



Smith + Andersen

1100–100 Sheppard Ave. East, Toronto ON M2N 6N5

416 487 8151 f 416 487 9104 smithandandersen.com

AUDIOVISUAL SPECIFICATION

PROJECT NAME:

THE GREAT HALL UPGRADE

YORK REGION

17250 YONGE STREET, NEWMARKET ON,
L3Y 6Z1

OUR PROJECT NUMBER:

14008.024.AV.001

DATE:

2026-05-22

ISSUED / REVISION:

FOR CONSTRUCTION

27 00 00.01 Index

SECTION	NAME	Page #
27 00 00.01	Index	1
27 00 00.10	Audiovisual Compliance Statement	2
27 40 05.00	Audiovisual Definitions and Abbreviations	3
27 40 10.00	General Instructions for Audiovisual System Installation	7
27 41 00.00	Audiovisual System Scope of Work	25
27 41 16.11	Displays	45
27 41 16.15	Control Systems	46
27 41 16.16	Audio Video Transmission Systems	48
27 41 23.10	Audiovisual Cabinets, Racks, Frames and Enclosures	52
27 41 23.11	Audiovisual Cabling	55
27 51 50.00	Audiovisual Networking	66

END OF SECTION

27 00 00.10 Audiovisual Compliance Statement

Our company has reviewed all specifications identified on the Audiovisual Index 27 00 00.00, all addenda and contract drawings as identified on AV-000 and confirm our bid submission is compliant with the requirements described in these contract documents. We commit to delivering the project in compliance with the contract documents at the price submitted on the tender form.

Signing Officer Signature

Signing Officer Name

Company

END OF SECTION

27 40 05.00 Audiovisual Definitions and Abbreviations

1. General

1.1. DEFINITIONS

1.1.1. Generally, the following definitions are used in this Division:

Addendum	-	Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports.
AV Contractor	-	The successful bidder to this Specification responsible for the supply and installation of the Audiovisual Systems as detailed in this document & associated drawings.
AV Consultant	-	Smith + Andersen Consulting Engineers
Deficiency Review	-	A meeting between the Owner, AV Contractor and AV Consultant to review the Project to determine whether the work meets the requirements of the Owner as detailed in this document and associated drawings.
Final Acceptance	-	The date which the Owner and AV Consultant have agreed the Project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout. Refer to section 27 40 10 "Final Acceptance" for greater detail.
Project	-	Supply and installation of a complete and functional Audiovisual System as described in this document.
Provide	-	Supply, install, terminate, test and commission.
Retainage	-	Contract amount equating to 10% of the value of the audiovisual contract. The is the value of testing, training, commissioning, deficiency correction and close out documentation submittal.
Substantial Completion	-	The period between the deficiency review meeting date and the date of final acceptance. The audiovisual system physical installation, programming and Contractor commissioning is complete and ready for review by Consultant and Owner.

1.2. ABBREVIATIONS

1.2.1. Generally, the following abbreviations are used in this Division:

ADA	-	Americans with Disabilities Act
AES	-	Audio Engineering Society
AFF	-	Above Finished Floor
AGC	-	Automatic Gain Control
AHJ	-	Authority Having Jurisdiction
ALS	-	Assistive Listening System
AV or A/V	-	Audiovisual
AVB	-	Audio Video Bridging

AVC	- Advanced Video Coding
AWG	- American Wire Gauge
BACnet	- Building Automation and Control Networking Protocol
BAS	- Building Automation System
BICSI®	- Building Industry Consulting Service International
BOM	- Bill Of Material
BTU	- British Thermal Unit
CAD	- Computer Aided Design
CATV	- Community Antenna Television (Cable Television)
CCIA	- Computer Communications Industry Association
CCTV	- Closed Circuit Television
CSA	- Canadian Standards Institute
CTS	- Certified Technology Specialist
CTS-D	- Certified Technology Specialist Design
CTS-I	- Certified Technology Specialist Installation
DANTE	- Digital Audio Network Through Ethernet
dB	- Decibel
dBa	- A-weighted Decibels
dBm	- Decibel milliwatt
dBmV	- Decibel millivolt
DCI	- Digital Cinema Initiatives
DHCP	- Dynamic Host Configuration Protocol
DM	- DigitalMedia
DNS	- Domain Name System
DSP	- Digital Sound Processing
DVI	- Digital Visual Interface
EBU	- European Broadcasting Union
EDID	- Extended Display Identification
EIA	- Electronics Industry Alliance
EMI	- Electromagnetic Interference
EMI/RFI	- Electromagnetic Interference / Radio Frequency Interference
FCC	- Federal Communications Commission
ft	- Foot / Feet
ft²	- Square Foot / Feet
FTP	- File Transfer Protocol
Gb/s	- Gigabit per Second
GC	- General Contractor
GHz	- Gigahertz
GUI	- Graphical User Interface
HDCP	- High-Bandwidth Digital Content Protection
HDMI	- High-Definition Multimedia Interface
Hz	- Hertz
IEC	- International Electrotechnical Commission
IEEE®	- Institute of Electrical and Electronics Engineers, Inc.®
IG	- Isolated Ground
in	- Inch
in²	- Square Inch
I/O	- Input / Output (Device)
IPv4	- Internet Protocol version 4
IR	- Infrared
ISDN	- Integrated Services Digital Network
ISO	- International Organization for Standardization
IT	- Information Technology
kb	- Kilobit
kB	- Kilobyte
kg	- Kilogram
Km	- Kilometre
KSVs	- Key Selection Vectors
kV	- Kilovolt
kVA	- Kilovoltampere
kW	- Kilowatt

kWh	-	Kilowatt hour
LAN	-	Local Area Network
laser	-	Light Amplification by Stimulated Emission of Radiation
lb	-	Pound
LCD	-	Liquid Crystal Display
LED	-	Light Emitting Diode
LSZH	-	Low Smoke Zero Halogen
m	-	Metre
m ²	-	Square Metre
mA	-	Milliampere
Mb	-	Megabit
MB	-	Megabyte
Mb/s	-	Megabit per Second
MB/s	-	Megabyte per Second
MHz	-	Megahertz
MIDI	-	Musical Instrument Digital Interface
mm	-	Millimetre
MM	-	Multimode
MMF	-	Multimode Fibre
ms	-	Millisecond
mW	-	Milliwatt
MW	-	Megawatt
NFPA	-	National Fire Protection Association
NIC	-	Network Interface Card
OD	-	Outside Diameter
OEM	-	Original Equipment Manufacturer
OFE	-	Owner-furnished equipment
OLED	-	Organic Light Emitting Diode
OTDR	-	Optical time domain reflectometry
PBX	-	Private Branch Exchange
PDU	-	Power Distribution Unit
PoE	-	Power-Over-Ethernet
POTS	-	Plain Old Telephone Service
PTZ	-	Pan, Tilt, Zoom
PVC	-	Polyvinyl Chloride
QA	-	Quality Assurance
QC	-	Quality Control
QoS	-	Quality of Service
QXGA	-	Quad Extended Graphics Array
RCA	-	Radio Corporation of America
RCDD®	-	Registered Communications Distribution Designer
RF	-	Radio Frequency
RFI	-	Radio Frequency Interference
rms	-	Root Mean Square
RU	-	Rack Unit (1.75")
RX	-	Receiver
SDI	-	Serial Digital Interface
SI	-	International System of Units (Le Système International d'Unités)
SIP	-	Session Initiation Protocol
SLA	-	Service level Agreement
SM	-	Singlemode
SNR	-	Signal-to-Noise Ratio
S/PDIF	-	Sony/Phillips Digital Interface
SPL	-	Sound Pressure Level
STP	-	Shielded Twisted Pair
STP-A	-	Shielded Twisted Pair A
TCP	-	Transmission Control Protocol
TDR	-	Time Domain Reflectometer
TFT	-	Thin Film Transistor
TIA	-	Telecommunications Industry Association
TP	-	Twisted Pair

TR	- Telecommunications Room
TRS	- Tip, Ring, Sleeve
TS	- Technical Standard
TV	- Television
UHD	- Ultra high definition
ULC	- Underwriters Laboratories of Canada
UPC	- Universal Product Code
UPS	- Uninterruptible Power Supply
USB	- Universal Serial Bus
UTP	- Unshielded Twisted Pair
V	- Volt
VA	- Volt-Ampere
VESA	- Video Electronics Standards Association
VGA	- Video Graphics Array
VLAN	- Virtual Local Area Network
VoIP	- Voice over Internet Protocol
VPN	- Virtual Private Network
W	- Watt
WAN	- Wide Area Network
WAP	- Wireless Application Protocol
WiFi	- Wireless Fidelity
Wi-Fi	- Wireless Fidelity
WLAN	- Wireless Local Area Network
WUXGA	- Widescreen Ultra Extended Graphics Array
WXGA	- Wide Extended Graphics Array
XGA	- Extended Graphics Array
XLR	- External Line Return

- 2. Products
 - 2.1. NOT USED
 - 3. Execution
 - 3.1. NOT USED
- END OF SECTION

27 40 10.00 General Instructions for Audiovisual System Installation

1. General

1.1. GENERAL

1.1.1. Conform to the requirements of Division 0, Division 1 and Division 25 which applies to and forms part of all sections of the work. If these are not included within Tender package, AV Contractor can request a copy from the Owner's representative.

1.1.2. This Specification is for the supply and installation of AV Systems at the 'facility' for the following project:

17250 Yonge Street
Newmarket Ontario

1.2. WORK INCLUDED

1.2.1. Read and comply with all sections of this document.

1.2.2. This Specification is to be read in conjunction with the corresponding Tender Drawings, which together, describe the complete scope of work, associated systems and system requirements necessary to achieve the intended performance, installation and functions of the Audiovisual Systems to be provided. Equipment shown on drawings but not written specifications or vice versa does not preclude the AV Contractor from supplying equipment. Take note of the "Division of Responsibility" table on drawing AV-000.

1.2.3. The Specification is divided into Sections which are not intended to identify contractual limits between Sub-Contractors nor between the AV Contractor and any Sub-Contractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.

1.2.4. Provide AV components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2.5. Provide all labour, materials, tools, and equipment required for the complete installation of work called for in all sections of the Contract Documents.

1.3. ERRORS AND OMISSIONS

1.3.1. Errors and/or omissions in the proposal documents shall be reported to the AV Consultant and Owner immediately during the time of response. Items not reported during this time shall not relieve the AV Contractor of the responsibility for providing properly functioning systems as specified or intended in the Contract Documents.

1.3.2. The AV Contractor shall review all reference drawings and site conditions, and report any discrepancies prior to award of contract, including additional electrical infrastructure requirements, to the AV Consultant as part of the review drawing submission.

1.3.3. While every attempt has been made to ensure all information is correct at the time of publication, verification for the availability of products specified and correct part numbers shall be the responsibility of the AV Contractor. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued products that meet the requirements of these specifications at no additional cost to the Owner. Any errors and/or omissions in this Specification shall be included with their bid submissions.

1.4. BID SUBMISSION

1.4.1. Bidder Information

1.4.2. Supply a description of the firm complete with the following information:

.1 Main contact information

- .2 Number and type of full-time staff
- .3 Corporate history
- .4 Office performing the work (if not the main office)
- .5 Product Representation
- .6 Certifications and Service Authorizations
- .7 Test Equipment (eg. Fluke, Sencore, SMAART)
- .8 Facilities
- .9 Financial Information
- .10 Average Gross Receipts (for past 5 years)
- .11 Bonding Capacity – state whether Performance Bond ever exercised
- .12 Insurance Limits
- .13 Bank Credit References
- .14 Recent and current litigation experience, both project and non-project related
- 1.4.3. Project Experience
 - .1 Provide summary and references for project experience of similar scope and scale.
 - .2 Qualified bidders should have completed a minimum of two projects of similar scope and scale within the past 24 months. Contact names and telephone numbers are required for these projects.
- 1.4.4. Statement of Qualifications
 - .1 The AV Contractor shall provide all required manufacturer certifications to procure, install and support all products and solutions indicated in this specification.
 - .2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.
 - .3 Please see “Warranty” section 1.12 for further submission requirements.
- 1.4.5. Project Schedule
 - .1 Provide a project schedule with milestones and completion dates. Milestones should include:
 - .1 Kick-off meeting (with Owner, general Contractor and AV Consultant)
 - .2 Approval drawing submission
 - .3 Coordination meeting with client’s IT department (if required)
 - .4 Equipment delivery to site
 - .5 Room-by-room completion dates
 - .6 Substantial Completion date
 - .7 Date for submission of Owner manuals and as-built drawings
 - .8 Training
- 1.4.6. Project Execution
 - .1 Provide a description of all techniques used to meet major deliverables including schedules, meeting reports, escalation procedures, approval drawings, testing, on-site installation, equipment and user manuals, training and commissioning.
- 1.4.7. Post Commissioning
 - .1 Provide a description of the Bidder’s post commissioning service procedures including response times, extended warranty information and extended services.
 - .2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.
 - .3 Please see section 27 40 10 clause 1.12 “Warranty” for further submission requirements.

1.4.8. Compliance Statement

- .1 The Bidder is required to review and sign the included compliance statement. The bidder's Compliance Statement must be provided with the bid response.

1.4.9. Project Personnel

- .1 Provide Curriculum Vitae or Statement of Qualifications for all project personnel. CVs should include past project experience, educational background and relevant certifications. Contractor must have personnel with AVIXA Certified Technology Specialist (CTS) designation.
- .2 Bid response should include CVs for the following personnel:
 - .1 Account Executive/Client Contact
 - .2 Project Manager
 - .3 Project Engineer
 - .4 Programmers (Control systems and DSP)
 - .5 Site Lead
 - .6 All other assigned technical personnel
- .3 Approved SubContractors
 - .1 All subContractors must be declared at the time of bid submission. Owner reserves the right to withdraw its purchase order at any time should the Systems Contractor engage a subContractor that does not meet the approval of the Owner.

1.4.10. Bill of Materials

- .1 Responses should include a complete and accurate itemized list of all equipment to be supplied including wire and all hardware. The list should indicate the manufacturer, manufacturer's model number and unit of quantity. The list should be divided according to subsections in section 27 41 00.00. Proposed substitutions should be explicitly stated. If the manufacturer has permanently stopped fabrication of a specific item or has replaced an item with an almost identical item but with new model number, this item should be explicitly noted in this list.
- .2 The AV Contractor shall review and submit a final Bill of Materials to the Owner four weeks prior to ordering product from the manufacturer/distributors.
- .3 Include in bid all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, taxes and all necessary and related items required to provide complete and operational systems shown and described.
- .4 Substitutions
 - .1 The AV Contractor is encouraged to review the equipment specified herein and suggest alternates that may provide increased functionality and savings to the Owner without degradation to system performance or functional requirements.
 - .2 The AV Consultant's decision regarding the acceptance or rejection of the proposed substitution shall be final. Substitutions may be accepted if the delivery of the component or item is such that it shall not jeopardise the construction schedule. Otherwise substitution shall not be allowed.
 - .3 The Owner reserves the right to accept or reject any alternate without question.
 - .4 Substitutions shall be proposed during the question period of the bid process.

