SECTION 27 41 16
AV SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

The scope of work includes furnishing all materials, labor, supports, services, programming and documentation to install a complete and fully working audio/video system for the project. The scope includes, but is not limited to, all provisions of this specification section, the attached audio/video drawings, the project general conditions and coordination with the owner and other contractors.

1.2 RELATED WORK

The AV Contractor is responsible for coordination with other trades on the project. It is the AV Contractor's responsibility to review specification sections for related work performed by others. Related work is found elsewhere in the following specification sections, but is not limited to the following sections:

A. General Conditions (Division 1)

B. Basic Electrical requirements (Division 26)

C. Conduit (Division 26)

D. Electrical Power Distribution (Division 26)

E. Telephone and Data Systems (Division 27)

1.3 DEFINITIONS

A. The term "AV Consultant" as used in this section shall refer to Lipp A/V Design, Inc. – Contact: Jeffrey Lipp.

B. The term "AV Contractor" as used in this section shall refer to the Audio/Video systems contractor.

C. The term "Owner" as used in this section, shall refer to the facility owner.

D. Refer to Division 1 and the general conditions for more definitions.

1.4 REFERENCES

Work is to be performed in a neat and professional manner and in accordance with the latest revision of the following reference standards:

A. National Electrical Code (NEC).

B. National Fire Protection Association (NPFA).

C. All applicable local building codes and ordinances.

D. Underwriters Laboratory (UL).

E. Davis, Don and Carolyn, Sound System Engineering, Third Edition. Howard W. Sams, Indianapolis, IN.

F. Giddings, Philip, Audio Systems Design and Installation. Focal Press, Boston, MA.

G. Glerum, Jay, Stage Rigging Handbook. Southern Illinois University Press, Carbondale, IL.

H. Laurik, Sven, CTS Certified Technology Specialist Exam Guide. McGraw Hill.

I. InfoComm International, Audiovisual Best Practices. Avixa International, Fairfax, VA.

J. InfoComm International, AV Installation Handbook, 2nd Edition. Avixa International, Fairfax, VA.

K. All applicable manufacturers' set up and operation recommendations.

L. If any of these references are in conflict with each other or are in conflict with the project requirements specified herein, the more stringent of the requirements shall apply.

1.5 QUALITY ASSURANCE

The work is to be performed by an AV Contractor who is skilled in the engineering and installation of systems of a similar type and scope to the project described herein.

A. The work is to be performed by an AV Contractor who has had a minimum of five (5) years direct experience in the engineering and installation of systems of a similar type and scope to the project described herein. The installing contractor shall assign employees to the work whose qualifications meet the following minimum requirements.

1. The AV Contractor shall assign an AV Project Manager to be the main contact for the AV Contractor. The AV Project Manager must have had a minimum of five (5) years direct experience in the engineering and installation of systems of a similar type and scope to the project described herein. The project manager shall have a current AVIXA Certified Technology Specialist certification with an installation endorsement (CTS-I) or a design endorsement (CTS-D) in good standing.
2. The AV Contractor shall assign a Lead Installer to the project. The Lead Installer must have had a minimum of three (3) years direct experience in the installation of systems of a similar type and scope to the project described herein. The lead installer shall have a current AVIXA Certified Technology Specialist certification with an installation endorsement (CTS-I) in good standing.
3. The AV Contractor shall assign other Installation Personnel to the project. The other installation personnel must have had a minimum of three (3) years direct experience in the installation of systems of a similar type and scope to the project described herein. The other installation personnel shall have a current AVIXA Certified Technology Specialist certification (CTS) in good standing. The AV Contractor may assign one apprentice installer without three (3) years direct experience and a CTS certification for every two CTS certified installers.
4. The AV Contractor shall assign Engineering and Programming Personnel to the project. The engineering and programming personnel shall have current certifications from any manufacture who offers certifications for their products.

B. At the AV Consultant's request, the bidding AV Contractor shall provide, within two (2) working days, a written list of three (3) recently completed systems of a similar type and scope to the project described herein. The list shall include the contact name, phone number, Fax number, address, system description and completion date for each of the projects.

C. At the AV Consultant's request, the bidding AV Contractor shall provide, within two (2) working days, a copy of the system "as built" documentation for any of the above listed projects.

D. AV Contractor's service facility requirements:

1. The AV Contractor must be a franchised dealer and authorized service facility for each of the major products furnished.
2. A fully staffed and equipped service facility with full time shop and field technicians.
3. The AV Contractor must be capable of providing a 24 hour response time to service calls.

4. The AV Contractor must be capable of providing loaner equipment to temporarily replace equipment that is being serviced. There shall be no additional cost for providing such loaner equipment during the warranty period.
5. At the AV Consultant's request, the bidding AV Contractor shall provide, within two (2) working days, evidence that the AV Contractor has adequate service staff and facilities to provide the required service.

E. If it is determined that a bidding AV Contractor has not successfully completed the appropriate quantity of similar projects, the AV Contractor's staff has not had appropriate experience or the AV Contractor does not have the appropriate service resources, the AV Contractor's bid shall be considered unresponsive and will not be considered.

1.6 SUBSTITUTIONS

A. Equipment, as listed herein by manufacturer name and model number, will serve as a basis for quality of each component part of the system.

B. The specifications, as published by the manufacturer, for any substitute equipment must meet or exceed the specifications for the equipment listed herein and be compatible with other products in the system. All substitute components must be capable of being integrated with the system as a whole.

