

# HARVARD UNIVERSITY



## Information Technology

Harvard University Audiovisual Systems Standards

Master Format Division 274100

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Version 2.1

DIVISION 274100  
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SECTION 274100 - AUDIOVISUAL SYSTEMS

**DIRECTION FOR SPECIFYER – TEXT OPTIONS/DECISIONS ARE HIGHLIGHTED IN RED FOR REVIEWER INPUT. MULTIPLE TEXT OPTIONS MAY BE PROVIDED AND MUST BE REVIEWED TO SELECT THE NECESSARY PORTIONS.**

**TEXT IN BLUE REQUIRES HARVARD REVIEW AND UPDATE PRIOR TO FIRST PROJECT USE**

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Division 1 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by the Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to their work.
- C. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of

their work as shown or referenced in the other trade documents. All work shown or referenced in the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.

- D. Division 07 – Through-penetration Firestop Systems
  
- E. Division 26 – Electrical, including:
  - 1. Common Work Results for Electrical
  - 2. Low Voltage Electrical Power Conductors and Cables
  - 3. Grounding and Bonding for Electrical Systems
  - 4. Hangers and Supports for Electrical Systems
  - 5. Box and Covers for Electrical Systems
  - 6. Raceways and Boxes for Electrical Systems
  - 7. Identification for Electrical Systems
  
- F. Division 27 – Communications, including:
  - 1. Section 27 00 00 Communications General Conditions
  - 2. Section 27 02 00 Telecommunications Equipment Spaces
  - 3. Section 27 05 26 Grounding and Bonding for Communications Systems
  - 4. Section 27 05 28 Pathways for Communications Systems
  - 5. Section 27 05 43 Underground Ducts & Raceways for Outside Plant – Manhole & Conduit Systems
  - 6. Section 27 05 53 Identification for Communications Systems
  - 7. Section 27 08 00 Commissioning for Communications
  - 8. Section 27 11 16 Communication Cabinets, Racks, Frames and Enclosures
  - 9. Section 27 11 19 Communication Termination Blocks and Patch Panels
  - 10. Section 27 11 23 Communication Cable Management and Ladder Rack
  - 11. Section 27 11 26 Communications Rack Mounted Power Protectors and Power Strips
  - 12. Section 27 13 13 Communication Copper Backbone Cabling
  - 13. Section 27 13 23 Communication Fiber Backbone Cabling

14. Section 27 15 00 53 Antennas Communications Horizontal Cabling
15. Section 27 15 13 Communication Copper Horizontal Cabling
16. Section 27 15 43 Communications Faceplates and Connectors
17. Section 27 16 19 Communications Patch Cords, Station Cords and Cross Connect Wires
18. Section 27 21 33 Data Communications Wired and Wireless Data Network Connectivity
19. Section 27 24 00 Data Communications Peripheral Data Equipment
20. Section 27 25 00 Data Communications Software
21. Section 27 50 00 Distributed Communications and Monitoring Systems

## 1.2 SUMMARY

- A. These specifications and accompanying drawings are intended to cover the furnishing of all labor, material, and equipment and superintendence of the Audiovisual (AV) Systems.
- B. It is the intent and purpose of this specification and accompanying drawings to cover and include each item, all materials, machinery, apparatus, and labor necessary to properly install, equip, adjust, and put into perfect operation the respective portions of the installations specified and to so interconnect the various items or sections of the work as to form a complete and properly operating whole.
- C. Any equipment, apparatus, machinery, material, and small items not mentioned in detail, and labor not hereinafter specifically mentioned, which may be found necessary to complete or perfect any portion of installation in a substantial manner, and in compliance with the requirements stated, implied or intended in these specifications shall be furnished without extra cost. This shall include all materials, devices, or methods peculiar to the machinery, equipment, apparatus, or systems furnished and installed as part of the AV Systems work.
- D. Drawings and this Section outline the performance requirements of the AV system. The Drawings are diagrammatic in nature and are meant to convey the performance intent of the system. Contractor shall develop a solution for each portion of the AV system and submit detailed shop drawings and product datasheets to indicate the proposed approach.
- E. The following major system components may be specified under this section:
  1. Signal Switching Transport
  2. Controllers and Control Interfaces
  3. IP encoders, decoders, PoE power supplies, and proprietary AV network hardware to support AV systems

- a. Proprietary network hardware includes any AV device which has a network interface, is specific to the Audiovisual system being deployed and must be purchased through traditional AV distribution or suppliers.
- b. All AV network switches, and other network controllers are to be Owner furnished, Contractor installed. Refer to Network coordination requirements below.

4. Signal Processing Systems
5. Signal Recording and Storage
6. Cabling and Connectors
7. Racks and Connection Panels
8. Conference & Collaboration Displays
9. Large Format Video Walls (LED & Flat Panel)
10. Projectors and Projection Screens
11. Collaboration Systems and Appliances
12. Collaboration and Event Cameras
13. Wireless Presentation System
14. Wired and Wireless Microphone System
15. Assistive Listening & Visual Assistance systems
16. Loudspeakers
17. Broadcast Capture and Transmission Systems

### 1.3 RELATED DOCUMENTS

- A. Division 1 Specifications, General and Supplemental Requirements apply to this section with additions and modifications specified herein.
- B. Instructions to Bidders, Bidding Forms, Forms of Agreement between Owner and Contractor, Contract Award Date, Starting and Completion Dates, Conditions of the Contract, Insurance Requirements, and other Owner Requirements will be furnished separately by the Owner. These documents, as well as any addenda issued, shall form a part of these Specifications, and this Contractor shall consult them in detail for instructions pertaining to his work.
- C. Each trade contractor shall receive all drawings and specification sections issued as part of the overall bid package. All contractors are to receive, review, and coordinate all of their work as shown or referenced in the other trade documents. All work shown or referenced in the other trade documents shall be included as part of the overall project scope for that particular discipline and trade.
- D. All other Division 27 Specifications.

### 1.4 AV SYSTEM INTEGRATORS

- A. The following integrators are approved to work on AV projects at Harvard University:
  1. **DIRECTION FOR SPECIFYER – REVIEW PREFERED PARTNERS WITH UNIVERSITY STAKEHOLDERS TO CONFIRM EXISTING PARTNER LIST.**
- B. The following are contacts for audiovisual related projects at Harvard University:

1. **DIRECTION FOR SPECIFYER – CONFIRM PROJECT CONTACTS, IF REQUIRED, WITH UNIVERSITY STAKEHOLDERS.**

1.5 HARVARD UNIVERSITY INFORMATION TECHNOLOGY “RULES OF THE ROAD”

- A. Any use of network enabled AV systems/equipment or integration with other Operational Technology Systems (Division 25, 27 and 28) shall follow guidelines specified HUIT’s “Rules of the Road for Integrators and Installers of Operational Technology (OT), Physical Security (PSS) and Audio-Visual (AV) Systems.”
  1. For any projects utilizing network enabled audiovisual equipment, or where network/internet services are required for the installation or operation of the audiovisual system, Contractor must request a copy of said document from HUIT, read and understand its requirements. Any questions shall be submitted in writing to HUIT prior to commencement of any work via an approved communication channel.

1.6 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

**DIRECTION FOR SPECIFYER – SELECT EITHER “NO PRODUCTS” OR THE FULL SECTION TEXT AND MODIFY AS NEEDED.**

- A. Refer to the Audiovisual scope of responsibility schedule included with the TA (Audiovisual) drawing set for a responsibility matrix assigning products furnished but not installed under this section. **NOTE TO SPECIFYER – INCLUDE AN ASSIGNMENT OF RESPONSIBILITIES LIST OF COMMON AV EQUIPMENT AND SUPPORT SYSTEMS WITH THE TA (AUDIOVISUAL) DRAWING PACKAGE SHEET NOTES. A SAMPLE CAN BE PROVIDED FOR REVIEW.**
- B. **OPTION:** No products have been identified to be furnished but not installed.
- C. **OPTION (MODIFY THE FOLLOWING ITEMS BASED ON THE RESPONSIBILITIES LIST):**
- D. Products furnished but not installed under this section include:
  1. Display in-wall boxes for power, data and audiovisual cable pathways behind displays.
    - a. Provide trim rings, specialty hardware and specialty power receptacles as required.
  2. Display mounts
    - a. Includes fixed, articulating, and custom display mounts.
    - b. Includes mount, mounting accessories and custom hanging hardware.

