0 dBmV,  $\pm 3.0$  dB.
6. Line and field tilt: 2% maximum.
7. Differential gain: 3% maximum.
8. Differential phase: 2° maximum.

#### F. Video, Timing

1. System synchronization coincidence shall be within 50 nanoseconds.
2. NTSC color timing shall be within 2° at 3.58 MHz.
3. Computer (RGBHV) color timing shall be within 1 pixel at system resolution.
4. Video timing shall be achieved without readjustment of source phasing.
5. Delay units, active or passive, shall be provided, if necessary, to achieve proper timing.

#### G. Video Displays

1. Review all locations with the Owner/Consultant prior to installation and provide according to Approval of the Owner/Consultant.
2. For the following tests and adjustments, test signals provided by the signal generator shall be injected into the system from the primary presentation location and displays optimized from this location.
  - a. Image Sizing:
    - 1) Using a crosshair or crosshatch pattern, adjust display device to show full

- image at system resolution.
- b. Black Level:
    - 1) Use a signal generator to provide a picture line up generating equipment (PLUGE) test pattern on the display to be adjusted.
    - 2) Adjust the brightness control upward until the "blacker-than-black" bar is visible on the screen.
    - 3) Decrease the brightness control slowly until this bar becomes fully extinguished. Continue until the test pattern background reaches the same point, i.e. no light output.
    - 4) The remaining vertical bar should be dimly visible. Record the value of the onscreen display.
  - c. System Gain:
    - 1) Use a signal generator to provide a PLUGE test pattern on the display to be adjusted.
    - 2) Adjust the contrast control until the 100% white bar begins to bloom or distort in size or stops getting brighter.
    - 3) Decrease the contrast control until the white bar is at the threshold of maximum brightness without any of these distortions.
    - 4) Record the value of the onscreen display.
    - 5) Perform Black Level and System Gain tests until there is no additional interaction between contrast and brightness control adjustments and record the final onscreen values for contrast and brightness.
  - d. Color Level or Gain
    - 1) Use a signal generator to provide a SMPTE color bars test pattern on the display to be adjusted.
    - 2) Adjust the color level, individually if possible, until each channel's large bar blends with the small patch underneath.
    - 3) Record the onscreen value for color level(s).
  - e. 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 record the final onscreen values for color and tint.
- H. Cabling
- 1. Upon completion of the installation of each area, the Contractor shall test all elements of the system. This testing shall include as a minimum:
    - a. Continuity of all circuits.
    - b. Operation of all circuits.
    - c. Phase checking of all circuits.
    - d. Operation of all equipment in all modes
  - 2. During and/or after installation, as appropriate, the Contractor shall test all cabling for continuity, phase, shielding, and unreasonable signal loss. The testing shall be conducted according to the submitted and approved test plan.

### 3.11 SPARE PARTS

- A. Provide replacement fuses, lamps, batteries and connectors in sufficient quantities to last one (1)

year.

### 3.12 QUALITY CONTROL

- A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.

### 3.13 PRE-INSTALLATION MEETING/SCHEDULE

- A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other subContractors whose work requires coordination with this work shall be coordinated.
- B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

### 3.14 APPLICABLE FEDERAL SPECIFICATIONS

- A. The list below forms only a part of this specification.
  - 1. J-C-30A & Am-1 Cable and Wire, Electrical (Power, fixed installations)
  - 2. W-C-3735B Circuit Breakers, Molded Case, Branch Circuit, and Service
  - 3. W-C-586C Conduit outlet boxes, bodies, and entrance caps, electrical: cast metal
  - 4. W-C-596E/Gen Connector, Electrical, Power, General Specifications
  - 5. W-F-406B Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible
  - 6. W-F-408C Fittings for Conduit, Metal, Rigid, (Thick wall and EMT)
  - 7. W-J-800D Junction Box: Extension, Junction Box; Cover, Junction Box (Steel, Cadmium, or Zinc Coated)
  - 8. HH-I-553C Insulation Tape, Electrical (Rubber, Natural, or Synthetic)
  - 9. HH-i-595C Insulation Tape, Electrical, Pressure Sensitive Adhesive, Plastic
  - 10. WW-C-0054OC Conduit, Metal, Rigid: and Coupling, Elbow, Nipple, Electrical Conduit: Aluminum
  - 11. WW-C-566C Conduit, Metal, Flexible
  - 12. WW-C-581 E Conduit, Metal, Rigid, and Intermediate: and Coupling, Elbow, and Nipple  
Electrical Conduit: Steel Zinc Coated
  - 13. C2-1990 National Electrical Safety Code
  - 14. C97.1-1972 Low Voltage Cartridge Fuses 600v or less
  - 15. Institute of Electrical and Electronic Engineers (IEEE)

16. 142-1982 Recommended Practice for Grounding of Industrial and Commercial Power Systems

**END OF SECTION**