C. A request for substitution must be made, in writing, to the AV Consultant, at least ten (10) days prior to the bid date. This requirement does not supersede any substitution requirements of the general conditions (Division 1). The request for substitution must include the following:

1. Manufacturer name and model number of listed part.
2. Manufacturer name and model number of requested substitute part.
3. Manufacturer's cut sheet (literature) for requested substitute part.
4. A statement giving the reason for the substitution.
6. A statement of impact on the rest of the system. Include any block diagram and detail drawings necessary to convey the impact.

A. The AV Consultant will provide written review of the substitution request. In the written review the AV Consultant will provide observations as to whether the requested product is in compliance with the project requirements.

B. If a piece of listed equipment has been discontinued and has been replaced by a direct replacement model, the new model should be used without a request for substitution.

1.7 SYSTEM DESCRIPTION

A. Stadium System

1. **General:** The Round Lake High School stadium was recently built and includes a scoreboard that provides video and scoring with a scoreboard mounted speaker system. The speakers are approximately 300 feet away from the press box, which causes a delay between the announcer's calls and the sound reaching the audience. At the time of the installation, this system met the district's requirement for the single function of football play-by-play announcements.

   However, the District is now considering using the stadium for other events such as graduation, band soloists on mic, band director announcements, singers, performances by cheerleading, etc. The current scoreboard mounted sound system is a more traditional speaker system design and not conducive to these more modern types of events. Therefore, a new sound system is being proposed.

   a. The proposed sound system will include two separate sound systems with an A/B switch to switch between them. The "A" system would be the original scoreboard mounted speakers, but reconfigured and retuned and the "B" system would be a system with speakers mounted on the press box.
   b. The "A" system will be used when the stadium is used for the graduation ceremony and other events (e.g. movie nights), that would have a stage location closer to the scoreboard to make use of the video display, the original speaker system will be reused. It will include the original speakers reconfigured with new electronics and retuning.
   c. The "B" system speakers would be mounted to the press box. This will locate the speakers much closer to the audience members and the presenters located at the 50-yard line and will eliminate the approximately 250ms (1/4 second) delay in the sound traveling to the presenter's ears. This previously made it difficult for presenters to talk or sing. The system also includes new and appropriate electronics, microphones, wireless microphones with antennas and wiring.
   d. This "B" system will eliminate the disconcerting delay for any presenters located at the 50-yard line, the band director announcing musical pieces and it will make it possible to use a wireless mic live in the bleachers or on the field in front of the bleachers (singing the national anthem or potential live on-camera interviews).
   e. For graduations ceremonies, with the stage located closer to the scoreboard, a stage monitor system is recommended when the scoreboard mounted system is used ("A" system) and presenters are on stage with mics near the endzone. These are the small wedge type

speakers that are seen at a singer's feet during a concert. The monitor speakers will provide an un-delayed sound to the presenter's ears that will be louder and take precedent over the sound from the scoreboard mounted speakers that are approximately 150 feet away and provide a disconcerting 170ms delay. This monitor system will be rented because this system is only needed one time a year for graduations

f. The rental system for graduations will include the hiring of a skilled sound engineer to operate the sound system during the graduation events. The rental will also include a mixer and additional microphones for the event.

2. **System Configuration:** A fully operational sound reinforcement system will be provided.

a. New outdoor type speakers will be mounted on large Unistrut L brackets on top of the press box. One speaker will aim to each side of the bleachers and a speaker will aim straight out to the bleachers right in front of the press box and will provide coverage to the field and visitor bleachers.

b. The existing speakers in the scoreboard with be checked and angles changed for optimal coverage. Angles are provided in the sound system construction document drawings. A lift will be required to access the speakers in the scoreboard.

c. The existing IT style equipment rack will be reused, but it will be slightly reconfigured, so the audio equipment is accessible. Work with the school district IT department on the exact configuration and any equipment which they will need to move prior to the sound system installation. Document the equipment rack changes on the shop drawings.

d. Microphone inputs will include the main announcer mic, with the specialty sports announcer style push-to-talk switch, and three wireless handheld microphones. There will also be an aux input Jack for music from a smart phone or computer input and a Bluetooth input.

e. All microphone and auxiliary line inputs shall be controlled by the existing rack mounted mixer.

f. The new press box roof mounted speakers will be configured to inconspicuously mount behind the existing fence as shown on the drawings. Special care must be taken to provide roof penetrations to secure the speaker mounting brackets as shown on the drawings.

1.8 COORDINATION

A. General: the AV Contractor shall be responsible for coordination with the owner, the architect, the construction manager and other trades on the project.

B. Formalities: the owner, architect, construction manager and AV Consultant reserve the right to waive any or all formalities stated herein.

C. Missing items:

1. Prior to bidding, if any piece of required AV equipment is found missing from the project documentation, the AV Contractor shall notify the owner, in writing, at least 10 days prior to the bid opening date. It such notification is not made, the AV Contractor shall supply such equipment, as part of the system, at no additional cost.

2. If any required conduit or AC circuit is found missing from the project documentation, the AV Contractor shall notify the owner, in writing, within 30 days after the award of sound contract. If such notification is not made the AV Contractor shall bear the cost to supply such provision at no additional cost.