- c. Contractor shall confirm all mounting locations meet Americans with Disabilities Act (ADA) requirements either based on mounting depth, recess mounting, furniture below or other method prior to ordering.
3. Projection screens
- a. Includes motorized feed, manual feed and fixed frame projection screens.
  - b. Includes screen case, screen roller, screen material, low voltage interface, wall switch, and any required custom hanging hardware.
  - c. Contractor shall confirm screen location, projection system optics, screen backing material, case color and closure, available power, adjacent lighting and mechanical system conflicts/impacts and mounting centerline prior to ordering.
4. Projector lifts
- a. Includes projector lift, closure panel, low voltage interface, plenum shroud, and any required custom hanging hardware.
  - b. Contractor shall confirm screen location, projection system optics, stored/operating/service heights, ceiling closure panel in-fill finish material, lift and trim color, available power, adjacent lighting and mechanical system conflicts/impacts and mounting centerline prior to ordering.
5. Loudspeaker back-cans/enclosure
- a. Includes recessed ceiling plenum back-can/enclosure.
  - b. Contractor shall confirm speaker model, speaker tap, ceiling clearances and alignment of speakers with architectural finishes, lighting fixtures and mechanical systems prior to ordering.
6. Loudspeaker rigging points
- a. Contractor shall furnish all rated hardware and safety systems required to meet the manufacturer's required safety factor for overhead rigging and shall coordinate final rigging hardware requirements and locations with provided support steel.
  - b. Contractor shall coordinate the location of additional supplemental steel with related contractors prior to ordering rigging hardware and after approval of shop drawings indicating rigging system provided, aiming angles and coverage of the loudspeaker systems and method for servicing the rigging hardware.

1.7 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

**DIRECTION FOR SPECIFYER – SELECT EITHER “NO PRODUCTS” OR THE FULL SECTION TEXT AND MODIFY AS NEEDED.**

- A. **OPTION:** No products have been identified to be installed but not furnished.

- B. **OPTION (ALL REMAINING TEXT IN THIS SECTION):**
- C. Products installed but not furnished include all Owner Furnished Equipment (OFE) items which shall be configured and installed as part of a complete and working system as identified in the section summary.
- a. **OPTION:** Warrantee - For all Owner furnished, Contractor installed equipment, Contractor shall warrantee all installation, setup and configuration labor to match the labor warrantee requirements required in this specification.
- D. Refer to the 274100 Appendix A – Audiovisual Systems Equipment list for equipment identified as OFE.
- E. All Owner Furnished Equipment, with the exception of Room PCs imaged with Owner’s standard user desktop profile, shall be maintained as part of the labor portion of the system warrantee.
1. Contractor shall assist in initial troubleshooting of Owner Furnished Equipment and if necessary, manage the equipment replacement process within the existing manufacturer warrantee period.
- F. New OFE Items
1. Contractor shall take receipt of any new equipment procured by the Owner for this project, including Room PCs, Mini PCs, CATV Tuners, etc. as indicated in the Audiovisual Systems Equipment list.
- a. If necessary for shop fabrication and testing, Contractor shall take receipt of equipment at Contractor’s system staging location and transport the complete AV assemblies to the project site.
- G. Existing OFE Items:
1. **OPTION:** No existing OFE items have been identified for this scope of work
2. **OPTION (ALL REMAINING TEXT IN THIS SECTION):**
3. As part of this scope of work Contractor shall allocate **xx** hours of time at the existing Owner sites to review existing Owner equipment which Owner may elect to include in the project scope.
- a. Contractor shall survey the existing equipment and provide revised pricing for reuse of existing equipment in place of new equipment included in the awarded scope.
- b. Contractor shall include demounting and packaging of equipment, transport to the project site and if necessary, to accommodate move out and move in schedule offsets, store equipment in Contractor’s secure facility.
- c. Site Locations
- 1) **ADD LOCATIONS**

d. Summary of existing systems

1) **ADD DESCRIPTION OF THE EXISTING SYSTEMS**

4. Prior to installation (rack fabrication or onsite), Contractor shall test all Existing OFE items and provide a list of any items found defective with costs to replace or repair as necessary. Contractor shall provide any available options and costs to extend existing manufacturer warranties to match the system warranty period.

- a. **OPTION:** See above listed labor warranty requirements

1.8 WORK NOT INCLUDED IN SCOPE

- A. Contractor shall coordinate with associated trades providing all work outside of this scope, which may be necessary for a complete and working system.

- B. Work not included in scope includes:

1. AV empty conduit, junction boxes, floor boxes, poke-thrus, j-hooks, and other pathways for AV low voltage cabling unless otherwise specified in this section.
2. **OPTION BASED ON 1.6-D** Display in-wall boxes.
3. Power receptacles supporting AV equipment.
4. AV furniture including tables, lecterns, and credenzas
5. Table hatches or table connectivity enclosures

- a. Contractor to coordinate and provide all hatch and enclosure faceplates, connectors, and cabling.

6. Architectural or event lighting control interfaces

- a. Contractor to coordinate and provide all cabling between AV and lighting controllers.

7. Owner network horizontal cabling and ports between an AV device and the Owner's IDF/MDF/Network rack.

- a. Contractor to coordinate and provide all patch cabling between Owner network drop termination points and AV devices including.

- 1) Refer to "Division 271100 - Network Communications Systems" specification for wire and cable standards.

- 2) Includes patch cabling run in glass front extrusions for use with room scheduling devices.

- b. Contractor to coordinate and provide all network drops between AV devices or between an AV device and contractor provided network switch.

- c. Contractor to coordinate cable routing, terminations, patch bay locations, patch bay/field device labelling, patch cable provisioning and all MDF/IDF, E-MDF/E-IDF AV requirements with the Division 27 Structured Cabling Contractor and Owner.
8. Owner network switches and wireless access points required for the operation of audiovisual equipment.
- a. **DIRECTION FOR SPECIFYER – REVIEW THE NETWORK STRATEGY WITH PROJECT STAKEHOLDERS AND HUIT TO CONFIRM AV EQUIPMENT ON/OFF NETWORK AND RESPONSIBILITIES TO FURNISH NETWORK HARDWARE FOR DEDICATED AV NETWORKS UNDER THIS SECTION.**

## 1.9 PRICE PROCEDURES

### A. Allowances

- 1. Refer to the 274100 Appendix A – Audiovisual Systems Equipment list for identified allowances.

### B. Unit Pricing

- 1. Contractor shall provide unit and system pricing as part of their bid submission and maintain unit pricing throughout the contract term.
  - a. **DIRECTION FOR SPECIFYER – IN SOME CASES, CONTRACTORS NEED TO PROVIDE EQUIPMENT COSTS SHOWING THE DISCOUNTED PERCENTAGE THAT THE SCHOOL OR DEPARTMENT IS RECEIVING. UPDATE WORDING IF REQUIRED.**
- 2. Non-equipment pricing to include separate sections for the following:
  - a. Engineering
  - b. Project Management
  - c. Fabrication Labor
  - d. Installation Labor
  - e. Programming
  - f. Quality Assurance
  - g. Shipping/Freight
- 3. Provide a separate cost for ongoing warrantee and maintenance services for years 2 and 3.

### C. Alternates

1. Refer to the 274100 Appendix A – Audiovisual Systems Equipment list for identified alternates.
2. Alternate pricing to be provided as the cost delta (add or deduct) to the base scope of work.

1.10 LAWS, REGULATIONS AND CODES:

- A. Perform all work in strict compliance with all laws, regulations, and/or codes applying, including all Federal, State, and local codes and any other authority having jurisdiction. Wherever drawings or specifications conflict with such regulations they shall be made to conform, and approval of the Design Professional obtained on such changes as may be involved.
- B. All electrical and telecommunications work shall comply with the requirements of the National Electrical Code, latest accepted revision.

1.11 PERMITS, FEES, AND CERTIFICATES OF APPROVAL:

- A. Unless stated otherwise in General Conditions or Division 1, obtain, and pay for all permits, fees, and licenses required, including those of utilities and Agencies. Provide copies to Design Professional in the quantity requested. "Fees" shall include connection charges construction costs, and other such charges by utility companies or service providers. Ascertain such charges during bidding period and include bid price.

1.12 REFERENCES

- A. The publications list below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
  1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
  2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.
- D. References:
  1. General: The system shall comply with all applicable codes, ordinances and standards as interpreted and enforced by the local authority having jurisdiction.
  2. AVIXA (Audiovisual and Integrated Experience Association, previously InfoComm) standards including:
    - a. Display Image Size for 2D Content in Audiovisual Systems

- b. Cable Labeling for Audiovisual Systems
  - c. Audio Coverage Uniformity in Listener Areas
  - d. Standard Guide for Audiovisual Systems Design and Coordination Processes
  - e. Projected Image System Contrast Ratio
  - f. Audiovisual Systems Energy Management
  - g. AV Systems Performance Verification
  - h. Audio, Video and Control Architectural Drawing Symbols Standard
  - i. Electronic Symbol Files - Audio, Video and Control Architectural Drawing Symbols
3. American Society for Testing and Materials (ASTM)
4. ANSI standards including:
- a. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements
  - b. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard
  - c. ANSI/TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
  - d. ANSI/TIA/EIA-606-A The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - e. J-STD-607-A Commercial Building Grounding and Bonding Requirements for Telecommunications
  - f. ANSI/TIA/EIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
  - g. ANSI/TIA/EIA-526-14A Measurement of Optical Power Loss of Installed Multimode Fiber Cable Plant
5. BICSI -- Telecommunications Distribution Methods Manual
6. BICSI -- Cabling Installation Manual
7. Underwriters Laboratories Listed; UL Certified
8. National Electrical Code Articles 770 and 800.
9. NFPA 780 - 2005 or newer.
10. RUS Standards (formerly REA)
11. Local State Uniform Fire Prevention and Building Code.
12. Local State Department of Labor Rules and Regulations
13. Local State Department of Health
14. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 90
15. Code of Federal Regulations (CFR) [Telecommunications] Title 47 Part 15
16. Americans with Disability Act (ADA)