1.4.11. Pricing

- .1 Provide each of the following in this section as separate sections of the bid.
- .2 Base Price
 - .1 The respondent shall state a stipulated price to provide all work shown and described in the System Specification that shall include all premium and/or overtime charges involved to finish the stages of work before the milestones stated under Schedule. This price shall exclude all Add/Delete and Option pricing
- .3 Detailed Pricing

- .1 Responses are to include a complete and accurate list of all AV equipment to be supplied including wire. Include name of manufacturer, model number, unit quantity and itemized pricing. Provide subtotals according to subsections in Audiovisual System Scope of Work.
- .4 Add/Delete Option Pricing
 - .1 An Add/Delete Option specifies work which may be added to/deleted from the Base Price at the discretion of the Owner. It can be carried separately at the discretion of the Owner. The bidder shall state a separate price for each Add/Delete option which shall increase/decrease to the total purchase price of the work, including all premiums/overtime charges.
- .5 Alternate Pricing
 - .1 Indicate increase/decrease to overall purchase price of work as a result of switching from one specified item to another.
- .6 Unit Labor Rate
 - .1 State hourly rates for all audiovisual specific trades on a separate page as part of the submission.
- .7 Taxes TO BE ADDED
 - .1 Include as a separate line item applicable taxes.
- 1.5. CODES, STANDARDS AND REGULATIONS COMPLIANCES
 - 1.5.1. The AV Contractor must ensure all federal, provincial, and municipal laws, codes, regulations are adhered to.
 - 1.5.2. All products installed must meet or exceed all Local, Provincial and Federal Building, Fire, Health, Safety and Electrical Codes.
 - 1.5.3. The AV Contractor is also responsible for any Sub-Contractors that are providing work or services under the same contract. The AV Contractor, where applicable, shall provide proof that final inspections have been adhered to and are completely satisfactory and clear with regards to the authority having jurisdiction, including any work performed by any and all Sub-Contractors. All costs associated with meeting these requirements shall also be carried within the price of the project.
 - 1.5.4. Comply with the following industry standards:
 - .1 CSA Standard T527 (ANSI/TIA/EIA-607) - Grounding and Bonding for Telecommunication in Commercial Buildings
 - .2 ANSI/AVIXA 10:2013– Audiovisual Systems Performance Verification
 - .3 EIA RS-310-C – Racks and Associated Equipment
 - .4 AVIXA International - AV Installation Handbook, 2nd Ed. – The Best Practices for Quality Audiovisual Systems
 - .5 ANSI/AVIXA 2M-2010 – Standard Guide for Audiovisual Systems Design and Coordination Processes
 - .6 ANSI/AVIXA 1M-2009 – Audio Coverage Uniformity
 - .7 ANSI/AVIXA 3M-2011 – Projected Image Contrast Ratio
 - .8 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems
 - .9 AVIXA F501.01:2015 – Cable Labeling for Audiovisual Systems
 - .10 ANSI/TIA-568.0-D – Generic Telecommunications Cabling for Customer Premises
 - .11 TIA-568.1-D – Commercial Building Telecommunications Cabling Standard

1.6. SUMMARY OF WORK AND AV CONTRACTOR PERFORMANCE

- 1.6.1. The A/V systems described herein, shall include providing and integrating a fully functional and seamlessly integrated Audiovisual system complete with high quality professional and commercial grade audiovisual and electronic products, which include for the following equipment and systems but not limited to:
- .1 Media Control Systems
 - .2 Flat Panel Displays
 - .3 Multimedia Projectors
 - .4 Motorized Projection Screens
 - .5 AV Control Systems including Touch Panel and other controllers
 - .6 Audio Conferencing Systems
 - .7 Loudspeakers
 - .8 Audio-Video Source Equipment
 - .9 Audio-Video Reinforcement and Distribution Systems
 - .10 Audio-Video Switching
 - .11 Audio-Video Interface Equipment
 - .12 Audio-Video Cabling and Terminations
 - .13 Ethernet and Control Support
 - .14 Architectural Elements and Mounting Hardware
 - .15 Display or projector lifts
 - .16 Video cameras (fixed or PTZ)
 - .17 Audiovisual production and broadcast consoles
- 1.6.2. Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the work. All dimensions and conditions must be verified at the job site prior to installation. The AV Contractor to include for any additional components, slack of cabling etc. as required to complete and neatly finish the installation throughout the interior design.
- 1.6.3. In assessing differences between customer specifications and vendor equipment specifications, the AV Contractor shall ensure customer's maximum specified parameters are met.
- 1.6.4. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued product that meets the requirements of these specifications.
- 1.6.5. The AV Contractor shall be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.
- 1.6.6. In addition to providing the services and materials as described, the AV Contractor is required to provide for the following services and perform the following on-site work.
- .1 Coordinate all AV requirements and system components with the project and construction team of all disciplines as required or specifically stated within the package.
 - .2 If required, remove any existing AV equipment not required for reuse and dispose of the equipment using environmentally accepted electronic waste disposal methods. Provide a disposal report to the project team of equipment being disposed of, include make, model and serial number for each item. Removal and disposal of all existing cabling from the ceiling space, walls and within conduit including all accessories (jacks, furniture adapters, decora straps, faceplates, surface mount boxes, patch panels, patch cords, punch down blocks, cross-connect wire etc.)
 - .3 Coordinate and ensure all AV cabling is provided via conduit infrastructure and raceways correctly installed to support the AV systems and related cabling networks. Where conduit

- infrastructure is not required, supply and install cable slings and J-hooks to supports any free cables. Any discrepancies shall be reported to the AV Consultant immediately.
- .4 Coordinate and verify the AV infrastructure required for all equipment including, but not limited to, projectors, loudspeakers and associated mounting hardware prior to installation. The AV Contractor to provide for any infrastructure that has not been coordinated (i.e. backboards).
 - .5 Any other structural support, blocking or infrastructure to be provided by others and required to support the AV systems shall be coordinated by the AV Contractor. The AV Contractor to provide for any infrastructure that has not been coordinated.
 - .6 Coordinate and ensure all AV related millwork is correctly implemented and provided to support the AV systems. The AV Contractor shall review all furniture shop drawings and report to the AV Consultant if there are any issues with cutouts, pathways, ventilation, etc.
 - .7 Pre-build and test all systems possible prior to delivery of equipment to project site.
 - .8 Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.
 - .9 Include for on-going project management, coordination among trades for all AV work and any required site meetings.
 - .10 Label all equipment to correlate with operation and maintenance manuals. Labelling schemes shall be confirmed with the AV Consultant prior to installation.
- 1.6.7. Supply all AV outlets, terminating hardware and selected connectivity devices as outlined in this Specification. All outlet shall be metal. Plastic decora plates are not acceptable.
 - 1.6.8. Supply all hoists and scaffolds necessary to install AV equipment.
 - 1.6.9. Visually inspect all equipment for damage or defects prior to installation. Damaged or defective materials shall be reported to the AV Consultant and the Owner.
 - 1.6.10. The AV Contractor is responsible for loss or damage of any and all system equipment until it is permanently fastened to the building or signed over to the Owner.
 - 1.6.11. All materials and equipment obtained for this contract shall be through manufacturer authorized distribution channels and the warranty shall be supported in the jurisdiction of the Owner. Under NO circumstances shall 'Grey Market' or 'Refurbished' items be acceptable
- 1.7. DRAWINGS, CHANGES AND INSTALLATION
 - 1.7.1. The location, arrangement and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the AV Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
 - 1.7.2. The location and size of existing services shown on the drawings are based on the best available information. The AV Contractor shall verify the actual location of existing services in the field before work is commenced.
 - 1.7.3. Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.
 - 1.7.4. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
 - 1.7.5. Where equipment is shown to be 'roughed in only' obtain accurate information from the AV Consultant before proceeding with the work.
 - 1.7.6. Location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on drawings (if shown) is diagrammatic. The AV Contractor to coordinate on-site or ask direction from AV Consultant to address any discrepancies on site.
 - 1.7.7. The AV Contractor is responsible to mark-out their work and fully co-ordinate with all other trades. The AV Contractor shall review architectural and interior design drawings for exact locations of equipment. Review with AV Consultant prior to rough in.

1.8. FINAL ACCEPTANCE

- 1.8.1. Final acceptance is the date which the Owner and AV Consultant agree the project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout.
- 1.8.2. A retainage equating to 10% of the value of the base contract shall be released on the date of Final Acceptance. 10% is equated as the value of testing, training, commissioning, deficiency correction and close-out documentation submittal.
- 1.8.3. The step-by-step process to reach Final Acceptance is as follows:
- .1 AV Contractor declares the scope of work is complete and ready for the deficiency walk-through.
 - .2 AV Contractor to complete the Compliance Checklist as supplied by the AV Consultant prior to deficiency walk-through.
 - .3 Deficiency walk-through visit between AV Consultant, AV Contractor and Owner Representative to review all systems to ensure compliance with the design intent.
 - .4 Following the deficiency walk-through, a final Job Report shall be issued by the AV Consultant outlining any deficiencies or outstanding items to be completed. The AV Contractor shall be responsible for making all corrections as identified in the report. A second visit may be required depending on the extensiveness of deficiencies.
 - .5 Submittal of as-built drawings, control and DSP program source code and manuals as stated in section 3.
 - .6 Training sessions supplied as described in this specification. Training sign-off sheets from each training session including a list of participants.
 - .7 Warranty letter with the start of service period marked as the date of final acceptance.

1.9. LABOUR

- 1.9.1. The AV Contractor must comply with all job-site requirements for the duration of the project.
- 1.9.2. The AV Contractor shall not assign or sub-contract any work without the prior written consent of the Project Manager. A list of sub-Contractors shall be submitted with the Tender response.
- 1.9.3. The AV Contractor agrees to use only tradesmen who are fully trained, qualified and experienced on the installation, termination and testing of the AV System Solution. The AV Contractor must have their AVIXA Certified Technology Specialist designation.
- 1.9.4. The AV Contractor shall supply unionized workers on construction sites where this is a requirement.

1.10. PROGRESS BILLING EVALUATIONS

- 1.10.1. Monthly progress billings shall be issued by the AV Contractor and payment certificates shall require approval from AV Consultant. The AV Contractor shall bill according to an estimate of the percentage of the completed AV sub-systems. Progress billings shall not be reviewed unless they are submitted in the format outlined in the following example:

BASE CONTRACT	
Total Contract Amount	\$250,000.00
Tender Completed to Date	\$125,000.00
Amount Previously Approved	\$25,000.00
Amount of this Draw	\$100,000.00
Less 10% Holdback	\$10,000.00
Amount of this Draw (less 10% holdback)	\$90,000.00
CHANGES	
Total Contract Changes:	\$5,000.00
Total Changes Completed to Date	\$2,500.00
Amount Previously Approved	\$0.00
Amount of this Draw	\$2,500.00
Less 10% Holdback	\$250.00
Amount of this Draw (less 10% holdback)	\$2,250.00

- 1.10.2. The AV Contractor shall not bill for materials that are not on-site and in the process of installation.
- 1.10.3. The AV Contractor may be asked to revise the amount being billed based on the AV Consultant's assessment of project progress and completed systems.
- 1.10.4. The AV Contractor shall provide current site progress photos with each draw to support the amounts requested.
- 1.10.5. The following milestones shall be deemed as acceptable for monthly draw (holdback not included):
- .1 Deposit and kick off – 25%
 - .2 Shops submitted & Reviewed – 35%
 - .3 Cables pulled/Site prepared – 45%
 - .4 Equipment delivered on-site – 60%
 - .5 Equipment installed – 80%
 - .6 Substantial Completion – 90%
 - .7 Project Complete & Close out Document Received – 100%
 - .8 all above do not include holdback
- 1.11. TRAINING
- 1.11.1. The AV Contractor shall provide a comprehensive review with the Owner to cover all system operation and maintenance.
- 1.11.2. Training shall be provided in multiple sessions, within a minimum total of sixteen (16) hours. Each session shall be a minimum of two (2) hours in length.
- 1.11.3. One (1) training session shall be scheduled immediately following final acceptance by the AV Consultant of the system.
- 1.11.4. Training materials shall be provided to the users prior to scheduled session.
- 1.11.5. The Owner shall have the ability to schedule sessions within the warranty period at mutually acceptable dates and times.
- 1.11.6. Provide a sign-off sheet for each training session. The sign-off sheet shall include:
- .1 A list of attendees
 - .2 Topics covered within session
 - .3 Date, time and duration of session
 - .4 Signature by an Owner's representative to confirm session was performed and completed to the satisfaction of the Owner.

- 1.12. WARRANTY
- 1.12.1. Provide a written warranty for all work of the AV system for a period no less than one (1) year from the date of substantial completion as certified by the AV Consultant. Warranty certificate shall be submitted as part of the close out documentation as described in Final Acceptance
- 1.12.2. Warranty shall cover the installation and equipment to be free of all defects resulting from faulty components, workmanship, installation or incorrect calibration. Replacements and repairs shall be made without cost to the Owner.
- 1.12.3. Provide the name of a contact, phone number and 24 hour emergency number and insert into all manuals and update as required. Ensure that all contact information is kept current.
- 1.12.4. All service calls should be answered or returned within four hours between 8:00am and 6:00pm (local time). All onsite responses should be within 24 hours.
- 1.12.5. Perform onsite replacement of failed equipment. All failed equipment must be replaced by identically functional and technically equivalent device. Timelines for equipment replacement have been separated into two types:
- .1 Critical Equipment
 - .1 Replacement must be provided by next business day of the initial service call.
 - .2 This includes any piece of equipment that renders the system of a room not useable for either conferencing or presentation capabilities.
 - .3 Temporary/rental equipment of similar functionality is acceptable upon approval from Owner at no additional cost.
 - .2 Non-critical
 - .1 Replacement must be provided at best effort within a week of the initial service call.
 - .2 This includes any piece of equipment that limits the functionality of a room system.
- 1.12.6. The system warranty shall include parts and labour for the duration of the warranty.
- 1.12.7. Warranties offered by manufacturers that exceed the AV Contractors installation warranty, shall be reported and noted with the Owner and recorded in the manuals. The AV Contractor shall be responsible for managing these extended warranties. Additional costs regarding removal, shipping and re-installation after the installation warranty period has expired, shall be reported to the Owner prior to commencing work.
- 1.12.8. All custom programming shall be warranted against faults and deficiencies for the duration of the installation warranty commencing at date of Final Acceptance. Any and all necessary changes under this warranty are to be at no cost to the Owner and the AV Contractor shall notify the AV Consultant of such changes.
- 1.12.9. When custom programming is used to mimic a manufacturer's graphical user interface to provide a consistent graphical user experience, the AV Contractor shall update the custom programming at no cost during the warranty period in the event that a firmware updated changes the manufacturer's graphical user interface. For example, if a project contains both Cisco and Crestron Touch panels, any changes made by Cisco to their graphical interface shall result in the AV Contractor adjusting the custom programming to reflect that change. Allow for one update to be complete within the last 60-days of the warranty period.
- 1.12.10. The AV Contractor must follow-up with the Owner ninety days after Final Acceptance to investigate any potential issues or concerns relating to the completed system. Any concerns raised shall be addressed appropriately and with the AV Consultant for clarification.
- 1.12.11. The AV Contractor shall provide one (1) preventative maintenance visit for the extent of the warranty period at no additional cost to the Owner. This system maintenance visit shall not be required until after duration of six (6) months after Final Acceptance. Subsequent services shall be coordinated and agreed to by Owner.

1.13. EXTENDED WARRANTY

- 1.13.1. Any extended warranty or service plan commencing after the installation warranty, may be offered by the AV Contractor to the Owner. Communications regarding this service must commence at least sixty (60) days prior to warranty expiration, at which time, the AV Contractor is responsible to update any firmware and software available for system components to the latest version and verify that update has not affected the functional requirements and system performance as outlined in within this scope of work.

2. Products

2.1. NOT USED

3. Execution

3.1. WORKMANSHIP AND BEST PRACTICES

- 3.1.1. The AV Contractor is responsible for the requirements of the practices and testing requirements detailed in this section.
- 3.1.2. Equipment installed by the AV Contractor shall not present safety hazards to the public, to other trades, or to equipment operators.
- 3.1.3. All equipment must be sufficiently ventilated when operating under worst-case power and heat dissipation scenarios.
- 3.1.4. Any equipment or material not directly specified within this document but still required for a fully functioning system shall be of commercial standard and high quality.
- 3.1.5. Submit proposed equipment and device samples to AV Consultant if requested.
- 3.1.6. Workmanship is as important a consideration for the overall job as functionality. Fabricate and install all equipment in accordance with the manufacturers' recommendations and the AV Consultant's specifications. Coordinate with other trades and the AV Consultant to provide an installation of the highest quality.
- 3.1.7. Before the system is deemed complete and ready for final acceptance, all hardware and software issues shall be rectified by AV Contractor and reviewed by AV Consultant.

3.2. APPROVAL DOCUMENTATION

3.2.1. General

- .1 Prior to ordering equipment, commencing work on site or expending labor on programming time provide the information detailed in this section.
- .2 Maintain a copy all documentation and software files for a minimum of three (3) years and provide accessibility to the Owner at any time within that time frame.

3.2.2. Equipment Cutsheets

- .1 Prior to ordering equipment, submit all equipment cutsheets to be included in the project. Identify all colour choices. Ensure cutsheets are submitted through the established construction process. The general Contractor, architect, interior designer and AV Consultant shall review the cutsheets.
- .2 Provide a spreadsheet of all items that are available to be ordered.
- .3 Organize and name the cutsheets according to product specification types identified in 27 41 00 Audiovisual System Scope of Work Part 2 "Products".
- .4 Indicate all colour choices on the spreadsheet.
- .5 Submit the spreadsheet for approval by the Owner or their representatives and the project team prior to ordering of any equipment.

- .6 Cutsheets for different equipment shall have their own dedicated file. The cutsheet file title shall be formatted as follows: "MANUFACTURER – MODEL NUMBER". Identify the file format naming convention in the spreadsheet.

3.2.3. Approval (Shop) Drawings

- .1 The AV Contractor must obtain written approval of shop drawings from the AV Consultant and/or Owner prior to procurement of equipment and commencement of work on site unless directed otherwise by the AV Consultant.
- .2 Approval drawings are defined as drawings required to execute the job to the standards and conformance of the specification and contract drawings.
- .3 Approval drawings are used to ensure conformance with the project system design. Only compliance with the Contract Documentation shall be reviewed as part of the approval process. Corrections or comments submitted by the AV Consultant do not relieve the AV Contractor of conformance to the specification and contract drawings.
- .4 The AV Contractor shall provide to the AV Consultant a complete set of electronic approval drawings in PDF format. Bound hard copies of shop drawings / engineering specifications must be made available on request by the AV Consultant and/or Owner.
- .5 Approval drawings should include:
 - .1 Cable pull schedules which includes wire numbers, source and destination locations, cable type, AV system serviced and conduit the cable is to be run within.
 - .2 AV system functional diagrams that show the interconnection of all equipment. For each wire indicate wire number (numbering scheme should indicate wire type). At each device connection indicate connector and termination type. For each device or device group identity type, model and location. For each multi-pin connection provide pin/conductor/function detail. For 70 V speakers indicate transformers with loudspeaker tap connections.
 - .3 Front and rear equipment rack elevations including rack accessories. Provide all specifications for equipment rack and accessories. Provide AC rack power distribution scheme.
 - .4 Wall plate, bulkhead and floorbox plate layouts. Give each plate a unique identifier. Give each connector a unique identifier.
 - .5 Sightline studies, equipment installation and any other details that clearly communicates the AV Contractor's installation methodology to the AV Consultant.
 - .6 For any custom or bespoke mounting solution designed by the AV Contractor or their representatives, the AV Contractor shall obtain a Structural Engineer stamp with appropriate jurisdiction in the region of that installation on the drawing. The shop drawing with the stamp shall be resubmitted for record. Installation of device or system shall not commence without a stamped drawing.
 - .7 Software flow diagrams and any preliminary control system programming code.
- .6 Include annotations, amendments and or comments as required. These must be corrected where noted and if modifications are needed or if added equipment is needed for the system to function as intended, there shall be no changes to the contract value as the AV Contractor is responsible to provide a proper working system. Corrections shall be made in a timely manner as to not impact Construction schedule or delivery of system.