3. If any required architectural accommodation is found missing from the project documentation, the AV Contractor shall notify the owner, in writing, within 30 days after the award of AV contract. If such notification is not made, the AV Contractor shall bear the cost to supply such provision at no additional cost.

D. Scheduling:

1. The AV Contractor shall provide a schedule identifying AV milestones and predecessors, made with professional scheduling software, to the construction manager. The schedule must be coordinated with the schedules of the owner and other trades on the project. Special attention shall be paid to predecessors provided by other trades (such as conduit for each sub-system provided by the electrical contractor).
2. If during progress on the project, it becomes apparent that other trades will delay completion of the AV system, the construction manager and owner shall be notified in writing.

E. Completion:

1. The AV Contractor shall complete the project, to the point of “substantial completion” on a date as directed by the owner and the construction manager.

F. Change Coordination:

1. The AV Contractor shall communicate and coordinate any changes to the project with the AV consultant prior to the initiation of the work for the change.

Coordinate with the AV consultant even for changes that are requested or directed directly by the owner and the construction manager.

1.9 SUBMITTALS

A. General: all submittals shall be made in the following format:

1. Submit all documents in a neat and professional manner.
2. Submit five (5) copies of all documents, except for the "Owner's Manual" where only two (2) copies are required.
3. All 8 ½" by 11" documents shall be neatly bound in a three ring binder. Provide tabs and a table of contents for multiple sections.
4. All drawings shall be submitted in "D" (24"x36") or "E" (36"x48") size or a standard size in-between the two.
5. All drawings shall also be submitted in electronic format using AutoCAD 2010 or newer (.DWG format).
6. These requirements do not supersede any submittal requirements of the general conditions (Division 1).

B. Review: after each of the documents is submitted, the AV Consultant will review the submittal.

1. Any changes, if approved by the owner and requested by the AV Consultant will be made to the submittal.
2. The changes will be made in a time frame as not to jeopardize the completion of the project.
3. Corrections or comments made on the shop drawings during this review do not relieve AV Contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The AV Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

C. Preliminary submittal:

1. Within 20 days of award of the project and before proceeding with the work or ordering equipment submit the "preliminary submittal".
2. Provide a list of equipment to be used for the project. Organize the list by sub-system. Alphabetize the list and include quantities for each item.

3. Submit manufacturer's product data sheets for ONLY pieces of equipment that differs from the equipment list (in the Products section of this document), is contractor selected or requires choices of finish or color.

D. Shop drawing submittal:

1. Within 45 calendar days of award of the project and before proceeding with the work submit the "Shop drawing submittal".
2. Provide drawings including the following:
    a. "Block diagram": for each sub-system. Include wire label and patch bay designation. Include the manufacturer's name, model number and description for each item. If the format of the AV Contractor's block diagram is much more complex than the block diagram in the construction drawings a "simplified block diagram" shall also be provided. The simplified block diagram will allow easy operation of the system.
    b. "Equipment layout": show major equipment items on the architectural floor plan backgrounds.
    c. "Conduit/wire layout": show A/V conduit and wire fill on the architectural floor plan backgrounds. Also, show AC power that is specifically provided, by the electrical contractor, for A/V use.
    d. "Detail drawings": show mechanical and electrical detail drawings as required. Include detail drawings for:
        1) Equipment rack layouts.
        2) Patch bay layouts.
        3) Custom fabricated panel and plate layouts.
        4) Custom control and touch panel layouts.
        5) Speaker rigging (with aim angles and coverage angle calculations).
        6) Video projector mounting.
        7) Room sections.
        8) Room elevations.
        9) Custom devices.
        10) Custom circuits.
3. Provide a disc and printed paper copy of all application software files for software driven equipment (control system touch panels, digital audio processors, etc.).

E. "As built" submittal:

1. After the completion of the installation and performance testing, but before training and substantial completion is granted, submit the "As built submittal".
2. Provide all drawings as detailed above in the shop drawing section. Include any minor revisions and additional details necessary due to field conditions.

3. Provide a laminated ½ size copy of all system block diagram drawings. Wall mount these drawings next to the main equipment rack.
4. Provide two (2) copies of a system "Owner's Manual". Include the following items:
    a. A folded copy of the system "as built" drawings.
    b. A written system description for each sub-system.
    c. A written set of step-by-step operation instructions for each sub-system.
    d. A copy of the manufacturer's owner's manual for each piece of equipment in the system.
    e. Conformance reports for as applicable Standards followed in this project.
    f. A written document reporting of the settings for all adjustable system controls.
    g. A written document reporting the test results for all system performance tests as detailed herein.
    h. A disc copy of all software for software driven equipment used on the project. This includes all A/V control systems, products that require a dedicated computer to operate and products that require a computer to set up. The AV Contractor is to purchase a software license, as required, in the name of the owner.
    i. A disc and printed paper copy of any application software developed specifically for the project. Include the "source code" for such software. The owner shall maintain the ownership rights to the said software and it may be used exclusively for this project and may not be copied or duplicated for any other project.
    j. A written document reporting the warranty start and completion dates, the AV Contractor's service contact and their phone and pager numbers.

1.10 WARRANTY

A. The AV Contractor shall warrant the system for a period of one (1) year after the date of substantial completion. Defects in materials or labor, occurring within the one (1) year warranty period, shall be rectified by repair or replacement.

B. Within the warranty period provide answers to requests for information within a 24-hour period and repair or replace any defective item within a 48 hour period without additional charge. Include both parts and labor.