## 1.13 DEFINITIONS

### A. Project Team

- 1. Owner: Harvard University
  - a. System Owner: **ADD SCHOOL NAME**

- b. Owner's network and telecommunications representative: Harvard University Information Technology (HUIT)
    - c. **DIRECTION TO SPECIFYER: LIST THE FULL HUIT PROJECT TECHNOLOGY TEAM IF REQUIRED, INCLUDING THE IMPLEMENTATION GROUP**
  - 2. Architect: **ADD NAME**
  - 3. Design Professional: **ADD NAME**
    - a. The Design Professional, or Consultant, is the designer of record for the audiovisual systems retained by the Owner to perform design services for the project.
- B. The following definitions of terms supplement those of the General Requirements and are applicable to all portions of the 274100 scope of work.
  - 1. Provide: As used herein shall mean furnish, install, and test complete.
  - 2. Infrastructure: As used herein shall mean cable, conduit, and raceway with all required boxes, fittings, connectors, and accessories; completely installed.
  - 3. Work: As used herein shall be understood to mean the materials completely installed, including the labor involved to meet the design intent.
- C. As used in the Documents for the Work, certain non-technical words and phrases shall be understood to have specific meanings as follows, regardless of indications to the contrary in the General Conditions or other documents governing the Work.
  - 1. "Furnish" – Purchase and deliver to the project site complete with every necessary appurtenance and support, all as part of the Work. Purchasing shall include payment of any surcharges as may be required to assure that purchased items are free of all liens, claims, or encumbrances.
  - 2. "Install" – Unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project, all as part of the Work.
  - 3. "New" – Manufactured within the past year and never before used.
- D. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Documents for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
  - 1. "As indicated" – As shown on, and/or in accordance with, the Documents.
  - 2. "Circuit" – Any specific run of circuitry.
  - 3. "Circuitry" – Any Work which consists of wires, cables, raceways, and/or specialty wiring method assemblies complete with associated junction boxes, pull boxes, outlet boxes, joints, couplings, splices, and connections except where limited to a lesser meaning by specific description.
  - 4. "Concealed" (as applied to circuitry) – Covered completely by building materials, except for penetrations (by boxes and fittings) to a level flush with the surface as necessitated by functional or specified accessibility requirements.

5. "Documents" – The term "Documents" means all security and security related drawings, specifications, and associated sketches, details, riser diagrams, Owner guidelines etc.
  6. "Exposed" (as applied to circuitry) – Not covered in any way by building materials.
  7. "Patch Panel" – A system of terminal blocks, patch cords, and backboards that facilitate administration of cross-connecting cables.
  8. "Raceway" – Any pipe, duct, extended enclosure, or conduit (as specified for a particular system) which is used to contain wires, and which is of such nature as to require that the wires be installed by a pulling in procedure. Where the word "conduit" is used without specific reference to type, it shall be understood to mean "raceway".
  9. "Relocate existing" – Remove existing item from present location. Reinstall, re- connect, and test existing items and make ready for use at new location as indicated.
  10. "Remove existing" – Remove existing item and return item to Owner.
  11. "Replace" – Remove existing item and return item to Owner. Provide new item as indicated.
- E. The term "Coordinate" means that Contractor will, while providing this scope of work or specific task, communicate, cooperate and collaborate with all associated trades, vendors and project team members whose products and services have a direct impact on the ability of contractor to deliver this scope. Coordination includes communicating, cooperating, and collaborating to organize the scheduling and performance of the scope of work. Contractor will inform the Owner of occurrences in which any project stakeholder, contractor or subcontractor fails to communicate, cooperate, or collaborate with Contractor relating to the performance of the scope of work.
- F. Abbreviations and Acronyms
1. ANSI American National Standards Institute
  2. AFF Above Finished Floor
  3. AHJ Authority Having Jurisdiction
  4. ARC Aluminum Rigid Conduit
  5. AWG American Wire Gauge
  6. AV Audio / Visual, audiovisual, audio visual
  7. AVIXA Audiovisual and Integrated Experience Association, formerly InfoComm
  8. BAS Building Automation Systems
  9. BTU British thermal Unit
  10. °F Degrees Fahrenheit
  11. ft Feet
  12. EMT Electrical Metallic Tubing
  13. FT Fiber Transceiver
  14. GbE Gigabit Ethernet
  15. GRC Galvanized Rigid Conduit
  16. HTML Hypertext Markup Language

17.	HUIT	Harvard University Information Technology
18.	HUPD	Harvard University Police Department
19.	HU	Harvard University
20.	Hz	Frequency in Hertz (k = kilo, M = Mega, G = Giga)
21.	ID	Inside Diameter
22.	in	Inch
23.	lbs.	pounds
24.	IMC	Intermediate Metallic Conduit
25.	IP	Internet Protocol
26.	ISO	International Organization for Standardization
27.	LAN	Local Area Network
28.	MAC	Media Access Control (Address)
29.	Mbps	Megabits per second
30.	NEC	National Electrical Code
31.	NEMA	National Electrical Manufacturing Association
32.	OD	Outside Diameter
33.	OFE	Owner Furnished Equipment
34.	PM	Project Manager
31.	PoE	Power-over-Ethernet protocol
32.	PVC	Polyvinyl Chloride
33.	RNC	Rigid non-metallic conduit
34.	RU	Rack Unit
35.	SNMP	Simple Network Management Protocol
36.	TCP	Transmission Control Protocol
37.	TIA	Telecommunications Industry Association
38.	TGB	Telecommunications grounding busbar
39.	TR	Telecommunications Room
40.	UPS	Uninterruptible Power Supply
41.	UL	Underwriters Laboratories
42.	VLAN	Virtual Local Area Network
43.	VoIP	Voice over Internet Protocol
44.	VPN	Virtual Private Network
45.	WAN	Wide Area Network
46.	WLAN	Wireless Local Area Network

1.14 RECORD DRAWINGS:

- A. During construction, keep an accurate record of all deviations of the work as shown on the drawings and that which is actually installed.
- B. Secure from the Design Professional a complete set of prints of the AV drawings and note changes thereon. Make a complete record in a neat and accurate manner, of all

changes and revisions to original design which exist in completed work, in the file format originally received.

- C. The cost of furnishing above drawing files and preparing these record drawings shall be borne by the Contractor. When all revisions showing the work as finally installed are made, the corrected prints and drawings files shall be submitted for review and approval by the Design Professional.
- D. Record drawings in both PDF and **CAD/REVIT** formats shall be delivered to Owner within 30 days after acceptance of completed project by Owner.

- 1. **DIRECTION FOR SPECIFIER: REVIEW REQUIREMENTS WITH HARVARD FOR CAPTURING AS-BUILT DOCUMENTS AS PART OF A DIGITAL TWIN OR POST-INSTALLATION ACTIVE REVIT MODEL.**

1.15 OPERATING INSTRUCTIONS:

- A. **DIRECTION FOR SPECIFIER: CONFIRM WITH HARVARD REQUIRMENTS FOR PAPER COPIES AND HOW ELECTRONIC SUBMISSIONS WILL BE ARCHIVED.**
- B. Provide to the Owner **one bound paper copy** and a single PDF with bookmarks of complete written instruction on the operation, care and maintenance of each piece of equipment and the installation as a whole. Include frequency of inspection, cleaning and adjusting and other attention as may be required in accordance with manufacturer's instructions. Material shall be manufacturer's brochures, catalog cuts, parts lists, wiring diagrams, etc. Also supply Owner with three complete sets of approved shop drawings.
- C. Furnish qualified personnel to instruct the Owner's personnel in the maintenance and operation of all equipment and systems. Instructing personnel shall remain on the job continuously during working hours until such instruction is complete, but not less than **xx hours**.

- 1. **DIRECTION TO SPECIFIER: REVIEW TRAINING REQUIREMENTS WITH AV STAKEHOLDERS.**

- 2. All training must include a turnover checklist including the status of all systems commissioning, as-built submittals, all training materials, support and warrantee information.

1.16 PERFORMANCE REQUIREMENTS

- A. Provide a complete, fully functional installation of the AV System and associated components including:
  - 1. Engineering and installation services aligning to the published project schedule.
  - 2. Coordination with the Owner, Architect, Design Professionals, General Contractor and all associated trades.
  - 3. Creation, submission, and revision to the point of receiving approval of an AV Systems Submittals package.
  - 4. Equipment procurement.
  - 5. Equipment delivery to the site and removal of all trash.