3.2.4. Graphical User Interfaces

- .1 Provide preliminary graphical user interfaces for touch panels, custom software, button interfaces or any other control surfaces. Format the document in a method that clearly indicates menu navigation hierarchies.
- .2 Submit user interfaces for review prior to the commencement of system programming. See section 27 41 16.15 Control Systems for further details.
- .3 Coordinate an on-site workshop with the Owner's user group to review the proposed interfaces for Owner feedback. This workshop should occur after GUIs are developed, before detailed

programming is completed. Allow for one (1) major revision and one (1) minor revision to the interfaces following the workshop.

3.3. AS-BUILT DRAWINGS

3.3.1. As-Built Drawings

- .1 As-Built Drawings shall include:
 - .1 Approval drawings revised to reflect as-built changes.
 - .2 Device locations showing all floor, wall and ceiling equipment locations
 - .3 Elevation drawings of all mounted AV equipment.
 - .4 Riser/cable diagrams indicating system conduit, back boxes, connector, and cable interconnections. Indicate cable quantity and type for each cable run.
 - .5 Functional line diagram of the completed system per specification
 - .6 Metalwork fabrication drawings can be excluded.
 - .7 Include any other drawings indicated in the specification.
 - .8 Any diagrams that is required for a complete description of the system.
 - .9 Supply two (2) soft copies of As-Built Drawings in PDF and AutoCad format. One copy shall be for the Owner, the other for the AV Consultant.

3.4. SYSTEM MANUALS

3.4.1. Approval System Manuals

- .1 Provide two soft copies of the System Manual, one to the AV Consultant and one to the Owner in PDF format by email/FTP for review and approval.
- .2 All operation and maintenance manuals and all testing and commissioning reports shall be provided to Owner and Owner's representative. Any deficiencies found during the testing or commissioning phase of work, shall be reported immediately to the Owner and the Owner's representative.
- .3 Manuals shall contain a minimum of the following:
 - .1 Detailed table of contents
 - .2 Title page which clearly indicated Project Name and Document Title.
 - .3 Contacts and credits page.
 - .4 User operating instructions with detailed views of various systems for the day-to-day user. Include all control panel layouts, screen dumps, DSP control interfaces, and any other GUI.
 - .5 Manufacturer product manual(s) and literature for all components. Include technical system manuals for all systems described in the specification which should include all service procedures.
 - .6 Software instruction manuals.
 - .7 Copies of all approvals, stamps and inspection certificates.
 - .8 Optimally configured settings for all signal processing equipment, zone selections, gain settings and control systems.
 - .9 Performance data of completed system test results.
 - .10 Amplifier connections and corresponding test results at normal operation.
 - .11 Termination records, for strips, switches, floor plug connections.
 - .12 Warranty Certificate with statement of completion.
 - .13 List of manufacturer's warranties by date of expiration.
 - .14 Room configuration procedures.

- .15 Troubleshooting activities
- .16 Service support contact numbers divided by Account Manager and 24/7 support staff.
- 3.4.2. As-Built System Manuals
 - .1 After AV Consultant sign-off of Approval Manuals, Provide two soft-copy sets in PDF format by cloud storage/FTP/email to the project team, AV Consultant and the Owner. At the request of the Owner or AV Consultant, supply one bound hard copy set of manuals.
 - .2 The Owner reserves the right to reproduce all documents for internal corporate use.
 - .3 The AV Contractor shall ensure an electronic copy of the close-out documentation are available to the Owner for a period of three years following the date of substantial completion.
- 3.4.3. Quick Reference Guide
 - .1 Provide (qty: 1) laminated quick reference guide for each custom user interface described in the Scope of Work. The quick reference sheet is intended to assist with training end-users on the AV systems in order to minimize unnecessary helpdesk calls. Quick reference sheet shall visually depict user interfaces and describe how the user is to interact with the system.
- 3.5. EQUIPMENT STORAGE
 - 3.5.1. The AV Contractor shall coordinate with the General Contractor/Construction Manager for any required on-site storage during construction.
 - 3.5.2. The AV Contractor is responsible for loss or damage of any and all system equipment until it is signed over to the Owner on the date of final acceptance.
 - 3.5.3. The AV Contractor shall include all storage costs as required to meet the project timelines at time of bid.
- 3.6. OFF-SITE SYSTEM STAGING
 - 3.6.1. All items within this section shall be completed offsite, at the AV Contractor facility.
 - 3.6.2. All equipment shall be tested prior to delivery to site to ensure fully functionality.
 - 3.6.3. All equipment shall be configured and shall be ready for use upon installation onsite.
 - 3.6.4. All equipment shall have it's firmware updated prior to testing.
 - 3.6.5. All equipment racks shall be configured and populated with equipment to allow for pre-delivery inter-rack cabling termination and labeling.
 - 3.6.6. All digital signal processors shall have the site file loaded to ensure that only calibration is required to occur on site.
 - 3.6.7. All control processors shall have the compiled files uploaded and tested.
 - 3.6.8. All touch panels shall have the control interface uploaded and fully operational.
 - 3.6.9. All AV network switches shall be configured with port assignments and VLANs.
 - 3.6.10. All systems shall be connected to simulate the onsite installation as close as possible prior to delivery on site to test interconnectivity so that upon arrive and installation, the systems shall be ready for testing and commissioning to minimize schedule impacts.
 - 3.6.11. All systems shall be left functioning as per the above for a minimum of two (2) days to allow for a burn-in cycle to occur and identify any possible defective equipment.
- 3.7. CONTROL HARDWARE AND USER INTERFACES
 - 3.7.1. All custom graphical user interfaces for touch panels and other control system user interfaces shall be submitted to the AV Consultant and the Owner for review and approval prior to system commissioning.
 - 3.7.2. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.
 - 3.7.3. Software programs that control operable machinery must require tally from said devices.

- 3.7.4. Any control hardware located on walls that may be subject to impacts shall include an impact resistant cover to prevent damage.
- 3.8. DEVICE SECURITY (PASSWORDS)
- 3.8.1. All device access and configuration passwords for devices shall be changed from default to a custom password.
- 3.8.2. All passwords shall be created to the maximum security level of the device.
- 3.8.3. Passwords shall include the below criteria items based on the level of security of the device:
- .1 Include a combination of upper and lower case letters
 - .2 Include a minimum of one number
 - .3 Include a minimum of one special character
 - .4 Minimum length of 8 characters
- 3.8.4. All passwords shall be recorded and included in close out documents.
- 3.9. SOFTWARE STANDARDS (CONTROL SYSTEM, DSP AND COMPUTER-BASED)
- 3.9.1. Supply two copies of custom developed software (compiled and uncompiled) and documentation along with System Manuals. The documentation shall describe all GUIs, modes of operation, licenses, presets, and programming so service personnel can competently operate and troubleshoot the system.
- 3.9.2. Upon request of AV Consultant, supply licensed development environment, compiler software, project-specific source code with source commenting, custom executables and libraries, uncompiled script files and any other code required for program evaluation and debugging.
- 3.9.3. The AV Contractor can expect that the AV Consultant shall expect the manufacturer to review the AV Contractor's programming. The AV Contractor may be requested to modify program according to manufacturer's recommendations.
- 3.9.4. All custom software shall be created by programmers with the appropriate manufacturer certification or by manufacturer authorized personnel.
- 3.9.5. Where security passwords are used, ensure that each security level is properly defined and all users have appropriate access as directed by the AV Consultant. The AV Contractor must submit to the AV Consultant for review all security features prior to commissioning.
- 3.9.6. When utilizing DSP processing for loudspeaker optimization, consult the manufacturer of the loudspeaker system to obtain recommended settings and/or macros. Include any custom loudspeaker setting within the system documentation.
- 3.9.7. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.
- 3.10. COMPUTER SYSTEMS
- 3.10.1. Computer system shall not be installed on site during construction with the presence of dust and debris.
- 3.10.2. All computer system components should be of premium quality and sourced from reputable vendors.
- 3.10.3. All computer-based systems should meet the Owner's specifications.
- 3.10.4. All computer systems should be 19" rack-mountable.
- 3.10.5. Backup all hard drives and ensure a duplicate image of the hard disk exists at time of Owner acceptance.
- 3.10.6. Integrate any security features with Windows Security standard suite where possible.
- 3.11. WIRING AND CABLE TERMINATION
- 3.11.1. The AV Contractor should take all measures to prevent electromagnetic and electrostatic interference.

- 3.11.2. All precautions should be taken to avoid inadvertent grounding of shield. All terminations of shielded twisted pair cables shall have the shield drain wire covered with a Teflon sleeve and a heat shrink or neoprene sleeve covering the point where the cable jacket and shield end. At the termination point, the unshielded leads should be less than 50 mm in length.
- 3.11.3. All wiring entering equipment racks should have a 2-meter service loop neatly dressed and harnessed within the equipment rack.
- 3.11.4. All cable bundles within equipment racks should be neatly and logically routed and organized. Bundles of varying signal level should be spaced at least 10 cm apart and secured using lacing bars. AC power cabling should be separated from low voltage cabling.
- 3.11.5. All runs of shielded twisted pair and coaxial cable shall be continuous.
- 3.11.6. Only cables and connectors listed in specifications and drawings shall be used.
- 3.11.7. All cable run free-air in ceiling spaces and in raised-access floors shall be FT-6 rated.
- 3.11.8. All IP-based audiovisual solutions utilizing category cabling shall terminate to patch panels at the equipment rack.
- 3.12. INTERCONNECTION BEST PRACTICES
 - 3.12.1. All audio level wires shall be balanced and floating unless otherwise specified.
 - 3.12.2. Where audio cables share conduits with control cables, appropriate precautions should be taken to prevent pops, clicks and noise in the system.
 - 3.12.3. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables.
 - 3.12.4. All BNC-type video connectors shall be of high quality with crimp style strain relief.
 - 3.12.5. All BNC-type RF connectors shall be of high quality with compression style strain relief.
 - 3.12.6. All XLR connectors should be inserted into panels from the rear. Ensure labelling strips do not interfere with the connector releasing mechanisms.
- 3.13. LABELLING
 - 3.13.1. Wire Labelling
 - .1 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition the labels shall meet the general exposure requirements in UL 969 for indoor use.
 - .2 Cable Labels shall be of self-laminating vinyl construction with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
 - .3 All labels must be mechanically printed using a laser printer. Hand-written labels are not permitted.
 - .4 All wires shall be marked as indicated on functional diagrams and cable schedules.
 - 3.13.2. Wall Plate, Floorbox Plate and Patch Panels
 - .1 Ensure each wall plate and floorbox plate is identified to indicate the physical location of the outlet, the designation and the circuit number of termination.
 - .2 All panels are to be laser engraved or marked with lamacoid label strips.
 - .3 Submit samples to AV Consultant for approval prior to manufacturing.
 - 3.13.3. Network Cabling
 - .1 Ensure all new network cable naming conventions are consistent with building infrastructure as specified by the Owner.

3.14. FIELD PANELS

- 3.14.1. All plates shall be 0.125" aluminum stock with 0.125" bevelled edges. All panels shall have anodized finishes.
- 3.14.2. Plastic decora style plates are unacceptable for field connections.
- 3.14.3. All panels shall be labelled and laser engraved.

3.15. METALWORK

- 3.15.1. All metalwork shall have a minimum tolerance of 0.63 mm (0.025"). All edges shall be smooth and free of burrs and other defects.
- 3.15.2. Holes on panels should line up on centers with consistent spacings as shown on fabrication drawings.
- 3.15.3. Finished panel surfaces should be free of any surface defects. Coordinate finishes with Owner.
- 3.15.4. Provide fabrication drawings to AV Consultant for approval prior to fabrication.

3.16. POWER

- 3.16.1. Verify all AC power on site serves the needs of the AV systems and report any concerns to the AV Consultant and the Owner prior to final acceptance testing.
- 3.16.2. Equipment racks shall be wired to AC circuits dedicated to AV systems.
- 3.16.3. The AV Contractor is responsible for AC power distribution within the racks. For fixed equipment racks, provide plug strips (free of switches, fuses and circuit breakers) and direct connect to supply provided by electrical Contractor.
- 3.16.4. All power cords of rack-mounted equipment shall be neatly dressed so the plug is easily associated with the connected equipment. Where this is not possible clearly label the plug and associated piece of equipment.
- 3.16.5. Ensure that low voltage cabling is dressed separately from high voltage cabling.

3.17. RIGGING AND OVERHEAD EQUIPMENT

- 3.17.1. All suspended systems shall use load-rated metallic fitting designed for a load safety factor of five or greater. All fasteners should be a minimum grade 8 steel.
- 3.17.2. All suspended systems shall be independently supported from structure using appropriate rigging fixtures approved by the manufacturer.
- 3.17.3. A Structural Engineer with appropriate jurisdiction in the province of that installation shall approve all custom-built rigging fixtures.

3.18. PORTABLE CABLING

- 3.18.1. All portable cable shall be stranded copper, flexible and durable for heavy use.
- 3.18.2. Portable cable exposed to damp environments shall be tinned copper.
- 3.18.3. All portable cable for AC power distribution shall conform to all National regulations.
- 3.18.4. All portable cables shall be permanently identified with system information and function. All labels should be heavy-duty type and covered with clear shrink-wrap.

3.19. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

- 3.19.1. Clean all equipment that has been exposed to construction dust and dirt.
- 3.19.2. The AV Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to inspection by AV Consultant and/or Owner.
- 3.19.3. The AV Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.
- 3.19.4. There shall be no smoking, and the site shall be kept clean at all times.

3.20. PREPARATION

- 3.20.1. Clean surfaces thoroughly prior to installation.
- 3.20.2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.21. EXISTING SERVICES AND EQUIPMENT

- 3.21.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the AV Consultant and/or the Owner so as to avoid any interruption of such services during normal working hours. If necessary, changes and connections to existing services shall be made outside of normal working hours, at no extra cost to the Contract.
- 3.21.2. Where connections are made to existing services, existing fire stopping shall be made good under this Division.

3.22. OWNER FURNISHED EQUIPMENT

- 3.22.1. All Owner Furnished Equipment (OFE) specified shall be installed by the AV Contractor.
- 3.22.2. Warranty for Owner Furnished Equipment shall be the equipment's warranty. The AV Contractor shall be responsible for any new programming that is supporting the system.

3.23. ACCESS DOORS

- 3.23.1. Adequate access or an Access Door shall be provided or arranged for with Division responsible for installation, for all audiovisual equipment that is concealed and requires accessibility, maintenance and or adjustment.
- 3.23.2. Exact details showing size, type and location shall be submitted to the AV Consultant for review and inclusion in floor plans and shop drawings.
- 3.23.3. Access Door details shall also be captured on as-built drawings and notations shall be included to indicate frequency of maintenance required for concealed equipment.

3.24. CUTTING, PATCHING AND REPAIRING

- 3.24.1. It is the responsibility of the AV Contractor to coordinate all cutting and patching required for AV Cabling work with the General Contractor.

3.25. PROTECTION

- 3.25.1. Protect installed products until completion of project.
- 3.25.2. Touch-up, repair or replace damaged products before Substantial Completion.

3.26. TESTING

- 3.26.1. Provide a test plan for approval by the Owner. Test plan shall identify all testing activities, include sample test reports and accommodate scheduling and sequencing.
- 3.26.2. Typical test plans/reports shall include full testing of all: Video inputs, Video outputs and switching, all device control. Touch panel/programming testing report. Audio inputs, Audio outputs and switching. DSP settings and test calls. Video conferencing test calls.
- 3.26.3. Supply completed testing reports verifying accurate implementation of all signal connections. Provide a written report to the AV Consultant verifying accuracy prior to software deployment on site.
- 3.26.4. Provide test reports of commissioning process for each area according to approved test plan prior to deficiency walk-through by AV Consultant.
- 3.26.5. Include in report confirmation of system implementation as per specification and whether it is inspection ready. Installation Supervisor shall sign-off.
- 3.26.6. All test results and set-ups must be reproducible by the AV Contractor.