C. If a piece of defective equipment cannot be repaired or replaced within the required time period, provide a piece of loaner equipment without additional charge.

D. During the warranty period, the AV Contractor shall process all manufacturer's warranty claims in the name of the owner. Include parts labor and any required shipping costs.

E. This warranty shall not void specific manufacturer's warranties for a greater period of time. Nor shall it void any legal rights granted to the owner.

F. This warranty shall exclude cases of obvious abuse or misuse.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Equipment, as listed herein by manufacturer name and model number, will serve as a basis for quality and features of each component part of the system. See the "substitutions" section of the substitution requirements.

B. All equipment used on the project shall be in unused, unscratched, new condition. Demo or "B stock" equipment shall not be acceptable.

2.2 GENERAL

A. The AV Contractor shall provide the equipment items as listed in the following equipment list. Equipment items are divided into subsystems for clarity.

B. Quantities: the listed quantities are for reference only. The AV Contractor is responsible to provide quantities of equipment as required to provide a complete and working system. If there is a conflict between quantities in the specification, the AV drawings, the architectural drawings and electrical drawings, the more stringent of the quantity requirements shall apply.

C. Accessories: the listed accessory items are for reference only. The AV Contractor is responsible to provide equipment accessory items, such as rack mounts, brackets, hardware, level matching amplifiers and transformers, as required to provide a complete and working system.

2.3 EQUIPMENT LIST

A. Stadium Sound System

Qty.	Manufacturer	Model	Description
SOUND SYSTEM WITH EXISTING SCOREBOARD SPEAKERS			
2	Community	R2-52N(MAX) - Existing	Existing Scoreboard Speakers - Outdoor - Large 3-Way - Full Range, Long Throw
1	Community	ALC-1604D	4 -Channel 1600 Watt Amp with Speaker Processing & Auto Standby
1	Community	I-215LVSN - Existing	Existing Scoreboard Subwoofer
1	Crown	XTi 6002 - Existing	Existing Amplifier for Scoreboard Subwoofer
1	Biamp	TesiraForte AI	DSP with 12 analog inputs, 8 analog outputs
1	Biamp	Tesira TEC-X	Control Panel for Preset Selection
1	Ashley	Ashley Mixer - Existing	Existing Rack Mount Mixer
1	Denon	DN-200BR	Bluetooth Input Unit
PRESSBOX SPEAKERS			
3	Community	R.5-96MAX	Press Box Speakers - Outdoor - 2 Way - Full Range
3	Custom	Unistrut Speaker Mount	Press Box Speakers - 42" High Unistrut Double "L" Bracket Speaker Mount for Top of Press Box Roof
3	Custom	Roof Bolts and Support to Fence	Press Box Speakers - Roof Bolts and Support to Fence as per Drawings
1	Community	ALC-1604D	4 -Channel 1200 Watt Amp with Speaker Processing & Auto Standby
WIRELESS MICROPHONES			
1	Shure	SLXD24D/SM58	Wireless Mic - Hand-Held 2 Mic System
1	Shure	SLXD24/SM58	Wireless Mic - Hand-Held 1 Mic System
1	Shure	UA844+SWB	Wireless Mic - Active Antenna Splitter 1x4
2	Shure	UA874	Wireless Mic - Directional Antenna
8	Contractor Selected	Wireless Mic Batteries	Wireless Mic - Batteries - Alkaline - 2 Sets
MICROPHONES AND PORTABLE EQPT.			
1	Shure	SM58-LC	Wired Vocal Mic
1	Proco	SAS3	Sports Announcer Mic Switch

1	Atlas-Sound	DS7E	Mic Stand - Short
2	Pro Co	EXM-25	XLR Mic Cable - 25'
1	Pro Co	EXM-3	XLR Mic Cable - 3' for Sports Announcer Mic
ASSISTIVE LISTENING SYSTEM			
1	Listen	LT-800-072-01	Assistive Listening System - (ALS) Transmitter72 MHz
1	Listen	LA-122	Assistive Listening System - Antenna
1	Listen	LA-326	Assistive Listening System - Rack Mount
8	Listen	LR-4200-072	Assistive Listening System - Receiver
8	Listen	LA-401	Assistive Listening System - Earphone
2	Listen	LA-430	Assistive Listening System - Neck Loop
1	Listen	LA-423	Assistive Listening System - USB Charger
1	Listen	LA-304	Assistive Listening System - Sign
EQUIPMENT RACK, STORAGE CABINET AND ACCESSORIES			
1	TBD	Equipment Rack - Existing	Existing IT Equipment Rack to be Reconfigured and Reused
1	Middle Atlantic	Contractor Selected	Equipment Rack - Closure Panels, and other Accessories as Required
1	Middle Atlantic	D2	Rack Storage Drawer
1	Middle Atlantic	AC Switch/Outlet Strip	AC Switch/Outlet Strip
MISC. PARTS & WIRE			
1	NetGear, Cisco or Equal	TBD (Contractor Selected)	Network Switch with POE, Heavy Duty Jacks and Power Supply - Sized w/ 20% Spare Ports
1	Radio Design Labs	ST-DA3	Line Level Distribution Amplifier - 1x3
1	Radio Design Labs	PS-24AS	Line Level Distribution Amplifier - Power Supply
1	Custom	Record Sub-Plate	Record Sub-Plate with XLR(M) Connectors and Labels
1	Furman	Remote Power Switch - Existing	Existing Remote Power Switch
1	Belden	9451/9451P	Mic/Line Wire (Plenum if Required)
1	Belden	2412F/2413F	Network Wire - CAT6, F/UTP (Plenum if Required)
1	Belden	5000UE/6000UE	Speaker Wire - Large/Program - 12/2 (Plenum if Required)
1	Custom	Misc. Wire & Patch Cables	Misc. Wire & Patch Cables
1	Custom	Misc. Parts	Misc. Parts

PART 3 – EXECUTION

3.1 PREPARATION

A. Before starting the field installation verify the proper installation of related work by other trades including but not limited to, the Electrical Contractor, the General Contractor, the Millwork Contractor and the owner.