6. Provide all installation tools and materials necessary to complete all equipment installation tasks including ladders, scaffolding and lifts.
7. Equipment installation.
8. Systems setup, configuration, and commissioning.
9. Systems demonstration to Owner and Design Professional.
10. Remediation of any systems identified by Owner and Design Professional as not meeting published equipment specifications or the requirements as set out in this scope of work.
11. As-built documentation.
12. End-User and Administrative Training.
13. AV Systems Warranty with turn-over ceremony to Contractor's warrantee team.
14. Follow all requirements listed in the Harvard "Requirements for the Protection of Harvard Personally Identifiable Information"

a. **OPTION: Include link:**

[https://ogc.harvard.edu/files/ogc/files/pii\\_rider\\_21021.pdf?m=1614632357](https://ogc.harvard.edu/files/ogc/files/pii_rider_21021.pdf?m=1614632357)

15. **OPTION: Provide Quarterly maintenance visits**

B. Demolition

1. **OPTION:** No existing audiovisual equipment or infrastructure has been identified for demolition as part of this scope of work
2. **OPTION (ALL REMAINING TEXT IN THIS SECTION):**
3. Following the scope areas and descriptions detailed in the TA drawing set, Contractor will demount, protect and store onsite any functioning audiovisual equipment scheduled for reuse.
4. Any equipment scheduled for permanent demolition shall be removed, reset to factory default/hard drives wiped and e-waste recycled by Contractor in accordance with published Harvard Information Security and Data Privacy and sustainability practices.
5. Any equipment scheduled to remain and protect in place to be provided with a protective cover to avoid damage during demolition or construction. If the General Contractor determines that the audiovisual systems or infrastructure cannot be protected in place, the Contractor shall demount, protect and store onsite for reuse and reinstallation as part of this scope of work.

C. Provide all equipment accessories, manuals, mounting hardware, remotes and other ancillary pieces furnished by the manufacturer but not required for installation.

D. Provide all AV low-voltage cabling, connectors, connector plates, patch bays and patch cables.

1. Confirm cable types and verify required length of all installed and portable premanufactured cables and assemblies prior to order.

E. Terminate and test all AV low-voltage field connections.

1. Provide all connectorized plates, connectors, cable labels and plate labels.
2. Confirm finish of all plates and labels with Design Professionals.

3. Provide cable test report confirming functionality of input/output locations and that installed cabling and terminations meet manufacturer specification.
- F. Install and configure Owner Furnished Equipment.
  - G. Confirm color selection of all exposed AV equipment with Owner prior to order.
  - H. Confirm required openings, recesses and mounting locations of all AV equipment to meet manufacturer requirements. Verify onsite prior to completion of wall framing and electrical rough-in.
  - I. Contractor to include manufacturer onsite oversight labor including commissioning services and end user training for any systems which Contractor does not have staff with relevant manufacturer training and any available manufacturer certifications.
  - J. Provision all video conferencing, wireless presentation and other collaboration hardware endpoints with Owner's network and collaboration system registration and license information.
  - K. Coordinate AV equipment blocking requirements with the General Contractor prior to installing AV equipment.
    1. All wall or ceiling mounted equipment to be provided with hardware sized for a 5:1 safe working load limit.
    2. All ceiling mounted equipment to be provided with a safety cable or redundant support system attached to building structure and sized for the equipment in accordance with the equipment manufacturer's requirements.
  - L. Install all AV rack hardware including rack bases and wall supports.
    1. Confirm that all AV rack locations will allow proper clearances.
    2. Coordinate with the General Contractor location of all AV rack power receptacles, data jacks, CATV jacks and empty AV low voltage junction boxes.
    3. Confirm sufficient heat exhaust and cooling systems have been provided to meet systems demand loads.
    4. Request of the General Contractor a normally closed fire alarm mute contact for all event systems as identified in the Audiovisual Drawings.
      - a. Where the local authority having jurisdiction requires audio muting on audiovisual devices provided without mute contacts, Contractor shall provide switched power modules with the ability to remove device power based on status from the fire alarm mute contact.
    5. Provide rack hardware, cable management hardware and rack accessories as necessary to meet rack and equipment manufacturer recommended configurations.
  - M. Provide all necessary copper and fiber patch cables for making all device interconnections. Patch cable type and color shall be coordinated with the structured cabling package to match project standards. Protect all fiber patch cables from rack to fiber patch panels inside protective flexible conduit.

- N. Provide an AV equipment network coordination submittal for Owner completion. Configure all AV equipment with the confirmed network settings and test operation on the Owner network.
  
- O. Loudspeakers
  - 1. Coordinate location of all speakers and speaker systems including location of low voltage and power infrastructure.
  - 2. Review all ceiling speaker mounting conditions and provide ceiling speakers with a tile bridge or other relevant manufacturer support system.
  - 3. Where indicated in the specification, paint all exposed speaker grills with a custom color as confirmed by Owner.
  
- P. Furniture
  - 1. Coordinate with furniture providers all AV equipment installation requirements including cutout sizes, connector/plate openings, wiring openings, raceways, methods of affixing cables and equipment.
    - a. All equipment and cabling shall be installed in a neat and professional manner with the intention of limiting visibility of supporting hardware and cabling.
    - b. All table cabling shall be secured to the table or hidden in a plinth, cloth wrap or articulating cable manager.
  - 2. For all technical furniture provided under this scope of work, coordinate equipment layouts, and finishes with Owner and Design Professional prior to ordering.
  
- Q. Wireless Audio Systems
  - 1. In coordination with HUIT, coordinate wireless frequency selection based on a site survey and relevant government agency requirements. Address any wireless channel conflicts and co-channel interference with HUIT prior to equipment ordering.
    - a. For meeting or event space wireless microphone and in-ear monitor systems, provide the Owner with a system capable of adjusting wireless frequency as necessary to maintain reliable system operation in the installed environment.
    - b. Provide a list of Owner and Contractor furnished audiovisual and supporting network devices and wireless frequencies used including frequency scan confirming no conflicts.
    - c. Owner will not be responsible to address existing wireless frequency use, and all wireless power or frequency conflicts will be resolved as part of the Contractor's equipment frequency selection and installation requirements.
  - 2. Coordinate placement of wireless antennas with HUIT, any other Contractors providing wireless systems as part of the Project, and published HUIT wireless

frequency standards and provide antenna splitting, combining and amplification as necessary to operate within manufacturer required signal strength ranges.

R. Control Systems

1. Coordinate with the General Contractor and Primary System Integrator and HUIT on the location and configuration of all external system interfaces including lighting, shades, occupancy, BMS as required.
  - a. Provide cabling between AV controllers and external system interfaces.
2. Provide uncompiled and compiled versions of all custom AV control system code development as necessary to operate all AV equipment user controls per specification.
  - a. **INSTRUCTION TO SPECIFYER: LANGUAGE TO BE MODIFIED IF A THIRD-PARTY PROGRAMMER IS ENGAGED EITHER DIRECTLY BY HARVARD OR VIA SUBCONTRACT TO THIS SECTION. MODIFY AS REQUIRED.**
  - b. **HARVARD TO ADD INFORMATION ON THE SPECIFIC REMOTE MONITORING PLATFORM CHOSEN FOR THE NEW STANDARD AND PROVIDE INFORMATION ON ANY STANDARDS OR PROCEDURES REQUIRED AS PART OF INTEGRATION TO THAT PLATFORM**
  - c. Manage a control interface confirmation process with Owner and Design Professional as outlined in the AV submittal requirements.
  - d. Provide control code hooks for remote monitoring integration into the Owner's existing audiovisual equipment management platform.
    - 1) Provide any licenses required at the local audiovisual controllers provided under this scope of work to communicate with the Owner's remote monitoring platform.
    - 2) **NOTE FOR SPECIFIERS: ADD SPECIFIC REMOTE MONITORING REQUIRMENTS BASED ON THE SCHOOL'S PLATFORM AND THE PROCESS FOR ADDING DEVICES TO THIS PLATFORM.**
  - e. Where integration to the building automation system is included in scope, coordinate all BAS points required with the Division 25 contractor.
  - f. Code requiring custom modules which are locked by the Contractor and unable to be edited by Harvard will not be acceptable.
3. Configure all digital signal processors, content management systems, scheduling systems and other processor-based platforms to optimize the spaces and systems being served.

1.17 QUALITY ASSURANCE

- A. Comply with the requirements of the following codes and/or standards:

1. ANSI.
  2. ANSI.
  3. UL.
  4. NEMA.
  5. NFPA.
  6. NEC.
  7. IBC 2009.
  8. BICSI.
  9. ANSI/TIA 568-D Series.
  10. ANSI/TIA 569-E.
  11. ANSI/TIA 606-C.
  12. ANSI/TIA 607-D.
- B. All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL) in accordance with the OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70 and National Electric Code (NEC), Article 90-7.
- C. The contractor shall be certified by the manufacturer of the products, adhere to the engineering, installation, and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning this Project.
- D. All members of the installation team shall be certified by the manufacturer as having completed the necessary training to complete their part of the installation. All hardware, software, firmware, and/or operating system requirements given are the minimum requirements. The Contractor's product shall meet or exceed these requirements. The product selected shall meet the operational, functional, and performance requirements specified herein. Additionally, due to the rapid advancement and antiquation of technology related products, the supplied product shall be the "contemporary technical equivalent" of that specified. "Contemporary technical equivalent" shall be based on a comparison of technology at the time of publication of specification to the technology at the time of the first product submittal. Final product approval is at the sole discretion of the Owner.
- E. Manufacturer: Where Contractor has the ability to select a preferred manufacturer for items not specifically covered in the Appendix A Audiovisual Systems Equipment list, the manufacturing company selected shall have a minimum of five years of experience in producing the products.
- F. Subcontracted labor and programming: All subcontractors used by the Contractor shall be required to meet the minimum requirements of this specification. Contractor shall audit the subcontractor's work and address all areas of non-conformance prior to system turn-over to Owner.