- 3.26.7. AV Consultant may elect to perform additional testing during the deficiency walk-through, with the assistance of the AV Contractor.
- 3.26.8. All wiring shall be tested for continuity and short-circuits between conductors and shields. Confirm isolation of conductors and shields, back boxes and conduit systems. Failure of any equipment, system or functionality as intended, shall be revised or replaced by the AV Contractor in full.
- 3.26.9. The following includes, but is not limited to, a list of sub-systems anticipated that shall require testing:
- .1 Equipment testing
 - .2 Power, Cable Systems and Isolated Ground
 - .3 Audio Systems
 - .4 Distribution outputs and inputs
 - .5 Computer System Hardware
 - .6 Control and Switching
 - .7 Video Systems
 - .8 Network Cable Systems
 - .9 Digital AV Systems
 - .10 RF Systems
 - .11 Signal System.
 - .12 Control Applications
 - .13 Cabling systems
- 3.27. PROJECT CLOSE OUT DOCUMENTATION
- 3.27.1. Provide the following items in this section upon project completion to form as-built documentation.
- 3.27.2. As-built Drawings
- .1 Refer to section 3.3.1 in this specification for requirements.
- 3.27.3. Compliance Checklist
- .1 Refer to section 3.26.5 in this specification for requirements
- 3.27.4. Control System Code
- .1 Refer to section 3.9.1 and 3.9.2 in this specification for requirements
- 3.27.5. Manuals
- .1 Refer to section 3.4 in this specification for requirements.
- 3.27.6. Network Information with Systems Passwords
- .1 For passwords, refer to section 3.8.4 this specification for requirements.
 - .2 For network information, refer to specification 27 51 50 – Audiovisual Networking.
- 3.27.7. Test Reports
- .1 Refer to section 3.26.3 and 3.26.4 in this specification for requirements.
- 3.27.8. Training
- .1 Refer to section 1.11.2 in this specification to provide a written sign off by the Owner of completed training sessions.
- 3.27.9. Warranty
- .1 Refer to section 1.12.1 in this specification to provide a written warranty letter.
- 3.27.10.

END OF SECTION

27 41 00.00 Audiovisual System Scope of Work

1. General

1.1. IMPORTANT NOTES AND RELATED SECTIONS

- 1.1.1. Bidders are required to review the Tender Specifications and Drawings in their entirety in order to understand the complete scope of work described herein.
- 1.1.2. Errors and omissions are to be addressed during the tender period. Refer to subsection 1.3 of 27 40 10.00 – General Instructions for Audiovisual System Installation for further detail.
- 1.1.3. All clarifications and substitution requests must be submitted to the Tender administrator before the end of question period, otherwise a response shall not be provided by the Consultant.
- 1.1.4. Provide all interconnecting cables required to complete a fully functioning system. Refer to section 27 41 23.11 - Audiovisual Cabling for further detail.
- 1.1.5. All graphical user interfaces (GUI) must be simple to operate and developed with input from Owner. GUI's must be consistent between system types. Refer to sections 27 40 10.00 – General Instructions for Audiovisual System Installation and 27 41 16.15 - Control Systems for further detail.
- 1.1.6. Throughout the entirety of the tender Specifications and Drawings, the term 'provide' means 'supply, install, terminate, test and commission'.

1.2. EXISTING EQUIPMENT

- 1.2.1. Remove all existing equipment in the space. This includes, but not limited to:
 - .1 Four (4) wall-mounted speakers
 - .2 Two (2) sub-woofer speakers
 - .3 Audio mixer
 - .4 One (1) AV equipment rack
 - .5 All AV wall-plates
- 1.2.2. Recycle all equipment. Confirm with Owner prior to removal from site if any equipment is to be saved. Record all information of equipment (make, model, serial, etc.).
- 1.2.3. Provide blank covers for any exposed wall openings where equipment was removed.
- 1.2.4. Patch and paint where required.

1.3. CAMERA SYSTEM

- 1.3.1. Provide five (5) cameras to capture video of local participants. These cameras shall be located:
 - .1 One (1) PTZ camera, with motorized pan, tilt and zoom features, mounted above the security station/desk.
 - .2 Two (2) PTZ camera, with motorized pan, tilt and zoom features, mounted to the south column of the Great Hall, across from the stage
 - .3 One (1) fixed camera with zoom, mounted on the column near the AV Desk.
 - .4 One (1) PTZ camera, with motorized pan, tilt and zoom features, mounted to the column at the Council Chambers
- 1.3.2. Provide a PTZ camera controller to allow for remote control and operation of PTZ cameras. This unit shall be located at the AV desk.
- 1.3.3. Provide a video production switcher to allow for the routing of video signals. This unit shall be located at the AV desk. As part of this:
 - .1 Provide (3) 27" monitors with wall-mounts. These monitors shall be used to view:
 - .1 A multi-view preview output of the switcher

- .2 The main program output of the switcher.
 - .3 The secondary program output of the switcher
- 1.3.4. Provide two (2) AV encoders with HDMI distribution amplifiers as shown on provided drawings.
- 1.3.5. Provide two (2) AV decoders for presentation ingest into the video production switcher.
- 1.3.6. Provide all required interconnecting video, control and audio interface cables.
- 1.4. VIDEO PRESENTATION SYSTEM
 - 1.4.1. Install an Owner supplied 115" all-in-one dvLED display for playback of video. This unit shall be located on the stage and shall be used to provide a video display to users in the Great Hall. To support this display, provide:
 - .1 A wall-mount solution.
 - .2 An AV decoder as shown on provided drawings.
 - 1.4.2. Install an Owner supplied 60" flat panel display, for playback of video. This unit shall be located on the column at the security desk and shall be used to provide a video display to users in the south-east corridor. To support this display, provide:
 - .1 An articulating wall-mount system for installation.
 - .2 An AV decoder as shown on provided drawings.
 - 1.4.3. Install an Owner supplied flat panel display, for playback of video. This unit shall be located near the column at the security desk, connected to AV location AV1-111, and shall be used to provide a secondary video display to users in the south-east corridor. To support this display, provide:
 - .1 A swing-arm wall-mount solution.
 - .2 An AV decoder as shown on provided drawings.
 - 1.4.4. Install an Owner supplied flat panel display mounted to an Owner-supplied mobile cart, for playback of text captions. This unit shall be located near the stage and shall connect to AV location BH-101. To support this display, provide:
 - .1 An AV decoder as shown on provided drawings.
 - 1.4.5. At the stage location (BH-101):
 - .1 Provide a video extension system between this location and the central equipment rack. The system shall include an AV transmitter and AV encoder.
 - 1.4.6. At the stage location (FP-119):
 - .1 Provide a video extension system between this location and the central equipment rack. The system shall include an AV transmitter and AV encoder.
 - 1.4.7. At the stage location (FP-120):
 - .1 Provide a video extension system between this location and the central equipment rack. The system shall include an AV transmitter and AV encoder.
 - 1.4.8. Near the AV desk location (BH-121):
 - .1 Provide a video extension system between this location and the central equipment rack. The system shall include an AV transmitter and AV encoder.
 - 1.4.9. At the south column (AV3-122):
 - .1 Provide two (2) AV encoders for presentation for a portable mobile event table. To support this:
 - .1 Provide a patch plate with:
 - .1 Two (2) HDMI connectors.
 - .2 Two (2) Ethercon connectors.
 - .2 A portable case to house the above.
 - .3 Portable cables:

- .1 Two (2) HDMI cables, 6' in length.
 - .2 Two (2) Ethercon cables, 15' in length.
- 1.4.10. At the central equipment rack (RACK1-113):
 - .1 Provide two (2) AV encoders for presentation for a portable devices at the AV Desk. To support this:
 - .1 Provide a patch plate with:
 - .1 Two (2) HDMI connectors.
 - .2 A rack shelf to mount the encoders.
 - .3 Portable cables:
 - .1 Two (2) HDMI cables, 15' in length.
- 1.4.11. Provide all required interconnecting video, control and audio interface cables.
- 1.5. AUDIO SYSTEM
- 1.5.1. Provide a digital audio mixer to control audio within the space. Also provide an appropriate digital stage box for connectivity to the mixer. All field inputs shall be connected to the stage box that shall be located in the central equipment rack. This shall allow for the mixer to be located at the AV desk and relocated in the house when required.
- 1.5.2. Provide a pair of studio monitors to allow the operator to monitor the audio mix and levels at the AV desk.
- 1.5.3. Provide a digital audio stage box for connectivity to the mixer. All field inputs shall be connected to the stage box to allow the mixer to be relocated when required in the field. The stage box shall be located within the central equipment rack.
- 1.5.4. Provide a wireless microphone system that shall be used for public address in the space. This shall include:
 - .1 Two (2) handheld transmitters
 - .2 Two (2) belt-pack transmitters
 - .3 Two (2) pin-on lavalier microphones
 - .4 Two (2) ear-set microphones
 - .5 Four (4) rack-mounted receivers
 - .6 An antenna distribution unit.
 - .7 Two (2) wall-mounted antennas
- 1.5.5. Provide four (4) steerable column surface-mounted speakers to support audio playback in the space at the stage. A pair of speakers shall be located at the left and right side of the stage.
- 1.5.6. Provide four (4) floor-mounted subwoofers to support audio playback within the space. Two (2) subwoofers shall be located at each the left and right side of the stage.
- 1.5.7. Provide the required power amplifier for the subwoofers.
- 1.5.8. Provide an additional steerable column surface-mounted speaker to support audio playback the south-east corridor. Speakers shall be powered with on-board processing.
- 1.5.9. An interconnection to the fire-alarm system shall be supplied by others and shall be connected to the AV system by the AV Contractor. This connection shall trigger a mute of the AV systems when a fire alarm is activated.
- 1.5.10. Provide all required interconnecting video, control and audio interface cables.
- 1.6. CONTROL
- 1.6.1. Provide a small control processor to allow for central control of the space. This unit shall be also used to interface between the AV system and fire systems.

- 1.6.2. Provide a table-top graphical control interface. This unit shall be located at the AV desk. The control interface shall allow for:
- .1 System on/off
 - .2 Input source selection and routing
 - .3 Volume control
 - .4 Camera controls
 - .5 Room controls
 - .6 Room presets
 - .7 Overflow capabilities to/from the Council Chambers.
- 1.6.3. All programming for the control system shall be completed by the Owner. Configure all devices with IP address and control IDs as required by the Owner.
- 1.6.4. Provide a network switch. This unit shall connect to all field equipment to allow all the AV equipment to reside on a common local area network. This network switch shall be uplinked to the client's existing AV local area network.
- 1.6.5. Provide all required interconnecting video, control and audio interface cables.
- 1.7. INFRASTRUCTURE SYSTEM
- 1.7.1. Refer to provided drawings for locations and cable/connector types.
- .1 Provide connectivity at each wall plate, floor box, bulkhead and patch-panel as shown on provided drawings.
 - .2 Connectivity shall include the bulk-cabling between locations with terminated connectors mounted on a plate (wall, floor box, patch-panel).
 - .3 All RJ45 connections shown shall be with CAT6 cabling or better, with Ethercon connectors.
 - .4 All patch-bay connectors shall be manufactured by Neutrik.
 - .5 Provide all required patch cables at the equipment rack for patch-bays.
- 1.7.2. Provide CAT6A and single-mode fibre cables with terminations between the central AV rack and the existing AV network in room 13020 as shown on the provided drawings.
- 1.7.3. Provide a full-size equipment rack to house all the central AV equipment. As part of this, also provide the following:
- .1 An uninterruptable power supply.
 - .2 A caster base.
 - .3 All rack accessories.
- 1.7.4. Provide all required interconnecting video, control and audio interface cables.

2. Products

2.1. MONITOR DISPLAY – 27”

- 2.1.1. Monitor display shall have a minimum diagonal of 27” and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.
- 2.1.2. Monitor display shall have either LED edge lit or full LED array backlight system.
- 2.1.3. Monitor display shall have a minimum brightness of 300 cd/m2 (nits).
- 2.1.4. Monitor display shall have a response time of 5ms or faster.
- 2.1.5. Monitor display shall have a contrast ratio of 1000:1 or better.
- 2.1.6. Monitor display shall be of IPS panel type.
- 2.1.7. Monitor display shall have at minimum the following inputs:
 - .1 HDMI (Qty: 2)
 - .2 DisplayPort
- 2.1.8. Monitor display screen shall have a haze value between 25%-50%.
- 2.1.9. Monitor display shall support a VESA mounting pattern.
- 2.1.10. Provide a desk-mount articulating-arm mounting solution with two arm links.
- 2.1.11. Typical device shall be LG 27US550-W with Chief K1D120-series or approved equivalent.

2.2. WALL DISPLAY MOUNT

- 2.2.1. Display Mount shall have a leveling control for post-installation for fine tuning of height and leveling to provide post-installation height adjustment and lateral shift for faster and easier installation.
- 2.2.2. Display Mount shall be an ultra-low-profile display mounting solution.
- 2.2.3. Display Mount shall have a minimum tilt range of -12 to 2-degree.
- 2.2.4. Display Mount shall be rated for the appropriate required display being mounted.
- 2.2.5. Provide a CPU mounting accessory and extenders for a low-profile installation (FCA series) as required if mentioned above.
- 2.2.6. Typical device shall be Chief Fusion Series or approved equivalent.

2.3. WALL DISPLAY MOUNT - SWING ARM

- 2.3.1. Display Mount shall have a leveling control for post-installation for fine tuning of height and leveling to provide post-installation height adjustment and lateral shift for faster and easier installation.
- 2.3.2. Display Mount shall be an ultra-low-profile display mounting solution with a depth no great than 2” (52mm) when collapsed.
- 2.3.3. Display Mount shall be comprised of a minimum of two (2) extension arms.
- 2.3.4. Display Mount shall allow for extension of up to 18”.
- 2.3.5. Display Mount shall have a minimum tilt range of up to -15-degree.
- 2.3.6. Display Mount shall have a cable management system integrated into the extension arms.
- 2.3.7. Display Mount shall be rated for the appropriate required display being mounted.
- 2.3.8. Provide a CPU mounting accessory and extenders for a low-profile installation (FCA series) as required if mentioned above.
- 2.3.9. Typical device shall be Chief THINSTALL Series or approved equivalent.

- 2.4. AV ENCODER
 - 2.4.1. AV Encoder shall input a local video source and allow the source to be accessible via a video stream on the network.
 - 2.4.2. AV Encoder shall have stereo analog audio input.
 - 2.4.3. AV Encoder shall at minimum support the following video resolutions: UHD, 4K60 DCI, WUXGA, 1080p and WXGA.
 - 2.4.4. AV Encoder shall support management of EDID (Extended Display Identification Data).
 - 2.4.5. AV Encoder shall support 4:4:4 chroma sampling.
 - 2.4.6. AV Encoder shall support at minimum (high dynamic range) HDR10.
 - 2.4.7. AV Encoder shall have a build-in 4K scaler.
 - 2.4.8. AV Encoder shall provide bidirectional infrared control and RS-232 control.
 - 2.4.9. Provide a local power supply. Confirm with AV Consultant prior to installation if device shall be powered by PoE or via the local power supply.
 - 2.4.10. All systems with three (3) or more transceivers located within an equipment rack shall provide card based units with the appropriate chassis to accommodate cards as required.
 - 2.4.11. Typical device shall be Crestron DM-NVX-E30.
 - 2.4.12. Typical card-based device shall be Crestron DM-NVX-E30-C with DMF-CI-8.
- 2.5. AV ENCODER HDBASET
 - 2.5.1. AV Encoder shall input a remote HDBaseT video source and allow the source to be accessible via a video stream on the network.
 - 2.5.2. AV Encoder shall have stereo analog audio input.
 - 2.5.3. AV Encoder shall at minimum support the following video resolutions: UHD, 4K60 DCI, WUXGA, 1080p and WXGA.
 - 2.5.4. AV Encoder shall support management of EDID (Extended Display Identification Data).
 - 2.5.5. AV Encoder shall support 4:4:4 chroma sampling.
 - 2.5.6. AV Encoder shall support at minimum (high dynamic range) HDR10.
 - 2.5.7. AV Encoder shall provide bidirectional infrared control and RS-232 control.
 - 2.5.8. Provide a local power supply. Confirm with AV Consultant prior to installation if device shall be powered by PoE or via the local power supply.
 - 2.5.9. All systems with three (3) or more transceivers located within an equipment rack shall provide card based units with the appropriate chassis to accommodate cards as required.
 - 2.5.10. Typical device shall be Crestron DM-NVX-E760.
 - 2.5.11. Typical card-based device shall be Crestron DM-NVX-E760-C with DMF-CI-8.
- 2.6. AV DECODER
 - 2.6.1. AV Decoder shall output a network video stream and allow the source to be accessible via a local HDMI output.
 - 2.6.2. AV Decoder shall have stereo analog audio output.
 - 2.6.3. AV Decoder shall at minimum support the following video resolutions: UHD, 4K60 DCI, WUXGA, 1080p and WXGA.
 - 2.6.4. AV Decoder shall support management of EDID (Extended Display Identification Data).
 - 2.6.5. AV Decoder shall support 4:4:4 chroma sampling.
 - 2.6.6. AV Decoder shall support at minimum (high dynamic range) HDR10.

- 2.6.7. AV Decoder shall have a build-in 4K scaler.
- 2.6.8. AV Decoder shall provide bidirectional infrared control and RS-232 control.
- 2.6.9. Provide a local power supply. Confirm with AV Consultant prior to installation if device shall be powered by PoE or via the local power supply.
- 2.6.10. All systems with three (3) or more transceivers located within an equipment rack shall provide card based units with the appropriate chassis to accommodate cards as required.
- 2.6.11. Typical device shall be Crestron DM-NVX-D30.
- 2.6.12. Typical card-based device shall be Crestron DM-NVX-D30-C with DMF-CI-8.