B. Provide site visits as necessary to confirm the related work, by other trades, is progressing on schedule and there will be no delays jeopardizing the on-time completion of the A/V system.

C. Verify measurements and dimensions at the project site. Confirm that devices installed by other contractors are installed at the locations shown, are in correct alignment and elevation, plumb, level and straight.

D. Verify size and orientation of all electrical boxes. Pay particular attention to the horizontal or vertical orientation of all electrical boxes installed by the Electrical Contractor. If it is determined a device has been installed incorrectly, revise the AV system device to comply with the field orientation. Provide all plate engraving so text is horizontal. Also, revise the system as built documentation to reflect the modification.

E. If during the initial site visits or the progress of the project, it becomes apparent that other trades are installing related the work incorrectly or will delay the completion of the AV system, the owner and construction manager shall be notified in writing.

3.2 INSTALLATION

A. General

1. Work is to be performed in a neat and professional manner. Only the highest quality craftsmanship will be allowed.
2. Install devices at locations shown, in correct alignment and elevation, plumb level and straight.
3. Finishes:
    a. For products that are offered in several optional finishes, provide finish option as directed by the architect.

B. Equipment Racks

1. Shop construct all equipment racks before transportation to and installation at the project site. Mount all equipment in the rack enclosure and fully wire and

test the system before delivery. Burn the rack in for a period of at least 24 hours before the testing procedure.

2. Rack accessories:
   a. Provide blank or vent panels to fill unused spaces, as required and painted to match rack enclosure.
   b. Provide isolated ground type AC power strips for each rack enclosure, as required to provide a power outlet for each piece of rack mounted equipment and 2 spare outlets.
   c. Provide manufacture standard copper grounding buss bar for each rack enclosure.
   d. Provide rear rails for mounted equipment greater than 15 inches deep.
   e. Provide ventilation or fans if needed to maintain a maximum rack temperature of 90 degrees Fahrenheit.
   f. Key door locks for all AV equipment racks with the same manufacture standard key.
   g. Provide lights mounted in the top of each rack if needed to light the interior of the rack. Lights to be individually switched with a pull string.
   h. Provide security covers for all pieces of rack-mounted electronic equipment that have no user controls (equalizers, crossovers, ADA's, VDA's etc.). Provide security covers made by the manufacturer of the individual piece of equipment or the manufacturer of the equipment rack.
3. Rack configuration:
   a. Looking at the rear of the equipment rack, install AC power and grounding bus bar on the left side and audio and video cabling on the right side.
   b. Locate operator adjustable equipment at a convenient height for operation.

C. Wiring

1. General:
   a. Provide undamaged splice free wire runs from cable start to ending termination points.
   b. Prevent electromagnetic and electrostatic hum and buzz. For line level audio wires, do not connect shield at the output of a source device. Do not cut off unused shield. Shields that are not connected shall be folded back and covered with heat-shrink tubing.
   c. Isolate wires of different signal levels to reduce cross talk and oscillation. Separate wire bundles within or outside of equipment racks. Do not pull cables of more than 1 – type in a single conduit. (Audio or Video line level or Control wire may share a single conduit with Mic

level wire if the run is less than 50 feet in length.) Keep the following wire types separated:

1) AC power
2) Speaker level
3) Audio or Video line level and Control
4) Microphone level

d. Run all cable bundles within or outside of an equipment rack in a neat fashion. Make all runs straight and plumb. Do not make diagonal runs. Use professional support methods to attach bundles to structure. In the case of a bundle attached to a ceiling slab, provide an independent set of "D" rings with 5 foot maximum spacing.

e. Confirm local code plenum cable requirements and provide correctly rated components.

f. Crimp spade-lugs with ratchet type tool. Make connections on non-screw type connectors with rosin-core solder.

g. Cover edges of wire pass-through holes in equipment racks and boxes with nylon bushings or grommets.

2. Wiring within equipment racks:

a. Bundle cables and wire within racks. Neatly tie bundles with plastic cable ties with a maximum of 4" spacing. Electrical tape is not acceptable. Cut wires in cable lengths as to minimize excess cable but still allow a service loop for service and testing. Provide horizontal support if cable sags.

b. Bundle excess AC power cable from rack mounted equipment with plastic cable ties on the left side (facing rear) of the rack.