#### 1.18 SUBMITTALS

- A. Contractor must receive approval from the Owner or Design Professional of a submittal before procuring equipment or performing services related to the submittal.

- B. All submittals shall be provided in electronic format unless requested in paper as noted below.
  - 1. If requested by owner, provide one full size paper submittal.
  - 2. Confirmation of the submittal schedule and submission format must be obtained by Owner prior to creating individual submissions.
- C. Revised submittals shall include clouding or other method to indicate revisions since the prior submission.
- D. Project Status Report
  - 1. A project status report shall be sent to the Owner and Design Professional weekly starting within two weeks of award. The project status report shall be used as the basis for Contractor coordination meetings and shall include:
    - a. Team member contact information
    - b. Project overall schedule
      - 1) Highlight changes to the schedule since last issuance
      - 2) Identify critical schedule items
      - 3) Identify opportunities to improve on the current schedule
    - c. Action items from prior coordination meeting and status of each item
    - d. Installation schedule and status for each unique space or system in the project.
    - e. Outstanding Owner coordination items.
    - f. Outstanding Design Professional coordination items.
    - g. Change Order Status
    - h. Submittal Approval Status
- E. Within five business days of award, submit an installation schedule including major milestone dates for construction phasing based on overall project construction schedule (along with separate phases where applicable), system and device configuration, testing and training. Include the following milestones:
  - 1. Separate milestones for each submittal.
  - 2. Signage content and system configuration coordination session.
  - 3. Required date for receipt of all OFE equipment per project phase or equipment type.
  - 4. Required data for receipt of any Owner furnished signage content
  - 5. AV project manager onsite.
  - 6. Delivery of all Furnished but not Installed equipment to site
  - 7. Cable pulls start and complete
  - 8. Mount and speaker installation start and complete
  - 9. Equipment installation start and complete
  - 10. Systems configuration and testing start and complete
  - 11. Systems ready for checkout, punch list, and final acceptance.
  - 12. Owner training
  - 13. As-built submission

- F. Within 30 business days of award submit an AV infrastructure review memo confirming infrastructure shown on the AV, Architectural, Telecom, Mechanical and Electrical design packages meet AV equipment installation requirements or identifying specific adjustments necessary to support the specified AV equipment.
1. Verify AV conduit sizing and pathways
  2. Verify architectural recesses and ADA clearances
  3. Verify data drops to support AV network connectivity
  4. Verify AV power receptacles and multi-discipline shared services device requirements (in-wall boxes, floor boxes, poke-thru or other similar device).
  5. Verify AV enclosure cooling/exhaust
  6. Verify ceiling device layouts and clearances, projector, and projection screen orientation
- G. Qualifications: The Contractor shall submit qualification data sheets for firms and persons as specified in the "Quality Assurance" section of this specification to demonstrate their capabilities and experience.
- H. Submit proposed product data sheets: The Contractor shall submit catalogue cut sheets that include manufacturer, trade name, and complete model number for each product specified or selected for use in the project.
1. Model number shall be highlighted to indicate exact selection per system type.
  2. Product data sheets shall be organized with separate folders per system type with a master equipment list broken into three sections:
    - a. System types and quantities of systems
    - b. Equipment and equipment quantities per system type
    - c. Master project equipment list and quantities
  3. Confirm manufacturer master quote numbers and the accuracy of the master quotes against the specified equipment.
- I. Submit shop drawings detailing proposed system architecture and interconnectivity.
1. All shop drawings sheets shall be sized to match the project architect's drawing format.
  2. Shop drawings shall include the following drawing information.
    - a. Scaled floorplans indicating the area of work and room types.
    - b. Enlarged plans indicating equipment locations, mounting requirements, clearances, infrastructure requirements, and cable routing.
      - 1) Provide projector and projection screen throw distance calculations.
      - 2) Provide display elevations and sections.
      - 3) Provide loudspeaker coverage area.
      - 4) Provide microphone coverage area.
      - 5) Identify any details which do not meet minimum ADA clearance requirements.

- 6) Identify equipment centerline coordinated with furniture and main display wall.
- c. Device details indicating mounting requirements for each unique equipment type in the project.
  - 1) All overhead equipment details must identify the safe working load and manufacturer provided safety hardware. Where a custom mounting detail is required using fabricated components or components provided by multiple manufacturers a structural detail, reviewed and stamped by a Structural Engineer license in the project state, must be provided.
  - 2) Copies of manufacturer cut sheet details shall not be considered sufficiently coordinated.
- d. Rack elevations and mounting details with clearances and infrastructure requirements
- e. System flow diagrams with cable labels, transport protocols, and corresponding cable schedule indicating wiring interconnections between all AV devices and Owner's network.
  - 1) Refer to Division 27 specifications for cable labeling standards
  - 2) All network connection to be indicated with the data-jack number/label
  - 3) All PoE devices to list the average and max power draw
  - 4) Audio, Video, Control, Power and Network diagrams to be provided.
    - a) Refer to the HUIT Rules of the Road requirements for network coordination and documentation expectations.
    - b) All system integration (lighting, shades, BAS, etc.) to be documented for coordination with other trades.
- f. Wiring termination details.
- g. Panel details showing all prefabricated and custom connector panels, connector types, labels and required backbox.
- h. Technical Furniture details indicating the location, required openings and cable management of all AV equipment in furniture and millwork regardless of what scope the furniture is provided under.

#### J. Control Systems

- 1. **OPTION 1: CONTRACTOR PROVIDES THE CONTROL SYSTEM**
- 2. Owner or Design Professional approval of all Control Systems submittals is required prior to installation. Failure to secure approval shall not be grounds for project schedule delay or Contractor change order.
- 3. Submit button panel layouts with labelling/engraving and sequence of operations.
- 4. Submit audio DSP configuration files.

5. Submit an initial and up to two revised sets of touch panel user interface submittals.
  - a. Contractor shall lead a user interface review session with Owner and Design Professional prior to start of touch panel user interface design. Contractor shall provide up to three design samples in advance of the user interface session for Owner and Design Professional review.
  - b. User interface layouts shall follow the best practices laid out in the InfoComm *Dashboard for Controls*
  - c. The overall user interface design process shall reflect the current draft AVIXA UX 701.01 *User Experience Design for AV* recommendations
  - d. User interfaces shall include the following basic features:
    - 1) Control of all local AV equipment addressable parameters required during the specified use cases.
    - 2) Call controls, transport controls, source selection, volume controls as appropriate.
    - 3) Standard controls formatted to match industry standard applications (knobs, sliders, buttons, interactive menus, etc.)
    - 4) Where required by the Owner as part of initial touch panel layout discussions, password protected or hidden advanced section allowing for control of individual device parameters (power, channel level controls, input selection, etc.) is to be provided.
    - 5) Utilize stock manufacturer pages and capabilities where possible. Custom scripting shall be avoided unless where required as part of this specification.
6. **OPTION 2: A THIRD-PARTY CONTROL SYSTEM PROVIDER IS USED**
7. This project will use a third-party control system programmer to provide control system user interface design, control system programming files and control system validation for the following spaces:
  - a. **LIST OUT ALL SPACES UTILIZING A THIRD-PARTY PROGRAMMER**
8. Coordinate with and support the work of the assigned third-party programmer including:
  - a. Meet with the third-party programmer to coordinate deliverables, installation and commissioning schedule.
  - b. Provide submittals for review and comment by the third-party programmer
  - c. Review the user interface wireframe reports and confirm hardware and wiring configuration will support the user interface requirements.
  - d. Load the third-party program and confirm control system input and output functions.
  - e. Troubleshoot control system hardware communication paths and validate all control system integrations are functioning with the equipment and systems included in this scope of work as well as any other building integrations tied to these systems (lighting, shades, temperature, occupancy, etc.).
  - f. Attend Owner and Design Professional system demonstration and punch-list sessions.

K. Network Coordination Submittal

1. Following the HUIT OT network access request process, submit a detailed list of all network enabled AV devices detailing:
  - a. MAC address
  - b. Serial Numbers
  - c. IP Address (for Owner to complete)
  - d. Subnet (for Owner to complete)
  - e. Wired and Wireless VLANs
  - f. DHCP requirement
  - g. Multicast/Unicast streaming requirements
  - h. PoE device requirements and power budget
  - i. Required port counts per AV enabled room
  - j. Required port counts per supporting AV rack room or IDF
  - k. Unique network requirements including firewall exceptions, port forwarding and QoS
  - l. For any device storing data locally, identify the data classification level based on Harvard Data Classifications
    - 1) **OPTION:** <https://privsec.harvard.edu/data-classification-table>
  - m. Equipment with multiple network interfaces and their network modes
2. Lead an AV network coordination session with the Owner and Design Professional to confirm overall project AV network requirements and set a schedule for completion and return of the Network Coordination Submittal by the Owner.
  - a. Engage with HUIT before purchasing equipment as part of the shop drawing review process. Coordinate with HUIT to receive approval/confirmation that all provided equipment will be accepted to work on the HUIT provided network.