- 2.7. AV TRANSMITTER 1-GANG
 - 2.7.1. AV Transmitter shall support HDBaseT and HDCP.
 - 2.7.2. AV Transmitter shall be capable of mounting to a standard single-gang opening. The maximum depth of the transmitter shall be 3".
 - 2.7.3. AV Transmitter shall support a HDMI input. AV Transmitter shall at minimum support the following video resolutions: UHD, 4K60, WUXGA, 1080p and WXGA.
 - 2.7.4. AV Transmitter shall support 4:4:4 chroma sampling.
 - 2.7.5. AV Transmitter shall support RS-232 and infrared control.
 - 2.7.6. AV Transmitter shall support management of EDID (Extended Display Identification Data).
 - 2.7.7. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.
 - 2.7.8. Typical device shall be Crestron DM-TX-4KZ-100-C-1G.

- 2.8. HDMI TRANSMITTER
 - 2.8.1. HDMI Transmitter shall support HDCP.
 - 2.8.2. HDMI Transmitter shall link to the receiver via a single CAT twisted pair cable.
 - 2.8.3. HDMI Transmitter shall be capable of mounting to a standard single-gang opening. The maximum depth of the transmitter shall be 3".
 - 2.8.4. HDMI Transmitter shall support a HDMI input. AV Transmitter shall at minimum support the following video resolutions: UHD, 4K DCI, WUXGA, 1080p and WXGA.
 - 2.8.5. HDMI Transmitter shall support management of EDID (Extended Display Identification Data).
 - 2.8.6. HDMI Transmitter shall support extension of bidirectional infrared and RS-232 control.
 - 2.8.7. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.
 - 2.8.8. For surface mount installation, typical device shall be Crestron HD-TXC-4KZ-101 or approved equivalent.
 - 2.8.9. For in-wall installation, typical device shall be Crestron HD-TXC-4KZ-101-G or approved equivalent.

- 2.9. HDMI RECEIVER
 - 2.9.1. HDMI Receiver shall support HDCP.
 - 2.9.2. HDMI Receiver shall link to the transmitter via a single CAT twisted pair cable
 - 2.9.3. HDMI Receiver shall at minimum support the following video resolutions: UHD, 4K DCI, WUXGA, 1080p and WXGA.
 - 2.9.4. HDMI Receiver shall support management of EDID (Extended Display Identification Data).
 - 2.9.5. HDMI Receiver shall support extension of bidirectional infrared and RS-232 control.
 - 2.9.6. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.

- 2.9.7. For surface mount installation, typical device shall be Crestron HD-RXC-4KZ-101 or approved equivalent.
- 2.9.8. For in-wall installation, typical device shall be Crestron HD-RXC-4KZ-101-G or approved equivalent.
- 2.10. HDMI DISTRIBUTION AMPLIFIER
 - 2.10.1. HDMI Distribution Amplifier shall have a total of 2 outputs.
 - 2.10.2. HDMI Distribution Amplifier shall have HDMI inputs and outputs.
 - 2.10.3. HDMI Distribution Amplifier shall be HDCP compliant.
 - 2.10.4. Typical device shall be Crestron HD-DA2-4KZ-E or approved equivalent.
- 2.11. PRODUCTION VIDEO SWITCHER
 - 2.11.1. Production video switcher shall support SDI and HDMI inputs.
 - 2.11.2. Production video switcher shall have a minimum of eight (8) HDMI and eight (8) SDI inputs.
 - 2.11.3. Production video switcher shall have a minimum of three (3) HDMI and three (3) SDI outputs.
 - 2.11.4. Typical device shall be Roland V-160HD.
- 2.12. PTZ CAMERA CONTROLLER
 - 2.12.1. PTZ camera controller shall have one (1) RS-422 RJ-45 output.
 - 2.12.2. PTZ camera controller shall have direct function buttons/knobs for:
 - .1 Exposure mode.
 - .2 R gain and B gain.
 - .3 Master black adjustment.
 - .4 Iris value adjustment.
 - .5 Shutter speed adjustment.
 - 2.12.3. Typical device shall be Sony RMIP500/1 or approved equivalent.
- 2.13. PTZ CAMERA
 - 2.13.1. PTZ Camera shall have pan, tilt and zoom capabilities.
 - 2.13.2. PTZ Camera shall have an 1/2.5 Exmore R CMOS image sensor.
 - 2.13.3. PTZ Camera shall have PTZ auto-framing capabilities.
 - 2.13.4. PTZ Camera shall support minimum resolutions of:
 - .1 3840 x 2160 at 30 frames with HDMI and IP Stream
 - .2 1920 x 1080 at 60 frames with SDI
 - 2.13.5. PTZ Camera shall have a minimum 20x optical zoom and 12x digital zoom.
 - 2.13.6. PTZ Camera shall support the following protocols:
 - .1 IPv4, IPv6
 - .2 TCP
 - .3 UDP
 - .4 VISCA over IP
 - .5 NDI
 - 2.13.7. PTZ camera shall have (Qty: 1) HDMI and IP streaming output.
 - 2.13.8. PTZ camera shall have (Qty:1) one 3G-SDI output and (Qty:1) one HDMI output.
 - 2.13.9. PTZ Camera shall support power-over-ethernet.

- 2.13.10. Typical device shall be Sony SRGA-40 with SRGWMZ300 mount or approved equivalent.
- 2.14. WIDE-ANGLE CAMERA
- 2.14.1. Wide Angle Camera shall have a ½" CMOS 2.3M Pixel Image sensor
- 2.14.2. Wide Angle Camera shall have a horizontal viewing angle of 111 degrees.
- 2.14.3. Wide Angle Camera shall utilize RS-232 serial control.
- 2.14.4. Wide Angle Camera shall include a receiver unit.
- 2.14.5. Typical device shall be Vaddio WideSHOT (999-6911-22).
- 2.15. LAVALIER AND EARSET WIRELESS MICROPHONE SYSTEM
- 2.15.1. Wireless Microphone System shall operate on multiple frequency bands (up to 900MHz) as appropriate for the location the system shall be installed into.
- 2.15.2. Wireless microphone system shall have a minimum frequency bandwidth response of 45 Hz to 15 kHz.
- 2.15.3. Transmitters shall operate a minimum of eight hours on two "AA" size batteries.
- 2.15.4. Receivers shall have XLR and ¼ inch outputs.
- 2.15.5. Receivers shall have detachable antennas.
- 2.15.6. Receivers shall be ethernet controlled.
- 2.15.7. Refer to drawings for antenna mounting locations. Provide all appropriate antenna distribution (combiners, power distribution amplifiers, splitters/combiners) for systems of two or more.
- 2.15.8. Provide ½ wave antennas.
- 2.15.9. Wireless Microphone System shall include a bodypack style transmitter.
- 2.15.10. Wireless Microphone System shall include a detachable lavalier microphone.
- 2.15.11. Lavalier microphone shall have a directional pick-up pattern with a condenser cardioid element per microphone.
- 2.15.12. Typical device shall be Shure QLXD series with QLXD1 transmitter, WL185 and MX153.
- 2.16. HANDHELD WIRELESS MICROPHONE SYSTEM
- 2.16.1. Wireless Microphone System shall operate on multiple frequency bands ((up to 900MHz) as appropriate for the location the system shall be installed into.
- 2.16.2. Wireless microphone system shall have a minimum frequency bandwidth response of 45 Hz to 15 kHz.
- 2.16.3. Transmitters shall operate a minimum of eight hours on two "AA" size batteries.
- 2.16.4. Receivers shall have XLR and ¼ inch outputs.
- 2.16.5. Receivers shall have detachable antennas.
- 2.16.6. Receivers shall be ethernet controlled.
- 2.16.7. Refer to drawings for antenna mounting locations. Provide all appropriate antenna distribution (combiners, power distribution amplifiers, splitters/combiners) for systems of two or more.
- 2.16.8. Provide ½ wave antennas.
- 2.16.9. Wireless Microphone System shall include a handheld style transmitter.
- 2.16.10. The handheld transmitter shall have a directional pick-up pattern with a dynamic element per microphone.
- 2.16.11. Typical device shall be Shure QLXD series with QLXD2/SM58 transmitter or approved equal.
- 2.17. EARSET MICROPHONE
- 2.17.1. Earset Microphone shall have a frequency response of 20Hz to 20,000 Hz.

- 2.17.2. Earset Microphone shall be electret condenser.
- 2.17.3. Earset Microphone shall have an omnidirectional pick up pattern.
- 2.17.4. Earset Microphone shall include a protective storage pouch, collar clip and three (3) windscreens.
- 2.17.5. Earset Microphone shall be available in black, tan and cocoa colours.
- 2.17.6. Typical device shall be Shure MX153 or approved equivalent.

- 2.18. DIGITAL AUDIO MIXER
 - 2.18.1. Digital Audio Mixer shall support DANTE/AES67 digital audio protocol.
 - 2.18.2. Digital Audio Mixer shall have sixteen (16) onboard inputs and eight (8) outputs.
 - 2.18.3. Digital Audio Mixer shall have onboard digital processing for each channel.
 - 2.18.4. Digital Audio Mixer shall have a USB interface for recording and playback.
 - 2.18.5. Digital Audio Mixer shall have motorized faders.
 - 2.18.6. Digital Audio Mixer shall have ethernet connectivity.
 - 2.18.7. Typical device shall be Yamaha TF1 with NY64-D Audio interface card.

- 2.19. DIGITAL MIXER – STAGE BOX
 - 2.19.1. Digital Mixer – Stage Box shall have qty:16 analog input terminals.
 - 2.19.2. Digital Mixer - Stage Box shall have qty: 8 analog output terminals.
 - 2.19.3. Digital Mixer – Stage Box shall utilize Dante protocol.
 - 2.19.4. Typical device shall be Tio1608-D2.

- 2.20. STEERABLE COLUMN SPEAKER (S1 & S3)
 - 2.20.1. Steerable Colume Speaker shall have (Qty:8) eight, broadband chasis.
 - 2.20.2. Steerable Column Speaker shall have (Qty:8) eight integrated DSP amplifiers at 75 W each.
 - 2.20.3. Steerable Column Speaker shall have a vertical beam with from 0-90 degress with a sound inclination angle of -40 to +40 degrees.
 - 2.20.4. Steerable Column Speaker shall include a wall-mount bracket.
 - 2.20.5. Typical device shall be Bose MSA12X.
 - 2.20.6. Location S1 shall each be comprised of two (2) column speakers.
 - 2.20.7. Location S3 shall each be comprised of a single column speaker.

- 2.21. AUDIO AMPLIFIER
 - 2.21.1. Audio amplifier shall be 1000 per channel.
 - 2.21.2. Audio amplifier shall have minimum 2 channels.
 - 2.21.3. Audio amplifier shall be capable of delivering full channel power to either low impedance loads or high impedance loads without bridging.
 - 2.21.4. Typical device shall be Bose PowerSpace P21000A.

- 2.22. SUBWOOFER
 - 2.22.1. Subwoofer shall have dual 12-inch long excursion drivers.
 - 2.22.2. Subwoofer shall have a frequency response fro 44Hz to 104Hz.
 - 2.22.3. Subwoofer shall have onboard signal processing and amplifiers.
 - 2.22.4. Subwoofer shall have a nominal coverage angle of 180 degrees (cardioid).

- 2.22.5. Typical device shall be Bose MB210.
- 2.23. STUDIO MONITOR
- 2.23.1. Studio Monitor shall have an onboard 2-way amplifier with processing.
- 2.23.2. Studio Monitor shall have a 135mm (5 inch) woofer and dedicated silk dome tweeter for full range sonic reproduction.
- 2.23.3. Studio Monitor shall have a minimum (-3 dB) frequency response of 54 Hz to 30 kHz measured on axis at a distance of 1 metre.
- 2.23.4. Studio Monitor shall be rated for minimum program wattage of 70W.
- 2.23.5. Typical device shall be Yamaha HS5 or approved equivalent.
- 2.24. CONTROL PROCESSOR - SMALL
- 2.24.1. Control Processor shall have real-time, pre-emptive multi-threaded/multitasking kernel; Transaction-Safe Extended FAT file system; supports up to 10 simultaneously running programs.
- 2.24.2. Conform to requirements of 27 41 16.15 – CONTROL SYSTEMS.
- 2.24.3. Control System shall have the following minimum specifications – 1 GB of SDRAM, 8 GB of Flash and supports USB mass storage devices.
- 2.24.4. Control System shall support Ethernet connectivity with the following features:
- .1 10/100 Mbps
 - .2 Auto-switching
 - .3 Auto-negotiating
 - .4 Auto-discovery
 - .5 Full/half duplex
 - .6 TCP/IP stack
 - .7 BACnet/IP
- 2.24.5. Control Processor shall support 2-way device control and monitoring, all ports support RS-232 up to 115.2k baud with software handshaking, one port also supports RS-422 or RS-485 and hardware handshaking.
- 2.24.6. Control Processor shall have IR/Serial shall support 1-way device control via infrared up to 1.2 MHz or serial TTL/RS-232 (0-5 Volts) up to 115.2k baud.
- 2.24.7. Control Processor shall have a minimum quantity of the following ports:
- .1 COM – Qty:1
 - .2 IR – Qty:2
 - .3 Relay – Qty:2
 - .4 Digital In – Qty:2
 - .5 Ethernet – Qty:1
 - .6 USB Configuration/Storage – Qty:1
- 2.24.8. Provide an Ethernet switch to create an audiovisual control network as shown on drawings.
- 2.24.9. Provide all required power supplies for connected equipment as required.
- 2.24.10. Typical device shall be Crestron RMC4 or approved equivalent.
- 2.25. TOUCH PANEL - 10"
- 2.25.1. 10" Touch Panel shall have a 10" TFT active matrix colour LCD display with aspect ratio of 16:9 pixels and resolution of 1920x1080 pixels.

- 2.25.2. 10" Touch Panel shall provide 400 nits brightness.
- 2.25.3. 10" Touch Panel shall utilize capacitive touch technology.
- 2.25.4. 10" Touch Panel shall support H.264 streaming.
- 2.25.5. 10" Touch Panel shall utilize PoE protocol.
- 2.25.6. 10" Touch Panel shall not have an onboard camera or microphone unless required in scope. Confirm with project team prior to ordering.
- 2.25.7. Typical device for table-top mounting provide Crestron TS-1070 series or approved equivalent.

- 2.26. NETWORK SWITCH
 - 2.26.1. Network Switch shall support Layer-3 Gigabit Ethernet switching.
 - 2.26.2. Network Switch shall provide Power Over Ethernet (PoE) on all ports.
 - 2.26.3. Network Switch shall be managed.
 - 2.26.4. Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.
 - 2.26.5. Network Switch shall have sufficient ports to accommodate all system AV devices, with an additional 4-ports for expansion or uplink.
 - 2.26.6. Network Switch shall be compatible with digital audio and video multicast protocols required as part of this project.
 - 2.26.7. Network Switch shall be network stackable.
 - 2.26.8. Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.
 - 2.26.9. Network Switch shall be rack mountable.
 - 2.26.10. Typical device shall be Netgear M4250 series or approved equivalent.

- 2.27. FULL-HEIGHT EQUIPMENT RACK - 37RU
 - 2.27.1. Equipment Rack shall be no greater than 24-inch in width, 28-inch in depth unless specified otherwise
 - 2.27.2. Equipment Rack shall have minimum 37 useable rack spaces.
 - 2.27.3. Provide a permanent work light with switch, mounted at the rear top of the rack to assist with service.
 - 2.27.4. Equipment Rack shall have two (2) vertical rack-mounted power strips, rated at 20-amps each of 120V. Distribution strip shall have surge and spike protection.
 - 2.27.5. Equipment Rack shall have a caster base.
 - 2.27.6. Typical device shall be Middle Atlantic WRK-series or approved equivalent.

- 2.28. UNINTERRUPTABLE POWER SUPPLY - LARGE
 - 2.28.1. Uninterruptable power supply shall be a series mode UPS.
 - 2.28.2. Uninterruptable power supply shall provide 2,000VA capacity.
 - 2.28.3. Uninterruptable power supply shall be rack mountable.
 - 2.28.4. Uninterruptable power supply shall have a maximum transfer time of 4 milliseconds.
 - 2.28.5. Uninterruptable power supply shall have automatic voltage regulation.
 - 2.28.6. Uninterruptable power supply shall have a minimum of eight (8) NEMA5-20R outlets that are able to be remotely controlled in two (2) banks.
 - 2.28.7. Uninterruptable power supply shall have a hot-swappable battery for easy service through front panel.
 - 2.28.8. Uninterruptable power supply shall provide the ability to connect an expansion battery.
 - 2.28.9. Uninterruptable power supply shall have ethernet connectivity.
 - 2.28.10. Typical device shall be Middle Atlantic UPX-RLNK-2000R-2 or approved equivalent.

2.29. AV FIELD PANEL

- 2.29.1. All field panels shall be 0.125" aluminum stock with 1/8" bevelled edges. Alternate metal stock shall be submitted to AV Consultant for approval.
- 2.29.2. Standard finish shall be anodized with vertical brush
- 2.29.3. Submit shop drawings of panels for Owner/architect/AV Consultant approval before fabrication. Indicate on drawings locations for each type of panel and finish.
- 2.29.4. Panels to be engraved and paint filled.
- 2.29.5. XLR connectors shall be inserted into panels from rear. Ensure labelling strips do not interfere with the operation of the connector release mechanisms. Holes shall be sized to suit male or female shell interchangeably.