3. AC Power and Ground wiring

a. Coordinate connection of AC power and ground wires to equipment racks with the Electrical Contractor.

b. Provide a direct conduit connection for AC power wires to the equipment racks. Portable AC power plugs, which may be detached, are unacceptable.

c. Do not electrically bond conduit for low voltage wiring entering the equipment rack to the rack. Provide nylon or PVC fittings as required.

d. Provide a copper ground buss bar, running from top to the bottom of each equipment rack. Isolate the buss bar from the equipment rack. Ground equipment chassis which do not having a grounded (three wire) power cord to the buss bar using a 12 AWG green wire. Connect the green ground wire from each AC power strip to the buss bar using a 12 AWG green wire.

e. Do not jeopardize any safety requirements of local or national codes. These requirements do not supersede any code requirements.

D. Software

1. Provide custom application software for software driven equipment (AV control systems, touch panels, digital audio processors, etc.).

2 For all touch panels and graphic display panels, provide icon based button layouts. For control system touch panels, provide sub-menu driven layouts in order to reduce the quantity of buttons simultaneously on any screen.

E. Labeling

1. Labels must be made in a neat and professional manor. Use text size and font type so all labels are readable in dim lighting. Indicate labeling method, text size and font type on the shop drawings.
2. Wire and cable labeling:
   a. All wire shall be logically and permanently labeled at each termination point. All cable labels shall bear the numeric characters of the circuit shown on the approved shop drawings.
   b. All wires shall be labeled with an approved identification marker, such as Brady type labels (with typed or printed text) or clear heat shrink sleeves over typed cloth labels. Portable cables shall be labeled with color coded heat shrink sleeves with heat stamped characters. Portable cables shall be color coded so each cable length shall have a different heat shrink sleeve color. The venue name and cable length shall be labeled on the colored sleeve. Cloth or vinyl tape type markers are not acceptable.
   c. Spare wire shall be marked "spare" at both ends and numbered consecutively.
3. Equipment labeling:
   a. Provide labels at the front and rear of all rack-mounted equipment. Mount labels in a neat, plumb and permanent fashion. The labels are to include the device description and the designation of where the piece of equipment is used in the system (Left Cluster – High Frequency Amplifier, Stage Monitor #1 - Equalizer, Etc.). P-Touch labels with white text on black tape background are acceptable. Standard white P- Touch tape is unacceptable unless it is labeling a white device.
   b. Provide labels on major equipment controls such as volume controls or mixer input controls. P-Touch labels with white text on black tape background are acceptable. Standard white P- Touch tape is unacceptable unless it is labeling a white device.
   c. The above labeling requirements are for areas that are not seen by audience members. Use engraved labeling for any wall plate, panel or control that is in view of audience members. Engraved directly on the

plate or panel. Where this is not possible, provide plastic engraved lamacoid plate with labeling.

4. Wall plate and rack panel labeling:
    a. All wall plates and rack panels shall be engraved and filled. Indicate the name and circuit numbers for each mounted control and connector.
5. Patchbay labeling:
    a. All patchbay connectors shall be labeled. Indicate the name and circuit numbers for each patchbay connectors.
    b. Provide approved professional labels on each patchbay. Dymo-Type or handwritten labels are unacceptable.

F. Suspension

1. General:
    a. Video projectors, monitors, program speakers, etc. shall be suspended in a safe and secure manner. All rigging hardware shall be “rated” and used in a manner as for which it was designed.
    b. Rigging is to be performed only by field installers who are experienced in rigging systems.
    c. Use only professional rigging components as designed by the manufacturer of the device to be mounted or other professional bracket, mount or rigging hardware manufacturer.
    d. All welding shall be performed by a welder, who is licensed in the state where the work is being done.
    e. Do not support loudspeaker from a particle or pressboard wood without internal bracing. Provide internal bracing on loudspeakers that do not have manufacturer installed internal bracing.
    f. Do not load an eye bolt or eye nut at an angle greater than 45 degrees.
    g. Provide a safety factor of at least 5 for all rigging systems.
    h. Paint all loudspeaker rigging equipment to match loudspeaker components or paint with a paint type and color as requested by the architect and approved by the owner.
    i. Mount all loudspeaker components so that horns have greater dispersion horizontally and smaller dispersion vertically, unless specifically called out in the project documentation. Pay particular attention to loudspeaker mounted with a horizontal orientation. Rotate horns within the loudspeaker cabinets where appropriate.
2. Loudspeaker cluster suspension
    a. Loudspeakers shall be suspended in a safe and secure manner.
    b. The loudspeaker clusters rigging system, shall be reviewed and certified by a registered structural engineer, if required by owner. The AV Contractors shop drawings shall bear the stamp of the structural engineer. The structural engineer shall also inspect the rigging system,

once installed, to verify compliance with the AV Contractor's stamped shop drawings.

c. All loudspeakers aiming angles shall be adjustable by 15 degrees horizontally or vertically.

d. Do not shadow the front of a loudspeaker with any structural member or material of more than ½ inch in diameter.

G. Cleaning

1. The AV Contractor shall clean all racks, back boxes and panels so they are free of dust, dirt and debris prior to the completion of the project. Cover all back boxes and equipment racks prior to the completion of the project.
2. If during the progress of the project, if excessive construction dust is generated, the AV equipment shall be covered with plastic and taped down until such a time as all dust is cleaned.
3. Provide daily job site clean-up, around all areas of AV work. Include carpet vacuuming and furniture dusting in the daily clean-up. This requirement does not supersede any cleaning requirements of the general conditions (Division 1).