L. Owner Training Plan

1. Identify specific systems to be trained on and training durations.
2. Identify required project stakeholders.
3. Identify training status and provide training sign-off sheets.
4. Provide training materials and user one-page operations sheets for each system types.

M. Operations and Maintenance Manuals:

1. This Section requires complete documentation of the AV System for the purpose of system operation and maintenance during and after the Warranty period. It is intended that the operation and maintenance manuals be exhaustive in the coverage of the system to the extent that they may be used as the sole guide to the troubleshooting, identification, and repair of defective parts. All documentation, as described herein, shall be submitted to the Owner for approval sixty (60) days prior to final submission.

2. Scope: These manuals shall include basic wiring diagrams, schematics, and functional details such that any component, wire, or piece of equipment in the system may be easily identified by going to the actual equipment and making reference to this manual. It is required that everything in the system be neatly labeled and easily identifiable. Every terminal, wire, component, or piece of equipment, and other such items shall have a number or letter designation. All of these identification characteristics shall be included in the maintenance and operation manuals.
3. The maintenance manual requirement of this Section is in addition to Shop Drawing requirements. Maintenance manuals and Drawing sets shall be compiled after system fabrication and testing and shall incorporate any changes made after Shop Drawing submittal process is completed and submittals have been approved.
4. Maintenance Manuals, Manufacturer's Literature: Provide manufacturer's standard literature, covering all equipment included in the system. The maintenance manuals shall contain specifications, adjustment procedures, circuit schematics, component location diagrams, and replacement parts identification. All references to equipment not supplied on this Project shall be crossed out.
5. System Administrator Documentation: This documentation shall provide complete information on the configuration, business rules, operation, maintenance, and troubleshooting of the system.

N. Testing Plan

1. Review the "HUIT Sample Audiovisual Systems Testing Plan" document and submit a systems testing and verification plan, matching specific project room types and capabilities provided, for approval by Owner and Design Professional.
2. [HARVARD TO COMPLETE THE TESTING PLAN DOCUMENT – REFER TO THE SAMPLES PROVIDED BY BALA](#)
3. The approved Testing Plan shall be completed and provided to the Owner and Design Professional prior to commencement of Owner testing and punch list efforts.

O. As-Built Documentation

1. Submit an updated version in CAD and PDF formats of all submittals revised to match installed conditions.
2. Submit the native version of all drawings, uncompiled control programs, digital signal processing and other systems configuration files.

P. Warranty

1. Within 30 business days of award, provide a summary of the system's warranty including all optional services for final Owner confirmation.
2. At time of as-built documentation submission provide two physical copies of the hardware and software warranty certifying that the final as-built installation is fully warranted by the manufacturer.

#### 1.19 GENERAL WARRANTY

- A. The system warranty shall commence on the date of Substantial Completion unless otherwise provided for in the Contract.
- B. The system warranty shall be for an initial period of one year
- C. Hardware Warranty:
  - 1. Contractor shall warrant that all components meet or exceed the specifications provided in the product data submittals.
  - 2. The Contractor shall warrant that the proposed merchandise will conform to its description and any applicable specifications and shall be of good quality for the known purpose for which it is intended.
  - 3. The warranty shall cover material and labor for the replacement or repair of defective products.
  - 4. Regardless of manufacturer warranties expiring before the full system warranty period, Contractor shall be responsible for extending any manufacturer warranties for the full length of the system warranty.
- D. Software Warranty:
  - 1. The warranty shall allow for replacement or repair at the discretion of the Owner. All software necessary to compile, modify, and maintain software developed for this specification shall be included in this warranty.
  - 2. The warranties shall include the price of all software upgrades during the warranty period. If a new version of the system software becomes available during the warranty period, it shall be upgraded as part of the warranty.

#### 1.20 MAINTENANCE AND SUPPORT SERVICES

- A. **REVIEW THE SPACE PRIORITY AND HUIT STAFFING EXPECTATIONS AND REVISED THE MAINTENANCE AND SUPPORT SERVICES TO MATCH PROJECT REQUIREMENTS**
- B. **OPTION:** Description of Work: During the warranty period provide 24-hour, 7 days a week live monitoring of the system from the Contractor's operations center. Provide customer service for subscriber issues Monday – Friday, 9am – 5pm local time. Provide quarterly system inspections, checks and updates during the warranty and maintenance period.
- C. **OPTION:** Description of Work: Provide customer service for subscriber issues Monday – Friday, 8am – 5pm local time. Provide quarterly system inspections, checks and updates during the warranty and maintenance period.
- D. **OPTION:** Emergency Service: The Owner will initiate service calls when the system is not functioning properly. Qualified personnel shall be available to provide service to the complete system repair. The Owner shall be furnished with a telephone number where the service supervisor can be reached at all times. Service personnel shall be on site

within 4 hours after receiving a request for service. The system shall be restored to proper operating condition within 8 hours after service personnel arrive onsite.

- E. Personnel: Service personnel shall be certified in the maintenance and repair of similar types of equipment and qualified to accomplish work promptly and satisfactorily. Service personnel shall hold a valid Airport security credential. The Owner or Owner's Designated Representative shall be advised in writing of the name of the designated service representative, and of any change in personnel.
- F. **OPTION:** Schedule of Work: The Contractor shall perform quarterly inspections of the installed system. Inspections shall be in accordance with manufacturer and Contractor recommendations. The adjustment and repair of the system shall include visual checks of installed equipment and inspection of system health logs and software. Recommended software updates shall be applied on the system at these pre-defined quarterly periods.
- G. **OPTION:** Scheduled Work: Scheduled work shall be performed during regular working hours, Monday through Friday, excluding holidays.
- H. **OPTION:** Scheduled Work: To maintain business continuity, scheduled work shall be performed after regular working hours, Monday through Friday or on Weekends.
- I. Records and Logs: The Contractor shall keep records and logs of each task, and shall organize cumulative records for each component, and for the complete system chronologically. A continuous log shall be maintained for all devices. The log shall contain all initial settings. Complete logs shall be kept and shall be available for inspection on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the system.
- J. Work Requests: The Contractor shall separately record each service call request, as received. The form shall include the serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what has to be done, the amount and nature of the material to be used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within 5 days after work is accomplished.
- K. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. System modifications shall not be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operation and maintenance manuals, and other documentation affected.
- L. Spare Equipment:
  - 1. Provide spare equipment where indicated in the 27 41 00 Appendix A.
  - 2. **ADD ANY NOTABLE ADDITIONAL SPARE EQUIPMENT REQUIREMENTS.**

#### 1.21 SERVICE LEVEL AGREEMENT (SLA)

- A. The Contractor shall provide with the bid a firm fixed pricing option(s) to provide continued warranty service and maintenance of the system for additional years two and three. The SLA shall mirror that of the warranty and maintenance requirements during the warranty period as outlined in the Warranty and Maintenance articles above.

#### 1.22 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate secure, climate controlled, storage onsite with the General Contractor and is responsible for the safe packaging (protection) delivery, storage and handling of all equipment covered in this scope of work through substantial completion of the work.

#### 1.23 PROJECT CONDITIONS

- A. Environmental Limitations: System components shall be equipped and rated for the environments where installed.
- B. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:
  - C. Interior, Controlled Environment: System components shall be rated for continuous operation in ambient conditions of 2 to 40 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing.
  - D. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F (minus 18 to plus 50 deg C) dry bulb and 20 to 90 percent relative humidity, noncondensing.
- E. Verify that field measurements are as shown on Drawings; no media, fiber, or copper, shall be installed in lengths surpassing project Division 27 standards.
- F. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project conditions.
- G. Where wire and cable routing are not shown, and destination only is indicated, determine exact routing and lengths required. Record actual routing on as-builts for all conduits larger than one inch.

#### 1.24 PROJECT COORDINATION

- A. Determine required separation between cables and other work.
- B. Coordinate conduit routing and proximity of high voltage or motor load wiring relative to sensitive audiovisual cabling with the Division 26 contractor

- C. Coordinate cable routing to avoid interference with other work disciplines.
- D. Coordinate grounding and bonding with the Division 27 Contractor.
- E. Coordinate use of fiber optic cabling infrastructure with the Division 27 Contractor.
- F. Coordinate network configuration requirements with the Division 27 Contractor.

## PART 2 - PRODUCTS

### 2.1 APPENDIX A – AUDIOVISUAL SYSTEMS EQUIPMENT LIST

- A. Refer to the attached 27 41 00 Appendix A - Audiovisual Systems Equipment List for product information, alternates, and manufacturer quotes.
- B. The Appendix A shall be used as the basis for Contractor pricing. A native Excel version of the appendix shall be filled out by the Contractor and returned with the bid response.
- C. Contractor shall verify any existing manufacturer quotes, including those listed in Appendix A, match the project requirements.
  - 1. Contractor shall be responsible for addressing any discrepancies between manufacturer quotes and project requirements.