2.30. WIRE

- 2.30.1. Refer to section 27 41 23.11 Cables and Pathway for Audiovisual Systems for all cabling requirements.

2.31. CONNECTORS

- 2.31.1. All input and output connectors for field plates and equipment rack patch panels shall be Neutrik D-series.

3. Execution

3.1. GENERAL REQUIREMENTS

- 3.1.1. All equipment supplied as part of this project shall conform to the requirements described in the following sections:

- .1 SECTION 27 40 10.00 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION

27 41 16.10 Sound System General Requirements

1. General

1.1. PROGRAM SOUND SYSTEM REQUIREMENTS

- 1.1.1. These are the minimum specifications unless otherwise stated in specific subsections. All equipment selected must meet or exceed these expectations.
- 1.1.2. All AC powered equipment shall be CSA or ULC approved devices.
- 1.1.3. Input and output power levels are expressed in dBm.
- 1.1.4. It is not the intention of the AV Consultant to direct the AV Contractor to verify all manufacturer performance specifications on an individual component level unless it is a necessary process to identify and resolve a fault in the system.

1.2. LOUDSPEAKER PERFORMANCE CRITERIA DEFINITIONS

1.2.1. Equipment

Performance Criteria	Definition
Measured Sound Pressure Level (SPL)	This is the long term SPL capability as measured with a sound level meter using A-weighting and slow response using pink noise. It is measured on axis of the loudspeaker at ear height at the intended listening position. It is measured in free field (direct plus reverberant) with an omnidirectional microphone. It is measured after the system is equalized to installed frequency response.
Predicted Sound Pressure Level (SPL)	This is the maximum long term SPL capability as calculated from manufacturer's data and location design data using inverse square law or approved computer design package, A weighted, slow response (average). It is calculated on axis of loudspeaker at ear height at the intended listening position.
Coverage area	This area is defined as the area where the off-axis attenuation of the direct SPL of the loudspeaker is less than 6 dB at 2 kHz.
Coverage variance	This is the variation in A-weighted SPL due to listener location within the coverage area of the loudspeaker as measured in the room free field. It is measured at ear height at the intended listening position.
Passband (bandwidth)	This is the nominal operating range of unequalized loudspeakers. It is determined by the 3 dB down points of the raw frequency response.
Installed frequency response	This is measured on-site after optimization of aiming and equalization. It is flat (maximum deviation of +1/-3 dB on tone-third octave intervals) within pass band at maximum SPL.
Loudspeaker Headroom	This is the nominal long term power handling capability above that needed to achieve maximum desired SPL. It is expressed in dB.
Amplifier headroom	The difference between the EIA power rating of power amplifier and the power required to achieve maximum SPL, expressed in dB

1.3. ELECTRONIC SIGNAL CHAIN PERFORMANCE REQUIREMENTS

- 1.3.1. The following minimum end-to-end specifications must be met by the electronic signal chain:

Performance Criteria	Value
----------------------	-------

Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Nominal line input impedance	10 K
Balanced line output impedance	600 Ω or less
Crosstalk (for multi-channel units)	More than 70 dB down

1.4. PROGRAM AUDIO SYSTEM PERFORMANCE REQUIREMENTS

1.4.1. Provide an audio system to meet the requirements defined in the Audiovisual System Scope of Work.

1.4.2. The following minimum must be met by the audio system:

Performance Criteria	Value
Measured sound pressure level capability	85 dBA (minimum)
Minimum bandwidth (-3 dB points)	125 Hz to 8 kHz
Distortion and noise (electronic)	Less than 3%
Coverage variance	+/- 3 dB SPL
Acoustic noise (as measured with SPL meter at any and all normal seated positions)	Greater than 25 dBA SPL
Switching noise (due to relays and electronics)	70 dB below nominal signal level

1.4.3. Program Loudspeakers Performance Requirements:

Performance Criteria	Value
Frequency response (minimum)	80 Hz to 12.5 kHz, +/- 3dB
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response
Drivers	Minimum 2-way

1.4.4. 70V Loudspeaker minimum performance requirements:

Performance Criteria	Value
Frequency response (minimum)	100 Hz to 12kHz, +/- 4dB
Minimum sensitivity	90dBm 1 watt @ 1m
Dispersion	90 degrees at 5 kHz
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response

1.4.5. For alternates to the proposed system design in the Audiovisual System Scope of Work aimed at providing value to the Owner while reducing cost, provide computer modelled speaker design data using industry standard speaker modelling software with the predicted SPL to meet the performance criteria described above.

1.5. AUDIO TRANSFORMER PERFORMANCE REQUIREMENTS

1.5.1. The following criteria must be met by any audio transformer except loudspeakers which are specified elsewhere:

Performance Criteria	Value
Frequency Response	30 Hz to 30 kHz +/- 1 dB
Insertion loss	Less than 1 dB
Primary nominal impedance	10k/40k
Secondary nominal impedance	10k/40k
Shield	Electrostatic shield between primary and secondary windings
Winding	Balanced winding

1.6. DIGITAL SIGNAL PROCESSOR (DSP) REQUIREMENTS

- 1.6.1. Digital signal processors provide audio signal mixing, routing and processing for sound system applications.
- 1.6.2. Provide a rack-mount digital signal processor. Include all rack-mounting and cabling accessories as required.
- 1.6.3. DSP platform shall allow the creation/connection of system components within each hardware unit. Available system components shall include (but not be limited to) mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, and diagnostics.
- 1.6.4. Inputs/outputs of the DSP shall be sized accordingly to support the mic/line functionality illustrated as per AV concept functional drawings. Provide a minimum of two additional input and output channels to support user design changes.
- 1.6.5. Ethernet communications shall be utilized for software control and configuration. Provide all PC-based software and files to the Owner to allow programming access through the AV IP network or Owner network when specified.
- 1.6.6. DSP platform shall be RS-232 controllable for interface to third party control systems.
- 1.6.7. DSP platform shall have selectable Phantom Power per channel. Phantom Power, Signal Present and Clip information per channel is preferred without the requirement for a PC.
- 1.6.8. Performance requirements:

Performance Criteria	Value
Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum input level	+18 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Balanced nominal line input impedance	10 kΩ
Balanced line output impedance	600 Ω or less
Crosstalk (for multi-channel units)	Greater than 70 dB down
Minimum sampling frequency	48 kHz
Minimum converter resolution	20 bit
Processing resolution	24 bit minimum

1.7. AUDIO CONFERENCING DSP REQUIREMENTS

- 1.7.1. Provide a digital signal processor with wide-band AEC mic/line inputs, standard mic/line inputs, mic/line outputs, and a telephone interface.
- 1.7.2. Where the Owner phone system is analog, provide an RJ-11 port to enable the DSP to interface with a standard POTS (aka PSTN or Analog PBX) telephone network.
- 1.7.3. Where the Owner phone system is VOIP, provide an RJ45 VOIP port or else external VOIP adapter to enable the DSP to interface to Owner's network.
- 1.7.4. Provide dedicated acoustic echo cancellation (AEC) processing on all audio channels used for audio and video conferencing. The AEC algorithm can be applied to signals coming from the local analog inputs or from the digital audio bus. All microphone inputs shall be fed into an AEC channel.
- 1.7.5. Automatic Gain Control (AGC) and Noise Cancellation (NC) should also be provided per AEC algorithm. AGC ensures that microphone levels remain at an optimum level, and NC removes steady state noise (such as from a projector fan or air conditioning device) from the signal path.

1.8. AMPLIFIERS

- 1.8.1. Program amplifiers must be capable of providing 200% of the power required by the loudspeaker.
- 1.8.2. Low Impedance Amplifier Performance Requirements:

Performance Criteria	Value
----------------------	-------

Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Distortion	Less than 0.1% THD at rated output
Signal to noise ratio 20 Hz to 20 kHz	> -106 dB
Amplifier headroom in watts	200% above load requirement
Mechanical noise	At ambient or below
Dampening Factor	>500

1.8.3. 70V Amplifier Performance Requirements:

Performance Criteria	Value
Output Voltage	70.7 V
Distortion	Less than 0.05% THD at rated output
Frequency Response	60 Hz to 20 kHz, +/- 0.5 dB
Signal to noise ratio	Greater than 90 dB
Amplifier headroom in watts	50% above load requirement
Mechanical noise	At ambient or below

2. Products

2.1. DSP

2.1.1. Acceptable DSP brands are: QSC and BIAMP. Any other brand/model must be approved by AV Consultant.

2.2. AMPLIFIERS

2.2.1. Acceptable amplifier brands are: QSC, Crown, and LabGruppen. Any other brand/model must be approved by AV Consultant.

2.3. LOUDSPEAKERS

2.3.1. Acceptable loudspeaker brands are: QSC, Community, JBL and Electrovoice/Bosch. Submit all other speaker proposals for AV Consultant approval.

3. Execution

3.1. AUDIO SYSTEM TESTING AND CALIBRATION

3.1.1. Optimize the digital signal processors, amplifiers, loudspeakers, speaker power taps, phasing, and speaker aiming as required to achieve the system's optimal performance with reference to the intent of the design and the performance criteria defined in the specifications.

3.1.2. The system is intended to provide (without clipping) an average program level of at least 85 dBa at 1.5m above the floor.

- .1 Using pink noise (with range of 250 Hz to 8 kHz), measure the sound pressure level at one randomly chosen position in each zone.
- .2 Adjust signal so the variation in sound pressure level within in each area shall approach +/- 3dB or better, measured in 1/3 octave bandwidth across a frequency range of 250 Hz to 8 kHz)

3.1.3. The AV Contractor shall have as a minimum the following test equipment available on site during testing and performance acceptance:

- .1 Sound-level meter (peak and average reading) c/w calibrated microphone
- .2 Phase checker generator/receiver set
- .3 Include all necessary cables and specialty adapters

- 3.1.4. All testing of loudspeakers to be installed overhead should be tested thoroughly prior to installation. It is important that all rigging systems are inspected for structural integrity and all fasteners are secured. Once installed, the speakers shall need to be tested for proper polarity.
- 3.1.5. The system shall be free of hum, clicks, RF pickup, thumps or other audible distortions in all configurations and phases of operation. Correct all deficiencies.
- 3.2. DIGITAL SIGNAL PROCESSORS
- 3.2.1. Where the DSP is used in conjunction with table microphones and audio/video conferencing, the DSP shall be configured for mix-minus operation to ensure maximum gain before feedback. Ensure room speakers are individually home run back to equipment rack. Provide enough DSP outputs and amplifier channels to support mix-minus operation.
- 3.2.2. DSP shall be programmed and commissioned by programmers and technicians certified on specified platform. Provide all certifications at time of bid.
- 3.2.3. Upon completion of the project, AV Contractor shall provide all custom programmed code to Owner on USB media or Owner identified preferred media format.
- 3.2.4. Provide all programming and end to end calibration to align the DSP with interconnected devices.
- 3.2.5. Provide all GUI's and interface control programming as required. Provide user manuals for custom GUIs.
- 3.2.6. Provide all software applications and tools to configure and maintain the DSP systems.
- 3.2.7. Provide system presets to capture and store signal routing and processing paths for table configurations.
- 3.2.8. Configure the software to allow full processing of all signal paths.
- 3.2.9. Where interfaced with a third party control system, control system shall hang up any open calls on system shutdown routines.
- 3.2.10. Microphone signal paths to include:
- .1 High pass filter
 - .2 Compression
 - .3 3 band parametric EQ
 - .4 Gain control on each input Level metering on each input
- 3.2.11. Line signal paths to include:
- .1 High pass filter
 - .2 Levelling
 - .3 3 band parametric EQ , Gain control on each input & Level metering on each input
- 3.2.12. Microphone mixing includes:
- .1 Automatic gain sharing mixing (organised into groups)
 - .2 Individual and group master levels which can be controlled in real time.
 - .3 Full metering of microphone input
- 3.2.13. Mixing and routing to include:
- .1 Matrix router to assign any combination of inputs to outs (some signals may be combined to reduce matrix size depending on facility operation)
 - .2 Microphones to be grouped and processed by gain sharing auto mixers
- 3.2.14. Loudspeaker signal paths to include:
- .1 High pass filter
 - .2 6 band parametric EQ
 - .3 Limiting and compression with side chain
 - .4 Up to 100ms Delay

- .5 Low pass filter
- .6 Level control on each output & Metering on each output

3.3. DISTRIBUTED AUDIO SYSTEMS

- 3.3.1. Remove distributed audio line from the output of the distribution amplifiers.
- 3.3.2. Connect an impedance meter to the distributed loudspeaker line.
- 3.3.3. Use the meter to verify the total load on the distributed line. The line load shall not exceed the intended design limits.
- 3.3.4. System Contractor shall include test results in the system manual.

3.4. DIGITAL AUDIO SIGNAL SYSTEMS

- 3.4.1. Test digital audio signals for proper operation between devices. Ensure no additional noise is introduced into the analogue audio and digital signal paths when all devices are interconnected for normal operation.
- 3.4.2. Ensure all signals throughout the digital audio path are functioning at designed levels.

END OF SECTION

27 41 16.11 Displays

1. General

1.1. WALL MOUNTS FOR DISPLAYS

- 1.1.1. Displays shall be mounted as shown on architectural drawings.
- 1.1.2. The AV Contractor shall provide wall-mount that allows accessibility to infrastructure located behind the display.
- 1.1.3. The AV Contractor shall select mounts to match blocking requirements shown on audiovisual and/or architectural drawings.

2. Products

2.1. WALL MOUNTS FOR FLAT PANEL DISPLAYS

- 2.1.1. Acceptable brands are Chief, Premier Mounts and Peerless. Any other model must be approved by the AV Consultant.

3. Execution

3.1. DISPLAYS

- 3.1.1. Provide all necessary mounting hardware to mount the displays to structural and route cabling concealed from view.
- 3.1.2. Displays to be wall mounted or ceiling mounted as per manufacturer's instruction.
- 3.1.3. Provide all necessary accessories and hardware for a fixed installation of the display system.
- 3.1.4. Locking display mounts shall contain the same locking mechanisms / keys on all mounts (unless specified otherwise).
- 3.1.5. The AV Contractor to confirm all required wall blocking, power and conduit required at display locations is adequate and properly installed prior to display installation.

END OF SECTION

27 41 16.15 Control Systems

1. General

1.1. DESCRIPTION

- 1.1.1. The control system provides a central microprocessor for control and automation of project audiovisual systems and equipment, and interfaces for user interaction with all devices.
- 1.1.2. Control processors shall be rackmount based. Provide all rackmount accessories to properly mount and house processor.
- 1.1.3. Provide all networking components required to provide an audiovisual control network. Coordinate with Owner's IT officers to arrange an IP subnet range as required.
- 1.1.4. Supply, install and program all expansion modules to provide functionality and control as outlined in the Specification.
- 1.1.5. Where devices are under the control of the AV system controller, connections and hardware shall support bi-directional communications with the AV systems controller.
- 1.1.6. Coordinate with the Owner and/or appointed representative to provide a user intuitive and functional control methodology for all room uses, configurations and user skill sets.
- 1.1.7. System programming shall meet with all specified requirements for a complete control solution.
- 1.1.8. All control system program files shall be created by the AV Contractor. Reuse of old programming code on existing systems is not acceptable without approval of the Owner and AV Consultant.
- 1.1.9. Upon completion of the project, all control system software files shall be submitted in compiled and uncompiled formats. Executable files that mimic the graphical control interfaces shall also be provided to the Owner to be used on designated computers.

2. Products

2.1. CONTROL SYSTEM

- 2.1.1. Acceptable control system products are: Crestron, QSC and AMX. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. CONTROL SYSTEM PROGRAMMING AND INSTALLATION STANDARDS

- 3.1.1. All control system programmers and field commissioning technicians must possess manufacturer specific programming certifications.
- 3.1.2. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall work with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.
- 3.1.3. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall coordinate a minimum of two (2) development workshops, each being a minimum of four (4) hours in length, with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.
- 3.1.4. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.