3.3 STANDARDS CONFORMANCE

A. Required Standards

1. General
   a. Use the following industry Standards for this project. **Provide a completed conformance form** for each applicable system showing testing and pass or fail situation. A pass is not required, but the proper execution of the conformance form is required.
   b. ANSI/AVIXA 10:2013, AV Systems Performance Verification

3.4 TESTING AND ADJUSTMENT

A. Testing

1. General
   a. After the final termination of all devices, check the entire system for proper functionality. Verify that the signal flow is in accordance with the system drawings and all devices are properly labeled. Confirm the proper installation and operation of all devices, including but not limited to, products, connectors, wire, tie lines, accessories, mounts and controls.
   b. Correct or re-adjust the system if any the following tests are failed.
   c. Document the test results for the following tests in the owner's manual.

d. Provide the listed testing as appropriate for this specific project. If there are some things that are not applicable for the project, those tests should be omitted.

2. Audio system testing

a. Speech playback verification:
Plug in a vocal microphone into all microphone receptacles throughout the facility. Speak into the microphone to confirm the proper operation of each jack and the overall quality of the system.

b. Program (music) playback verification:
Play music on CD through the system. Confirm the overall quality of the system.

c. Loudspeaker polarity:
Use a polarity tester to check the correct polarity of all loudspeakers. Apply a positive pulse to a microphone input receptacle with a click generator. Measure positive polarity at all loudspeakers in the system with a polarity sensor.

d. Loudspeaker load impedance:
Measure the impedance of all loudspeaker loads in the system. Use a 1 KHz impedance meter to measure all full range speakers. Confirm that all loudspeaker loads measure within 20% of their calculated impedance readings.

e. Loudspeaker rattle:
Once a loudspeaker cluster is installed and before scaffolding or lifts are removed, perform a rattle test. Feed the output of a sine wave oscillator to an amplifier and then to each speaker system. Turn the amplifier up so the speaker produces 85 dB SPL in the room and sweep the sine wave from 20 Hz to 20 KHz, but not below the operating range of the speaker. Confirm that there are no rattles. Report any rattles in the building structure to the owner and construction manager.

f. Distortion:
Check all audio systems to assure that they are free of distortion. Use a distortion meter if any audible distortion is noticed in the system. Confirm the entire system distortion falls below 1.5%.

g. Noise:
Check all audio systems to assure that they are free of noise. Use a dB meter if any audible noise is noticed in the system. Confirm the entire system signal to noise ratio falls below 75 dB.

h. Oscillation, RF pickup and buzz and hum:
Check all audio systems to assure that they are free of oscillation, stray RF pickup and buzz and hum due to ground loops. Use an oscilloscope to detect unwanted signals at speaker termination points in equipment racks.

3. Video system testing

a. Viewability:
Play an NTSC video test tape through the video system. Confirm high quality viewability of the NTSC video on all system monitors and video projectors. If ghosting is seen confirm that all video lines are properly terminated, at the end of the line, with a 75 Ohm resister. If the video quality is poor use a waveform monitor and a vectorscope to confirm that the video signal levels falls within industry standards.

b. Bandwidth:
Play an RGBHV signal generator test signal and computer output through the video system. Confirm high quality viewability of RGBHV and VGA video on all system multi-scan monitors and video projectors. If the video quality is poor or the image is fuzzy, use an RF spectrum analyzer to confirm the entire system bandwidth falls above 150 MHz.

c. RF field strength:
Measure each RF outlet with a field strength meter. Confirm that the output level is between +6 dBm to +15 dBm at 450 MHz, or at the highest operating frequency.

d. Oscillation, RF pickup and hum:
Check all video systems to assure that they are free of oscillation, stray RF pickup and hum due to ground loops. Use an oscilloscope to detect unwanted signals at video termination points.

4. AC power testing

a. Although it is the responsibility of the Electrical Contractor, the AV Contractor shall confirm the proper condition of the AC power system prior to installation of A/V equipment.

b. Test the proper connection of AC power feed to each A/V rack and device. Use a voltage meter to confirm 120 volts are present between the hot and neutral conductor and 0 volts are present between the neutral and ground conductor. Confirm that each circuit is properly fed by individually switching off each breaker.

c. Except at a single bonding point, the audio ground shall be totally isolated from all other electrical grounds. Use a Ohm meter to measure a DC resistance of less than .2 Ohms between the two. Temporarily disconnect the connection between the audio ground network and the building ground. No continuity between the audio ground and the building electrical ground shall exist. Use an Ohm meter to measure a DC resistance of greater than 1,000 Ohms between the two.

B. Adjustment:

1. General:

   a. Adjust each piece of equipment as per the manufacturer's instructions.
   b. Document the final settings of each major piece of equipment in the system owner's manual.
   c. Mark final settings on each control of each piece of equipment with a pencil. Provide this marking on each knob for each piece of equipment (mixer, equalizer, cross-over, etc.) regardless of whether a security cover is provided for that piece of equipment.