### 2.2 SUBSTITUTIONS

- A. **CONFIRM IF SUBSTITUTIONS WILL BE ALLOWED AND UPDATE LANGUAGE BELOW OR ADD SPECIFIC AREAS WHERE SUBSTITUTIONS WILL BE ACCEPTABLE.**
- B. Contractor requests for substitutions shall be made in writing and shall include:
  - 1. The equipment or process requested for substitution and a summary of the reason for substitution.
  - 2. The requested equipment or process to substitute with and a feature comparison with the base scope of work.
  - 3. Proposed cost and schedule impacts.
- C. No substitution shall be allowed without written approval of the Owner or Design Professional.
- D. Cost and schedule impacts will only be considered for approval in the event that the substitution is due to factors outside of the control of the Contractor.
  - 1. When substitutions are requested and approved after submittals have been submitted for review, impacted submittals are to be re-submitted.

## 2.3 SYSTEM DESCRIPTIONS

- A. DESCRIPTIONS BELOW HAVE BEEN PROVIDED AS EXAMPLES OF THE MINIMUM LEVEL OF DETAIL REQUIRED. SPECIFYER SHALL PROVIDE SPECIFIC USE CASE DESCRIPTIONS, BUT AVOID INFORMATION LIKE DISPLAY SIZE, MANUFACTURER, ETC. WHICH IS DUPLICATED ON THE APPENDIX A AND COULD CREATE A POTENTIAL SCOPE CONFLICT BETWEEN THE DOCUMENTS. SPECIFYER SHALL INDICATE ANY NOTABLE INTEGRATIONS, SYSTEM FUNCTIONS OR COORDINATION REQUIREMENTS WHICH MIGHT NOT BE OBVIOUS IN THE TA DRAWING PACKAGE.
- B. The following spaces are scheduled for audiovisual equipment. Refer to the 27 41 00 Appendix A for the full list of major equipment requirements. The following descriptions are provided as high-level summaries and are not intended to limit the scope of work or exclude devices and equipment shown on the drawings or Appendix A:
1. Digital Signage Display – location counts per Appendix A
    - a. (1) Wall mounted digital signage display with articulating mount and onboard digital signage app playback capability.
  2. MRP/Faculty Lounge – location counts per Appendix A
    - a. (1) Wall mounted flat panel displays with CATV, wired and wireless presentation capability.
    - b. Ceiling speaker system with presentation, local input and Bluetooth audio playback capability.
    - c. Wall mounted button panel for source selection, routing, volume and power control.
  3. Classroom
    - a. Projection system and motorized projection screen with ceiling rigging hardware
    - b. Local sources including CATV, wired and wireless video
    - c. Wall mounted PTZ camera with touch panel camera control
    - d. “Throw down” AV over IP transceivers for use with wall, floor and ceiling infrastructure
    - e. AV Streaming appliance
    - f. Confidence monitor and cart
    - g. Hanging ceiling mic for use with assistive listening and program audio systems
    - h. Wireless microphone system with antenna distribution
    - i. IR based assistive listening system
    - j. Loudspeaker system (loudspeaker and amplifiers)
    - k. Wall and Control room touch panels. AV Control system
    - l. AV over IP (separate video and audio platforms) for all AV routing and switching
    - m. AV over IP management software (audio and video)
    - n. Audio DSP platform with AV over IP endpoints (portable and fixed)
    - o. All routing/switching/control rack hardware to be located in the AV Rack Room

- p. Wall, ceiling and floor plates and AV connection infrastructure/wiring
- q. Equipment racks, carts, cabling, UPS, patching and accessories to enable operation of all specified equipment and infrastructure.
- r. Network hardware for routing audio and video signals separate from campus network

#### 4. Broadcast Studio (w/ control room)

- a. Grid and pedestal mounted PTZ cameras with NDI signal routing
- b. Pedestal mounted operator camera with NDI signal routing and remote
- c. Portable PTZ cameras for use with broadcast service panels located at various locations on the building exterior. Include audio and video signal extension equipment.
- d. HD-SDI Teleprompter
- e. Camera remote controller
- f. Tally light management system
- g. On-air light for broadcast and radio
- h. Video production platform and control surface
- i. Broadcast recording system
- j. HD-SDI broadcast router
- k. HD-SDI and Audio patchbays and patch cabling
- l. Open Gear Frame an allotment for Owner selected frame modules with connections back to rack patching and signal distribution as needed
- m. Test signal and reference generator
- n. Audio and video delay
- o. Wireless IFB transmitter, antenna and receivers
- p. Digital Intercom System with operator stations and wired belt packs
  - 1) Provide a 30' rugged tactical network cable for all belt packs
- q. Dante bridge, AES bridge, HDMI to NDI converter, DMX merge and other signal routing/distribution hardware as needed for interconnection of all studio hardware
- r. Control room audio monitors
- s. Control room power distribution
- t. Radio console, audio codec and phone interface
- u. Owner furnished CATV tuners
- v. Audio mixing console, rack mounted I/O panel
- w. Audio DSP
- x. Studio monitoring microphone
- y. Wireless microphone system with transmitters, multichannel receiver and antenna distribution
- z. Control system with tabletop touch panel for studio routing control, CATV control and audio routing and exterior display routing control.
- aa. Studio ceiling speakers with talkback capability
- bb. Control room operator console furniture with seating for multiple control positions
  - 1) Cabling to be routed from within furniture system trough
- cc. Studio 4-postion desk

- 1) Desk finish and options to be confirmed with Owner during shop drawings
- dd. Wall mounted displays with articulating mounts and AV over IP connections for studio monitoring
- ee. Furniture mounted displays for control equipment monitoring/operation
- ff. Network hardware for routing of studio audio and video signals separate from campus network
- gg. Rugged cabling for all portable equipment and rack patching
- hh. Wall, ceiling and floor plates and AV connection infrastructure/wiring
- ii. Equipment racks, carts, cabling, UPS, patching and accessories to enable operation of all specified equipment and infrastructure.
- jj. All routing/switching/control rack hardware to be located in the AV Rack Room with cable ties to the Control Room and Studio

#### 5. Meeting Room

- a. (1) Wall mounted flat panel displays with CATV, wired and wireless presentation capability.
  - 1) Existing Owner Furnished display to be relocated as part of this work
- b. USB camera/audio bar with USB wall plate connection
- c. Ceiling speaker system with presentation, local input and Bluetooth audio playback capability
- d. Wall mounted button panel for source selection, routing, volume and power control

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Contractor shall install all system components including furnished equipment, and appurtenances in accordance with the manufacturer's instructions, and shall furnish all cables, connectors, terminators, interconnections, services, and adjustments required for a complete and operable system.
- B. Grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
- C. Contractor shall adhere to the following during installation of the system:
  1. Underwriters Laboratories (UL) listing for restricted access installations in business and customer premises applications. This listing is required by the National Electric Code for customer premise installations.
  2. Fire resistance requirements specified by Underwriters Laboratories in UL 1459, 2nd edition.

- D. Where undefined by codes and standards, Contractor shall apply a safe working load of at least five (5) times the rated load to all fastenings and supports of system components.
- E. The Contractor shall adhere to the installation schedule of the General Contractor and should attend all construction meetings scheduled by the General Contractor.
- F. Contractor shall place materials only in those locations that have been previously approved. Any other locations shall be approved, in writing, by the Owner.
- G. Contractor shall meet all Americans with Disabilities Act requirements including those that impact equipment mounting, placement, visibility and accessibility.
- H. All wiring and cables shall be properly dressed and/or bundled with Velcro-type hook and loop straps per Division 27 standards. Twisted wire, tape, rope, twine, phone wire and similar bits of debris usually available on site are not acceptable substitutes for proper securing hardware. All inter-rack cables and wiring must be properly routed, and where available, run in cable trays. Overhead cables must be easily removed or reworked within the cable trays. Proper care must be taken to ensure that new cables added to the trays are not stressed or intertwined with existing cables. Overhead cables may not cross perpendiculars or be suspended in mid-air without support. No support may be installed without prior approval from the Owner. All long cable runs must be properly identified at each end and every 100 feet indicating the carried frequency and communication room of origin. All cabling within the building must be cut to proper length.
- I. The Contractor shall obtain written permission from the Owner before proceeding with any work which requires cutting into or through any part of the building structures such as, but not limited to, girders, beams, concrete, carpeted or tiled floors, partitions or ceilings. The Contractor shall also consult with the General Contractor before cutting into or through any part of the building structures where fireproofing or moisture proofing could be impaired.

### 3.2 INSTALLATION

- A. System equipment shall not be installed until the environment is free of dust. A dust-free environment shall be considered one in which all construction work has been completed and the air handling system for the area has been operated continuously for at least two weeks with a filter change after one week. During and following installation of the system equipment, relay assemblies and equipment cabinets, the air handling system shall be kept operational continuously and shall be adjusted to maintain a positive pressure relative to building spaces outside the areas of installation. Openings into the installation spaces shall be kept closed, filters shall be changed at frequent intervals, equipment enclosures shall be kept closed, covers shall be installed and any other provisions for keeping the equipment, assemblies, and cabinets clean and free of dust and debris shall be employed.
- B. Verify exact location and sizes of all conduit runs and back boxes prior to rough-in.
- C. All switches, connectors, outlets, etc. shall be clearly, logically, and permanently labeled during installation.