- 3.1.5. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.
- 3.1.6. Control system shall manage all system devices and provide full feature control of the following devices using the protocols indicated in brackets.:
- .1 Audiovisual Matrix Switchers (RS-232 or Ethernet)
 - .2 Flat panel displays (RS-232 or Ethernet)
 - .3 Projector/display lifts (Relay or contact closure)
 - .4 Video conference codec (RS-232 or Ethernet)
 - .5 Audio DSP (RS-232 or Ethernet)
 - .6 Document camera (RS-232 or Ethernet)
 - .7 Lighting (Ethernet or RS-232; Interface at AV rack location by others)
 - .8 Blinds and shades (Ethernet, Relay or RS-232; Interface at AV rack location by others)
 - .9 Projection screen low-voltage controller (Relay)
 - .10 Partition status and activation where applicable
- 3.1.7. In addition to typical device control, the AV Contractor programming is to include the following functionality within the control software and touch panel page design:
- .1 Provide pop window to indicate "System initializing" upon system start when projection systems are utilized.
 - .2 Provide pop-up window to indicate "System shutting down":
 - .1 Include countdown timer, or bar graph indication of time remaining
 - .1 Confirm timer setting during workshop
 - .2 Provide menu to cancel shutdown request.
 - .3 Upon timer expiration, the system shall automatically shutdown without user action.
 - .3 Automatic system shut down with timing to be confirmed with Owner. Provide 15 minute prompt screen pop-up
 - .4 Room program audio and voice reinforcement level and mute controls. Include master fader and mute control as required
 - .5 Password protected start up page (to be confirmed during workshop)
 - .6 Dynamic and speed dial facilities for audio conferencing
 - .7 Dynamic and speed dial facilities for video conferencing.
 - .8 Automated system on/off when a user connects a presentation device to the system such as a laptop/tablet to a input presentation cable.
 - .9 All other programming features deemed appropriate by the Owner and/or appointed representative to provide an intuitive and easy to understand user interface.
- 3.1.8. Where the project contains graphical user interfaces from multiple manufacturers, provide a consistent graphical user experience regardless of manufacturer. For example, if a project contains both Cisco and Crestron Touch panels, ensure the custom Crestron interfaces match the Cisco user interface/user experience as closely as possible. Provide mock-ups of interfaces for Owner/AV Consultant approval prior to the completion of development of custom software and the deployment of custom software to touch panel hardware on site.
- 3.1.9. All control programming with custom graphical user interfaces shall be controllable through the Owner's computers, mobile devices or tablets. Provide executable files of the control system program graphical user interface and deploy on computers as directed by the Owner. Submit executables as part of the as built documentation. Provide a method (eg. QR code) to allow the user to transfer the interface to their own device (mobile or tablet). Confirm with Owner/consulting preferred operating system and network configuration requirements

END OF SECTION

Zeidler

Smith and Andersen

22 May 2026

27 41 16.16 Audio Video Transmission Systems

1. General

1.1. MULTI-SIGNAL MATRIX SWITCHING AND TRANSMISSION SYSTEMS

1.1.1. Audio video transmission systems shall transcode multiple types of AV signals to a single signal type for distribution. The system shall support the following AV signal inputs:

- .1 HDMI 2.0 (High Definition Multimedia Interface)
- .2 DVI 1.1 (Digital Visual Interface)
- .3 DisplayPort Multimode 1.1
- .4 Analog RGB
- .5 YPbPr
- .6 Component video
- .7 Analog Stereo Audio

1.1.2. The AV distribution system shall use multimode fiber or shielded twisted pairs for AV signal distribution.

1.1.3. The twisted pair structured cabling used to carry the AV signals shall be shielded.

1.1.4. The AV Contractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.

1.1.5. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

1.1.6. The AV switching system shall allow configuration of the EDID presented to sources on each AV input.

1.1.7. The AV switching system shall allow the user to enter each input's EDID video timings individually.

1.1.8. The AV distribution system shall allow all source and sink transmitters and receivers to be monitors through PC based software.

1.1.9. The AV distribution system shall transmit the following control signals for AV sources and sinks using the same cabling infrastructure:

- .1 RS-232
- .2 Infrared
- .3 Ethernet
- .4 Contact closure

1.2. HIGH BANDWIDTH DIGITAL CONTENT PROTECTION (HDCP) MANAGEMENT

1.2.1. The AV switching system shall support HDCP 1.1 or greater.

1.2.2. The AV switching system shall detect the number of KSVs supported by each source, and not send a source more Key Selection Vectors (KSVs) than it supports.

1.2.3. The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.

1.2.4. The AV Contractor shall notify AV Consultant if a particular AV source cannot provide enough KSVs to route to all sink destinations simultaneously.

1.3. HDBASET AUDIO VIDEO TRANSMISSION SYSTEM TRANSPORT

1.3.1. The audio video transmission system transport shall be an advanced signal extender capable of extending multiple AV signals from source to sink location using a single STP or fibre optic cable.

1.3.2. The system shall support the following features:

- .1 Signal transmission up to 330 feet via STP cable
 - .2 Signal transmission up to 3000 feet via fiber
 - .3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)
 - .4 IR and RS-232 control
 - .5 Advanced video detection on every video type, including resolution, frame rate and color depth.
- 1.3.3. Cabling for all 4K DCI and UHD systems shall be shielded.
- 1.3.4. HDBaseT Audio video transmitters shall be able to extend HDMI (including digital audio), DVI-I, RGBHV, RGBS, RGsB, YPbPr, and Analog 2-channel audio.
- 1.3.5. HDBaseT Audio video receivers shall receive and decode any signal sent from a cabling transmitter or from matrix switch. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling receivers are mandatory.
- 1.4. IP AUDIO VIDEO DISTRIBUTION SYSTEM TRANSPORT
- 1.4.1. The audio video distribution system shall be a Gigabit IP network based advanced signal distribution system capable of extending multiple AV signals from source to sink location(s) using a single UTP or fibre optic cable to each end device.
- 1.4.2. The system shall support the following features:
 - .1 Signal distribution up to 330 feet via STP cable
 - .2 Signal distribution up to 3000 feet via fiber
 - .3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)
 - .4 IR and RS-232 control
 - .5 Advanced video detection on every video type, including resolution, frame rate and color depth.
 - .6 USB HID
- 1.4.3. UTP cabling for all 4K DCI and UHD systems shall be rated for Gigabit speed or higher.
- 1.4.4. IP Audio Video encoder shall be able to ingest HDMI (including digital audio).
- 1.4.5. IP Audio Video decoder shall receive and decode any signal available from an encoder. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling decoders are mandatory.
- 1.5. MATRIX SWITCHER
- 1.5.1. The matrix switcher shall consist of a card-cage type unit, capable of accepting different input and output cards while fulfilling the functionality described in sections 1.1, 1.2 and 1.3.
- 1.5.2. Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.
- 1.5.3. Configure switcher system to accommodate all inputs and outputs as indicating on project functional drawings. Provide two additional "spare" inputs, two additional "spare" DVI-I inputs and at least one spare output as part of each switcher configuration.
- 1.5.4. Provide fast HDMI switching with switch timings less than three seconds.
- 1.6. PRESENTATION SWITCHERS
- 1.6.1. The presentation switcher is a single central switching and control unit that integrates audio-video switching, audio mixing and amplification, and a complete system controller.
 - .1 The presentation system shall be a single central switching and control unit integrating the following functions:
 - .1 Audio matrix switching.
 - .2 Microphone pre-amplification.

- .3 Acoustic echo cancellation where audio conferencing is specified.
 - .4 Microphone and program audio mixing.
 - .5 Audio amplification.
 - .6 Digital multi-channel audio router.
 - .7 Analog to digital video transcoding.
 - .8 Video matrix switching.
 - .9 Single Cable Signal Transmission.
 - .10 System control processing.
- 1.6.2. Ensure presentation switcher accepts and routes all signal types shown on functional drawings.
- 2. Products
 - 2.1. AUDIO VIDEO TRANSMISSION SYSTEMS (HDBASE-T)
 - 2.1.1. Acceptable products are: Crestron Digital Media and Extron XTP. Any other brand/model must be approved by AV Consultant.
 - 2.2. AUDIO VIDEO TRANSMISSION SYSTEMS (AV-OVER-IP)
 - 2.2.1. Acceptable products are: Crestron Digital Media NVX, Extron NAV, Visionary Solutions and Aurora Multimedia. Any other brand/model must be approved by AV Consultant.
- 3. Execution
 - 3.1. COMMISSIONING
 - 3.1.1. All field commissioning technicians must possess manufacturer specific certifications. The AV Contractor shall supply to AV Consultant all required system certifications at time of bid.
 - 3.1.2. All infrastructure wiring should be tested before connecting any active equipment.
 - 3.2. SHIELDED TWISTED PAIR (STP) CABLE
 - 3.2.1. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the "*Permanent Link*" performance specification as defined in the Category ANSI/TIA-568-C Standard.
 - 3.2.2. Field structured cables should be tested for the following, in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard".
 - 3.2.3. Test Result Documentation
 - .1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.
 - 3.3. FIBER
 - 3.3.1. Each fiber end should be inspected with a 100x-200x microscope and cleaned if necessary before testing. Each fiber should be tested for optical loss using the 'IEC 61280-4-1 single reference cable method' or 'TIA 526-14 OFSTP-14 Method B' with the acceptable link attenuation (insertion loss) on each fiber end-to-end link of <4dB @ 850nm and <4dB @ 1300nm.
 - 3.3.2. Test Result Documentation
 - .1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.

3.3.3.

3.4. SYSTEM TESTING AND COMMISSIONING

3.4.1. Testing

- .1 A Manufacturer Certified Engineer shall perform the AV Contractor verification tests.
- .2 The AV Contractor shall verify that all components of the system are installed according to manufacturer's specifications and are compliant with Division 27 specifications.

3.4.2. Commissioning

- .1 A Manufacturer Certified Engineer shall perform acceptance testing and commissioning.
- .2 The AV Contractor shall provide a copy of the system commissioning Test Report in electronic format upon request.
 - .1 All reported information shall be generated by the matrix unit and the configuration software and cable testing device.
- .3 Commissioning engineer shall run all available tests and include all installed system components.
- .4 Commissioning Test Report shall include the following:
 - .1 Tests Failures and Notices
 - .1 Sink Device EDID Test – Open items or failures shall not be accepted.
 - .2 Cable Length Test - Open items or failures shall not be accepted.
 - .3 HDCP KSV Limitations – Limitations shall not be accepted.
 - .4 Cable Limitations – Limitations shall not be accepted.
 - .5 EDID Limitations – Limitations shall not be accepted.
 - .6 Cable Length Limits exceeded – Failing cables shall not be accepted.
 - .2 Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
 - .3 Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
 - .4 EDID – Input Resolution and 3D support status for each input.
 - .5 EDID – Supported Output Resolution and 3D support status for devices connected to each output.
 - .6 EDID – Supported Audio formats for each input.

END OF SECTION

27 41 23.10 Audiovisual Cabinets, Racks, Frames and Enclosures

1. General
 - 1.1. FIXED INSTALLED RACKS
 - 1.1.1. All equipment racks must conform to the following standards:
 - .1 EIA RS-310-C, Racks, Panels and Associated Equipment
 - .2 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems
 - .3 IEC 60297-3-100 – Mechanical Structures for Electronic Equipment
 - 1.1.2. Provide openings top and bottom as required for cabling.
 - 1.1.3. Provide rack elevations as part of shop drawing submissions.
 - 1.1.4. Racks to be Black unless otherwise specified.
 - 1.1.5. All racks to be of a professional quality, all steel welded construction, baked enamel finish, removable side panels, sliding front and rear equipment mounting rails, formed dress panels and a bottom dress panel.
 - 1.2. PORTABLE RACKS
 - 1.2.1. Provide portable steel equipment racks with dress panels and removable sides as required for a completed look and finish. Top panel should be solid or vented depending on cooling requirements and rear doors with flush key locks are required. Doors should be perforated unless solid doors are required in cooling scheme.
 - 1.2.2. Top and bottom planes should incorporate a recess on the rear edge to allow for the passage of cables when the cabinet is located against a surface to the rear.
 - 1.2.3. Provide approval drawing of this equipment for review by the AV Consultant prior to construction.
 - 1.3. WALL MOUNT RACK REQUIREMENTS
 - 1.3.1. For wall mounted racks, provide swing-out style steel racks with locking front doors and vented side panels. Ensure the rack has appropriate ventilation requirements.
 - 1.4. RACK ACCESSORIES
 - 1.4.1. Supply cable tie bars for all horizontal cable transitions and vertical lacing bars.
 - 1.4.2. Supply vent panels at the top and bottom of all 44RU equipment racks.
 - 1.4.3. Supply blank panels (blank or vent) to fill all empty rack spaces. Panels can be 1, 2 or 3 RU.
 - 1.4.4. Provide one 3 RU steel pull out drawer in each rack that is greater than 27RU in capacity.
 - 1.4.5. Provide a multi-duplex AC outlet plug strip in each rack, one outlet for each 3 RU.
 - 1.4.6. Provide a permanent work light with switch, mounted at the rear top of the rack to assist with service.
 - 1.4.7. Provide adjustable front and rear mounted rails tapped with #10-32 mounting holes.
 - 1.4.8. Provide all mounting hardware and rack screws with nylon washers.
 - 1.4.9. Where isolated ground systems are specified provide copper ground buss bar with tapped holes. Provide copper cable clamps ("Burndy") for connection to equipment. Provide 12 AWG stranded copper strap between buss bar and each rack mount component.
 - 1.5. AUDIO AND VIDEO RACK PATCH PANELS
 - 1.5.1. For audio and video cable interconnectivity, provide custom rack patch panels with the following requirements:

-
- 1.5.2. Nominal panel dimensions to be 19" wide and 1.75" (1RU), 3.5" (2RU), 5.25" (3RU) or 7" (4RU) high as required. Refer to EIA Standard RS-310-C for allowable tolerances.
 - 1.5.3. Panels shall be made of #16 C.R.S. folded back ½" top and bottom.
 - 1.5.4. Panel shall have integrated "tie-bar" to support cables at rear of panel of sufficient depth not to impede connector wiring.
 - 1.5.5. All connector cut-outs shall be sized to accommodate Neutrik D-format or equivalent connectors.
 - 1.5.6. All rack panel mount audio connectors shall be XLR-type, premium quality with metallic shells, universal Neutrik D-format, gold contacts.
 - 1.5.7. All panel mount video connectors shall be coaxial 75 ohm BNC, isolated ground, suited for bandwidth and signal type.
 - 1.5.8. All jack panel designations shall be silk-screened.
 - 1.5.9. Data patch panels with the following requirements:
 - .1 Data patch panels shall be rack-mountable
 - .2 Data patch panels shall be 24-port CAT6 RJ45, 1RU
 - .3 Data patch panels shall have labelling strip to allow three lines of text
 - 1.5.10. Data patch panels shall be Blackbox, Panduit or approved equal.
 - 1.6. UNINTERRUPTIBLE POWER SUPPLY (UPS)
 - 1.6.1. Provide a series mode UPS for all equipment racks that house microprocessor devices such as control systems and DSP.
 - 1.7. WORK INCLUDED
 - 1.7.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.
 - 2. Products
 - 2.1. FIXED INSTALLED RACKS AND ACCESSORIES
 - 2.1.1. Acceptable brands are: Middle Atlantic. Any other brand/model must be approved by AV Consultant.
 - 2.2. PORTABLE RACKS
 - 2.2.1. Acceptable brands are: Engineered Case Manufacturer. Any other brand/model must be approved by AV Consultant.
 - 2.3. UNINTERRUPTIBLE POWER SUPPLY (UPS)
 - 2.3.1. Acceptable brands are: Middle Atlantic, Surgex, Eaton and APC. Any other brand/model must be approved by AV Consultant.
 - 3. Execution
 - 3.1. FIXED INSTALLED RACKS
 - 3.1.1. Amplifiers should be mounted at the bottom rail of the equipment rack to maintain balance and stability. Support the weight of the amplifier with angle brackets attached to the side rails of the equipment rack or with the rear support flanges included with some amplifiers. Attach a label to the faceplate of each amplifier to indicate function.

3.2. EQUIPMENT RACKS IN MILLWORK

- 3.2.1. Racks in millwork must have a minimum of 2" clear space behind the racks and rear of the cabinet.
- 3.2.2. Millwork should be cut to allow access to electrical, data and AV wall boxes.
- 3.2.3. Millwork and credenza must have ventilation slots provided to allow for proper cooling of the audiovisual equipment.

3.3. VENTILATION

- 3.3.1. Provide vent panels at the top and bottom of all 44RU equipment racks.
- 3.3.2. Provide blank or perforated metal panels as required to provide adequate cooling. If rack is convection cooled, install a 1RU panel above and below each power amplifier.
- 3.3.3. Internal equipment rack temperature should not exceed 85°F. Provide passive or active thermal management solutions to maintain an internal temperature lower than stated.
- 3.3.4. For equipment racks mounted in credenzas, ensure adequate cutouts are provided to dissipate heat. Cutouts should be provided at the bottom and top (or rear) of all millwork for ventilation. Provide active thermal management if required to the millwork. Coordinate with millwork Contractor.
- 3.3.5. Avoid locating racks directly under supply ductwork. The flow of hot air rising from the top of the rack should have no impediments on its way back to the return air intake duct.

3.4. PORTABLE RACKS

- 3.4.1. Provide four high-quality locking casters, 4" wheel diameter for cabinets taller than 21".wall mount RACK REQUIREMENTS

3.5. UNINTERRUPTIBLE POWER SUPPLY (UPS)

- 3.5.1. All connected equipment shall be considered critical use devices.
- 3.5.2. Ensure all power cords connected are properly labelled with destination device name.