2. Audio Adjustment:

   a. Signal to Noise Ratio:
      Adjust the gain on each piece of electronic equipment for the lowest signal to noise ratio. Adjust the gain on each piece of "in line" signal processing equipment for unity gain.
   c. Equalization:
      Adjust system equalizers for room tuning and then feedback control. For room tuning, use a 1/3 octave spectrum analyzer to set the equalizers for the following curve: 100 Hz to 4 KHz – Flat (+/- 2db), above 4 KHz – 2 dB per octave roll off, below 100 Hz – 0 to 6 dB per octave roll off. Use an average of three random microphone positions for room tuning measurements. Do not boost any frequencies beyond the normal operating range of the speaker. After room tuning is complete, set up system microphones and adjust the system equalizers for feedback control. Turn the system level up until feedback is heard then cut the frequency that is feeding back with as tight a notch as possible. Make 2 to 6 cuts, as required.
   d. Limiting:
      Adjust system limiters so the level is limited at a point ½ dB below the point of clipping for the associated amplifier. Apply a dummy load, equal to the impedance and power handling of the associated loudspeaker, to the amplifier before making the measurement and adjustment. Apply a signal, in the frequency range intended for the associated loudspeaker, to the amplifier before making the measurement and adjustment.
   e. Signal Delay:
      Adjust system signal delays for each set of delayed speakers. Use a setting of 1 millisecond per each foot of traveled distance. Audibly test the delay with clicks and program material in the zone where both the main and delayed speakers can be heard. Confirm the sound is psycho-

acoustically steered toward the main speakers. Make any adjustment required.

f. Active Crossovers:
Adjust system crossovers as required for speaker system design. Make all system crossover and amplifier level adjustments before adjusting the system equalizers.

4. Video Adjustment:

a. Picture Control:
Adjust the brightness, contrast, color & tint on each piece of video display equipment with such controls.

b. System Timing:
Adjust the system timing to make up for unequal cable lengths on each piece of video equipment with such controls.

c. Video Projector and Display Alignment/Convergence:
Align and converge the system video projectors. Adjust the projector zoom, focus and lens shift controls. Confirm that the projectors are mounted at a position as to fill the entire projection screen without borders, overlap or keystoning. If the entire projection screen is not correctly filled, move the projector as required.

C. Test Equipment: Make the following test equipment available during AV Contractor's testing and AV Consultant's final review. Provide current models from professional test equipment manufacturers. Homemade test equipment will not be acceptable.

1. General audio and video test equipment:
   a. Volt/ohm meter
   b. AC voltage/dB meter
   c. Oscilloscope – dual trace 100 MHz
   d. Ladders, scaffolding or lifts necessary to provide access to all equipment
   e. Two (2) – two way radios Cell phones
2. Audio test equipment:
   a. Time windowed FFT analyzer (Smaart or equal)
   b. Audio oscillator – 20Hz – 20KHz
   c. Test microphone with cable
   d. CD player with test CD's
   e. SPL meter – 40-120 dB SPL range
   f. Pink noise generator
   g. Dummy load – 100 watt 8/4 ohm
   h. Polarity tester
   i. Impedance meter
   j. Distortion meter (if required for type of system)

3. Video Test equipment:
    a. Video (NTSC) signal generator HDMI or SDI?
    b. RGBHV signal generator
    c. Video monitor – NTSC and RF inputs
    d. Portable laptop computer – VGA, SVGA and XGA outputs
    e. RF field strength meter – 750 MHz
    f. RF/video spectrum analyzer (if required for type of system)
    g. Waveform monitor (if required for type of system)
    h. Vectorscope (if required for type of system)

3.5 REVIEW

A. AV Consultant inspection: the AV Consultant may review the AV Contractor's work during the progress of the project.

1. The AV Consultant reserves the right to inspect the shop construction, in the AV Contractor's facility, at any time during the progress of the project.
2. The AV Consultant reserves the right to inspect the AV Contractor's field work, at the project site, at any time during the progress of the project.

B. AV Consultant's final review:

1. At a time after the AV Contractor has performed the initial testing, adjustment and tuning and completed the ANSI/AVIXA 10:2013, AV Systems Performance Verification checklist the AV Contractor shall assist the AV Consultant with a final review of the system. Notify the AV Consultant ten (10) days in advance of the requested date for the review.
2. The AV Consultant's review shall include operation of all sub-systems, repeating of any of the testing procedures listed herein and re-adjusting any component in the system.
3. The AV Contractor shall provide at least two engineers who are familiar with installation. The engineers shall be available for the entire review period (day and night). They shall make any required adjustments, modification and repairs to the system during the review period. The AV Consultant's final review process is estimated to take up to 8 hours.

C. AV Consultant observations: the AV Consultant may provide an observation report regarding the AV Contractor's work or site conditions, at any point during the progress of the project.

1. The AV Consultant shall provide observation reports at various times in the progress of the project. These reports may include a "punch list". The AV Contractor shall make any modifications (after owner approval) to the

installation as requested by the AV Consultant in order to bring the project into compliance with the project documents. The AV Contractor shall coordinate with other trades.

2. Corrections or comments made in the observation reports during this review do not relieve AV Contractor from compliance with requirements of the drawings and specifications. This check is only for review of general conformance with the design concept of the project and general compliance with the information given in the contract documents. The AV Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

3.6 INSTRUCTION

A. Provide a 2 hour instruction sessions to owner designated personnel on the operation of the system. The instruction sessions shall be scheduled as to agree with the owner's schedule and shall be presented by the AV Contractor's AV Project Manager.

B. Videotape the instruction session. Use a standard consumer quality camcorder. Provide a camera operator during the instruction session and turn over the video file to the owner at the end of the sessions. Only the system overview and demonstration of step-by-step operation need to be videotaped.

C. The system operation manuals shall be complete at the time of this instruction and it shall be used as the outline for such instruction.

D. The AV Contractor's AV Project Manager or engineer should be present at the first formal use of the system.

END OF SECTION