- D. All items of equipment related to the AV system shall be installed in the designated positions as defined on the drawings.
- E. All wiring terminations shall be trimmed to the required length for proper system operation and neatly dressed. No excess wire loops shall remain in the final system unless required for maintenance access. Each system wire and cable shall be clearly marked at each end.
- F. All audio and video interconnections shall use the highest quality signal path available.

### 3.3 WIRING

- A. Wiring within equipment enclosures shall be neatly grouped or tied or run-in plastic snap cover wireway sections. All connections to panel mounted devices shall employ compression attached full 360° ring type or 'push-on' type terminators securely fastened to the device terminals. Wiring shall run behind the panel in a manner that is not visible from the operator's position. A 3" termination loop shall be formed immediately adjacent to each terminal.
- B. Terminal strips shall be fully insulated but allow insertion of test equipment probes. Each terminal segment shall be numbered to correspond with the drawings and conductor identification numbers.
- C. All wire and cable shall extend to each outlet location with complete electrical continuity and without any shorts or grounds. Cables shall run uninterrupted and un-spliced to each remote device.
- D. Cables shall be routed so as to maintain a separation of at least 2 feet from all heat sources and from ballasts, transformers, dimmers and all other sources of electromagnetic interference.
- E. Care shall be exercised during installation not to damage the cable insulation. Damaged cables shall be removed and replaced.
- F. Each cable termination shall be tagged and labeled in accordance with this specification.
- G. Wire color coding for all AV cabling shall be at the option of the Contractor, but each individual conductor shall be the same color throughout its entire length.
  - 1. Refer to Division 27 cable standards for cable color requirements.
- H. After testing is complete, audio levels on all systems shall be set to levels satisfactory to the Owner.
  - 1. Systems shall meet AVIXA A102.01:2017 Audio Coverage Uniformity standard for coverage
  - 2. **DIRECTION FOR SPECIFIER – SPECIFIC AUDIO LEVEL REQUIREMENTS HAVE BEEN INTENTIONALLY OMITTED IN THE STANDARD SPECIFICATION AS THEY ARE INFLUENCED BY THE ACOUSTIC REQUIREMENTS, MECHANICAL SYSTEMS CHOSEN AND ROOM**

ARCHITECTURAL FINISHES SELECTED FOR INDIVIDUAL SPACES.  
COORDINATE REQUIREMENTS WITH ARCHITECT AND ACOUSTICIAN  
AND ADD ANY SPECIFIC REQUIREMENTS AS NEEDED PER PROJECT.

### 3.4 SYSTEM CONFIGURATION

- A. Contractor shall provide for configuration of all devices and software into a complete and fully operational AV System.
  - 1. All configuration files shall be provided to the Owner as part of the close-out package
    - a. The Owner shall maintain ownership of any custom software files.
    - b. Contractor shall extend to the Owner a perpetual license for use and modification of any custom software files when used with systems provided as part of this scope of work.
- B. During the installation phase of the project, the Contractor shall work with the Owner to establish the baseline configuration requirements for the different AV elements.
- C. Contractor shall make best efforts to diagnose and address any audiovisual equipment network coordination, configuration, operation or stability issues prior to engaging the Owner or HUIT.
  - 1. A summary of testing and troubleshooting steps taken prior to contacting HUIT shall be provided by the Contractor as part of any request for support.

### 3.5 CONFIGURATION REQUIREMENTS

- A. An IP Addressing Plan shall be coordinated, developed, and finalized with the Owner and submitted for approval prior to implementation.
- B. VLAN(s) shall be configured to support the LAN as identified during Owner network coordination efforts.
- C. Configure AV devices for centralized management to an existing centralized AV management platform. Training shall include management of the AV devices via the management platform user interface.
  - 1. **NOTE FOR SPECIFIER: LIST SPECIFIC PLATFORMS THAT ARE IN USE AND NEED TO BE CONNECTED TO. REMOVE THIS ITEM IF NOT REQUIRED/APPLICABLE FOR THIS PROJECT**

### 3.6 TESTING

- A. Project Testing: This scope of work shall not be considered complete until On-Site Testing is completed. The purpose is to test the complete system and demonstrate that

all specified features and performance criteria are met. All requirements of the specification shall be tested with the audiovisual systems configured in each designed use case, including the highest functioning use case.

- B. Contractor shall follow the AVIXA/ANSI 10:2013 *Audiovisual Systems Performance Verification* testing and documentation process and submit a completed testing plan prior to final Owner and Design Professional testing.
  - 1. Design Professional may elect to request retesting of individual rooms following the AVIXA/ANSI 10:2013 standard until satisfied that systems are properly installed and configured.
- C. For any system or equipment type not covered in the AVIXA/ANSI 10:2013 standard, Contractor shall provide the proposed test plan/procedures for each testing phase for review by the Owner or Design Professional. The test plan for each phase of testing shall detail the objectives of all tests. The tests shall clearly demonstrate that the system and its components fully comply with the requirements specified herein. The submission of Test Plans shall adhere to the following:
  - 1. A draft test plan shall be presented to the Owner at least forty-five (45) days prior to the scheduled start of each test.
  - 2. A workshop for reviewing comments shall be conducted with the Owner at least thirty (30) days prior to the scheduled start of each test.
  - 3. A final test plan shall be submitted to the Owner at least fourteen (14) days prior to the scheduled start of each test.
  - 4. Test plans shall contain at a minimum:
    - a. Functional procedures including use of any test or sample data.
    - b. Test equipment is to be identified by manufacturer and model.
    - c. Interconnection of test equipment and steps of operation shall be defined.
    - d. Expected results required to comply with specifications.
    - e. Testing matrix referencing Specification requirements with specific test procedures.
    - f. Record of test results with witness initials or signature and date performed.
    - g. Pass or fail evaluation with comments.
- D. The test procedures shall provide conformity to all Specification requirements. Satisfactory completion of the test procedure is necessary as a condition of system acceptance.
- E. All Test plans must be reviewed by the Owner. To successfully complete a test, the test document must be signed and dated by both the Contractor and the Owner.
- F. The Owner will review, witness and validate the execution of all formal test procedures prepared by the Contractor and deliverable under the contract to assure the tests cover all requirements and that there is a conformity between the conducted test, the test results and Specification requirements.
- G. Documentation verification both interconnects and operationally, shall be part of the test. Where documentation is not in accordance with the installed system interconnect and

operating procedures, the system shall not be considered accepted until the system and documentation correlate.

- H. The Contractor shall provide the Owner or Owner representative the opportunity to participate in any or all of tests.
- I. Test Reports: The Contractor shall prepare, for each test, a test report document that shall certify successful completion of that test. Submit to the Owner's representative for review and acceptance within seven (7) days following each test. The test report shall contain, at a minimum:
  - 1. System power measurement results and settings
  - 2. Commentary on test results
  - 3. A listing and discussion of all discrepancies between expected and actual results and of all failures encountered during the test and their resolution.
  - 4. Complete copy of test procedures and test data sheets with annotations showing dates, times, initials, and any other annotations entered during execution of the test.
  - 5. Signatures of persons who performed and witnessed the test
  - 6. Test Resolution: Any discrepancies or problems discovered during these tests shall be corrected by the Contractor at no cost to the Owner. The problems identified shall be corrected and the percentage of the entire system re-tested determined by the Owner before any subsequent testing is performed.

### 3.7 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.

### 3.8 TRAINING

- A. The Contractor shall provide the Owner specified trainees with detailed as-built information. The training shall provide trainees with a working knowledge of the system design and layout, ability to configure and monitor the system, and troubleshooting methods and techniques. In addition, the training shall cover testing, maintenance, and repair procedures for all equipment and applications, which are provided under this Specification.
- B. Course materials shall be delivered to the Owner. Final delivery of the course materials shall include a master hard copy of all materials and an electronic copy in a format reviewed in advance by the Owner.
- C. The Contractor shall supply a video recording of each training course.
- D. All training shall be sequenced with the project installation and commissioning schedule to avoid training on systems which have not been fully commissioned and all punch list items addressed. Training for all Audiovisual systems under this scope of work must be completed with sufficient time for the Owner to complete training and staff onboarding prior to the system becoming operational and utilized by the Owner. The training

schedule shall be added to the General Contractor's project schedule by the Contractor for review and approval or comment by the Owner prior to schedule sign-off.

### 3.9 ACCEPTANCE

A. Acceptance will be withheld until the following have been completed successfully:

1. Acceptance of all submittals
2. Delivery of final documentation
3. Successful testing
4. Completion of training
5. Demonstrate system to designated Owner personnel as required by applicable sections of these specifications. Use submitted operation and maintenance manual as reference during demonstration and training. Demonstrate as-built records are in format required and can lead troubleshooting technicians to port level of detail in field.

END OF SECTION 274100