END OF SECTION

27 41 23.11 Audiovisual Cabling

1. General
 - 1.1. WORK INCLUDED
 - 1.1.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.
 - 1.1.2. Supply and install cabling as detailed in Contract Documents. The AV Contractor shall provide all required pathways to distribute the cables throughout the facility where the pathway has not been provided by Division 26. Where cables leave the pathways, the AV Contractor shall supply and install cable slings and/or j-hooks to support cabling up to point of termination. Comply with the following section - *27 05 28.00 Pathways for Communication Systems*.
 - 1.1.3. Supply and install conductors and cables as detailed in Contract Documents and as required and as recommended by the manufacturer to ensure proper operation of all systems. The AV Contractor shall use pathways (by Division 26) to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point the AV Contractor shall ensure cable have appropriate infrastructure to support and secure the cables.
 - 1.1.4. Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The AV Contractor without any additional compensation shall replace damaged cables.
 - 1.1.5. Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
 - 1.2. CABLE ROUTING
 - 1.2.1. Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Audiovisual Engineer's Representative prior to installation.
 - 1.2.2. For all schemes of cable routing, no point in the path shall be subjected to a bend radius of less than eight times the cable diameter or minimum cable bend radius specified by the manufacturer.
 - 1.3. CABLE PROPERTIES
 - 1.3.1. Conductors and cables shall be CMR where installed completely in conduit and/or where installed in non-plenum rated areas. Conductors and cables shall be CMP where not completely installed in conduit and/or installed in plenum rated areas. All cable shall conform to the recommendations of the manufacturers of the audiovisual systems.
 - 1.3.2. Conductors and cables shall be outdoor rated where installed outdoor and /or installed in locations where exposed to weather elements.
 - 1.3.3. Provide and install shielded cables where required and or recommended by the manufacturer of the audiovisual systems.
 - 1.3.4. Wiring shown is for typical systems. All wiring shall be as required and recommended by the manufacture of the audiovisual systems.
 - 1.3.5. All wiring shall be of proper gauge, type and quantity of conductors as required and as recommended by the manufacturer to ensure proper operation of audiovisual systems and peripheral devices.
 - 1.3.6. Multi-conductor cables shall have color-coded conductors.
 - 1.3.7. All conductors and cables shall be CSA approved and must bare stamping by the manufacturer. .
 - 1.3.8. Consult drawings and provide FT-6 rated cable where cables are outside of conduit systems

1.4. CABLE DISTRIBUTION

- 1.4.1. Utilise all indicated and available cable pathways such as conduits, communications cable tray, ducts, surface raceways and furniture system channels except where otherwise noted.
- 1.4.2. Wires and cables shall be segregated according to signal type. In addition, audio cable shall be subdivided into three classes: microphone level circuits, analog line level circuits and speaker level circuits.
- 1.4.3. Microphone level audio circuits shall be kept at least 75mm (3") away from any other type of parallel signal circuits and at least 150mm (6") away from any parallel AC power circuits.
- 1.4.4. Speaker level audio circuits shall be kept a minimum of 75mm (3") from line level audio and AC power circuits. All other signal circuits shall be kept at least 75mm (3") away from any parallel AC power circuits. Where conditions allow, high impedance and low impedance (8 ohm) speaker levels shall be separated by minimum of 75mm (3").
- 1.4.5. Where circuits of different types must cross, they shall do so at right angles and then return to the above required separations in as short a distance as possible.
- 1.4.6. Inside buildings minimise any possibilities of disruption by maintaining the following minimum clearances from electrical and heat sources when routing cables.

Item	Minimum Clearance
Motors	1.20 m (4'-0")
Transformers	1.20 m (4'-0")
Conduit and cables used for electrical distribution less than 1kVA	0.30 m (1'-0")
Conduit and cables used for electrical distribution greater than 1kVA	1.00 m (3'-0")
Fluorescent Luminaries	12 cm (0'-5")
Pipes (gas, oil, water, etc.)	30 cm (1'-0")
HVAC (equipment, ducts, etc.)	15 cm (0'-6")

1.5. FIRE STOPPING

1.5.1. General

- .1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.
- .2 The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly to the Code Requirements.
- .3 Moisture seals as well as fire and smoke seals shall be required for all floor penetrations in Laboratories and Operating Rooms in Hospitals, Universities and Schools.
- .4 The Communications Contractor shall establish/re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed, or that were created by others for use by the Communications Contractor.
- .5 Supply and install Fire Stop pillows for existing cable tray penetrations through firewalls.
- .6 For the purposes of this specification, the only acceptable Fire Stop Systems shall be those that have been tested to the CAN/ULC S115 Standard.
- .7 Supply and install non-permanent CSA approved Fire Stop systems that are dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).
- .8 All fire stopping shall maintain a minimum one hour rating and shall meet applicable Federal, Provincial and Local building codes.
- .9 All Fire Stop Systems shall be listed and tested by an SCC and accredited Third Party Testing Agency in accordance with the Standards.
- .10 Fire resistance ratings of installed Fire Stop Systems shall not be less than the fire resistance rating of the surrounding Fire Separation or Firewall.
- .11 All Smoke Seals selected for use shall comply with Standards.

- .12 Where moisture seals are required for floor penetrations in Operating Rooms, Morgues, and Laboratories in Hospitals, Universities and Schools, the Fire Stop Materials selected shall be compatible with Formalin.
- .13 All Fire Stop Materials and Smoke Seals shall have elastomeric characteristics to allow for building settling and seismic movement. All Fire Stop Materials and Smoke Seals shall be free of asbestos.

1.5.2. Quality Assurance

- .1 Provide fire stopping systems that comply with the following requirements following:
 - .1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.
 - .2 Fire stopping products bear the classification marking of qualified testing and inspection agency.
- .2 Provide the work of this Section using competent installers, experienced in the application of the materials and systems being used, approved and trained by the material or system manufacturer.
- .3 Fire Stop Systems shall conform to the fire (F), hose (H) and temperature (T) ratings of Codes.
- .4 Fire Stop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").
- .5 For the purposes of this specification the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.

1.5.3. Performance

- .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes shall occur.
- .2 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
- .3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
- .4 Openings for cable trays shall be sealed using re-enterable fire stopping pillows.

1.5.4. Project Conditions

- .1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer
- .2 Do not install fire stopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
- .7 Schedule installation of fire stopping after completion of penetrating item installation but prior to covering or concealing of openings.

2. Products

2.1. MIC/LINE LEVEL ANALOG AUDIO CABLE (TYPE MLA)

- 2.1.1. The mic/line cable is an installation grade cable intended for permanent analog microphone and line level installations.
- 2.1.2. Mic/line level cable shall be minimum 22 AWG stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.1.3. Mic/line cable shall have 100% foil shield with 22 AWG drain wire.
- 2.1.4. Mic/line cable shall have a voltage rating of 300 V RMS.
- 2.1.5. Mic/line cable shall be Belden 9451 (FT-4), 9451P (FT-6) or approved equivalent.

2.2. MIC/LINE LEVEL DIGITAL AUDIO CABLE (TYPE MLD)

- 2.2.1. The mic/line level digital audio cable is an installation grade cable intended for digital audio (AES/EBU signals).
- 2.2.2. Mic/Line Level digital audio cable shall be minimum 24 AWG stranded shielded twisted pair copper with propylene or equivalent insulated conductors and PVC outer jacket.
- 2.2.3. Mic/Line Level digital audio cable shall have minimum 95% braided shield and bare copper 26 AWG drain wire.
- 2.2.4. Mic/Line Level digital audio cable shall have a voltage rating of minimum 300 V RMS.
- 2.2.5. Mic/Line Level digital audio cable shall have a nominal impedance of 110 ohms.
- 2.2.6. Mic/Line Level digital audio cable shall be Belden 1800B (FT-4), 1801B (FT-6) or approved equivalent.

2.3. SPEAKER CABLE HIGH IMPEDANCE (TYPE LS16 AND TYPE LS14)

- 2.3.1. The speaker cable –high impedance is an installation grade cable intended for permanent 70-volt speaker system installations.
- 2.3.2. Speaker cable – high impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.3.3. Speaker cable – high impedance shall be minimum 16 AWG for low power (under 200 watt loads) to a maximum of 500ft – 152m.
- 2.3.4. For higher than 200 watt loads or cable runs longer than 200ft, utilize a 14 AWG unless otherwise specified. See "Speaker Cable – Low Impedance".
- 2.3.5. Speaker cable – high impedance shall have a voltage rating of 300 V RMS.
- 2.3.6. Speaker cable – high impedance shall be Belden 6200UE (16AWG FT-6), 5200UH (16AWG FT-4), 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4) or approved equivalent.

2.4. SPEAKER CABLE LOW IMPEDANCE (TYPE LS14 AND LS12)

- 2.4.1. Speaker cable – low impedance is an installation grade cable intended for permanent performance audio system installations.
- 2.4.2. Speaker cable – low impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.4.3. Speaker cable – low impedance shall be minimum 14 AWG for runs that are not longer than 75ft (23 metres).
- 2.4.4. Speaker cable – low impedance shall be minimum 12 AWG for runs that are longer than 75ft (23 metres) to a maximum of 200ft (63 metres).
- 2.4.5. Cabling for speaker cable runs longer than 200ft (63 metres) to be coordinated with the AV Consultant.
- 2.4.6. Speaker cable – low impedance shall be Belden 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4), 6000UE (12 AWG FT-6), 5000UH (12 AWG, FT-4) or approved equivalent.

2.5. AUDIOVISUAL STRUCTURED CABLING (TYPE D)

- 2.5.1. Audiovisual structured cabling is an installation grade cable used for IP control, video-over-IP solutions or audio-over-ethernet solutions (eg. Dante, AES67).
- 2.5.2. Cabling used for IP-based audiovisual solutions such as AES67 or H.264 shall comply with ANSI/EIA/TIA standards (minimum Category 6) and manufacturer specific networking requirements.
- 2.5.3. Comply with the following specifications:
- .1 27 13 13.00 Communications Copper Backbone Cabling
 - .2 27 13 23.00 Communications Optical Fibre Backbone Cabling
 - .3 27 15 00.19 Data Communications Horizontal Cabling
 - .4 27 15 33.00 Communications Coaxial Horizontal Cabling
- 2.5.4. Refer to division of responsibility between AV Contractor and communications Contractor on AV drawings and scope of work specification (27 41 00.00) for project specific audiovisual structured cabling requirements.

2.6. ANTENNA CABLE UHF (TYPE ANT-U)

- 2.6.1. The antenna cable is an installation grade cable intended for permanent wireless microphone system antennas and assistive listening system transmitters (IR radiators and antennas) operating in the UHF frequency bands.
- 2.6.2. Antenna cable shall be RG-8X type with 10AWG solid copper conductor.
- 2.6.3. Antenna cable shall have minimum braided shield and over foil shield.
- 2.6.4. Antenna cable shall have a nominal impedance of 50 ohms.
- 2.6.5. Antenna cable shall be Belden 9913 (FT-4), 89913 (FT-6) or approved equivalent.

2.7. ANTENNA CABLE DECT (TYPE ANT-D)

- 2.7.1. The antenna cable is an installation grade cable intended for digital wireless systems operating the DECT frequency bands (above 1GHz).
- 2.7.2. Antenna cable shall have a frequency range of 30MHZ to 8000MHZ.
- 2.7.3. Antenna cable shall have minimum braided shield and over foil shield.
- 2.7.4. Antenna cable shall have a nominal impedance of 50 ohms.
- 2.7.5. Antenna cable shall be Times Microwave LMR-400-LLPX or approved equivalent.

2.8. 12 GHZ SERIAL DIGITAL INTERFACE COAXIAL VIDEO CABLE (TYPE SDI)

- 2.8.1. The 12G-SDI digital video cable is intended for permanent installations requiring transmission of uncompressed UHD and 4K-DCI video signals requiring an approximate 12 Gb/s data rate.
- 2.8.2. 12G-SDI Digital Video Cable shall be minimum 18 AWG bare silver-plated copper insulated conductor, shielded and PVC outer jacket.
- 2.8.3. 12G-SDI Digital Video Cable shall have a minimum 95% braided shield and 100% foil shield.
- 2.8.4. 12G-SDI Digital Video Cable shall have a nominal impedance of 75 ohms.
- 2.8.5. 12G-SDI Digital Video Cable shall adhere to SMPTE 2082-1 specifications.
- 2.8.6. 12G-SDI Digital Video Cable shall be Belden 4794R or approved equivalent.

2.9. HDBASE-T CABLE (TYPE HDBT)

2.9.1. Refer to 27 41 16.16 Audio Video Transmission Systems for projects with HDBase-T solutions.

2.10. FIRE STOP

2.10.1. Products manufactured by Hilti Corporation (or approved equivalent) are acceptable.

2.10.2. Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.

3. Execution

3.1. CABLE INSTALLATION

3.1.1. Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.

3.1.2. All cables and components shall be installed and terminated in accordance with applicable Codes, Standards and Regulations.

3.1.3. Supply and install all wiring as required for the proper operating of each audiovisual system and each peripheral device.

3.1.4. After installation, and before termination, all wiring and cabling shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields.

3.1.5. Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination.

3.1.6. Protect wire and cable from kinks.

3.1.7. Provide grommets and strain relief where required.

3.1.8. Comply with controller and peripheral device manufactures installation and termination recommendation.

3.1.9. Where more than two cables shall terminate at the output of a device a terminal block with identification must be provided near the device to gather the cables together so only one cable actually terminates on the device. Provide terminal blocks, marking and mounting systems.

3.1.10. Provide brush plates or scoop wall plates to cover all mudrings and backboxes used for cable passthrough.

3.2. CABLE SUPPORT

3.2.1. Hangers shall be installed at 4' intervals (maximum). Cables shall be run such that sag between supports does not exceed 4". Secure all cables to J-hooks/supports with Velcro tie-wraps. Cables shall be combed and dressed for all visible portions of the install. The above noted conditions shall be strictly checked and the AV Contractor shall be required to comb and redress any cables that are unsatisfactory at no additional cost.

3.2.2. Attaching to T-bar support rods is not acceptable. Anchors for hangers must not be drilled into post tensioned beams under any circumstances. The AV Contractor shall not use Hilti Pneumatic hammers. All anchors must be drilled into slab.

3.2.3. The AV Contractor must minimize the disturbance or removal of 'fire spray' insulation during installation of cable supports.

3.3. NON-CONTINUOUS CABLE SUPPORT

3.3.1. The AV Contractor shall supply and install cable support for the distribution of horizontal and backbone cables where conduit or ladder tray has not been provided.

3.3.2. The size of J-hooks/support shall suit quantity of cables in runs used for distribution.

3.3.3. Include any other miscellaneous hardware (angled hanger bracket, hammer/screw on clamps) required to support horizontal and backbone cabling.

3.4. GROUNDING WIRE

- 3.4.1. Supply and install #6 AWG green grounding wire for all metallic components that shall be grounded and Code Conductor Two Hole Long Barrel with Window Lug to bond the conductor to the ground bus.

3.5. VELCRO TIE-WRAPPS

- 3.5.1. Velcro tie-wraps shall be used to neatly dress cables; they shall be placed at a maximum of 4' intervals for horizontal distribution (centre points between cable supports).

3.6. CABLE DISTRIBUTION

- 3.6.1. Do not exceed the copper cables maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension specifications during installation. The tension limit shall be set at or below the manufacturer's limit. The cable shall be taken up at intermediate pulling points with an intermediate take-up device as approved by the Audiovisual Engineer's Representative, to prevent over tension on the cable.
- 3.6.2. Minimum bend radius shall be as per manufacturer's recommendations.
- 3.6.3. Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.
- 3.6.4. Protect exposed cable ends from moisture ingress.

3.7. DUCT AND CONDUIT

- 3.7.1. Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Audiovisual Engineer's Representative of the problems encountered.
- 3.7.2. Apply manufacturer's recommended lubricant to cables to reduce friction between the cable and the conduit. Cable grip shall be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.

3.8. TESTING

3.8.1. Coaxial Cable Testing

- .1 All horizontal CATV Coaxial cables shall be swept tested to industry standards using a Time Domain Reflectometer (TDR).
- .2 All horizontal CATV Coaxial cables shall be sweep tested after installation for opens, shorts, and kinks. Damaged cables shall be replaced by installing a new cable. Indicate on the floor plans the actual length of each cable section as installed.
- .3 The AV Contractor shall provide soft and hard copy of cable test result for each CATV cable. Cable test results shall identify cable numbers and associated test results.

3.8.2. Copper Cabling Test Requirements

- .1 Every cabling link in the installation shall be tested (as required by the Cabling specified) in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA-568-B.1.
- .2 The installed twisted-pair horizontal links shall be tested from the Telecom Room to the workstation against the "Permanent Link" performance limits Specification as defined in ANSI/TIA/EIA-568-B.1.
- .3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. Appropriate training programs include installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals) and Vendor supplied certifications for their product.

- .4 The test equipment shall comply with or exceed the accuracy requirements for enhanced level II and/or level III field testers (according to Cabling specified) as defined in TIA-568-B; Annex I: Section I.4. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table I.4 of Annex I of TIA/EIA-568-B.2.
- .5 The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The AV Contractor shall provide proof that the interface has been calibrated within the period recommended by the Vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568-B; Annex I: Section I.2.2).

3.8.3. Optical Fibre Cabling Test Requirements

- .1 Every optical fibre cabling link in the installation shall be tested in accordance with the field test Specifications defined by the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA- 568-C (or by the appropriate network application Standard(s) whichever is more demanding).
- .2 ANSI/TIA/EIA-568-B, defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fibre patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. This TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
- .3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. These certificates may have been issued by any of the following organisations or an equivalent organisation:
 - .1 The manufacturer of the optical fibre cable and/or the optical fibre connectors
 - .2 The manufacturer of the test equipment used for the field certification
 - .3 Training organisations authorised by BICSI (Building Industry Consulting Services International) or by the ACP (Association of Cabling Professionals™).
 - .4 Vendor supplied certifications for their product.
- .4 Field test instruments for multimode fibre cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B; Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source. Field test instruments for singlemode fibre cabling shall meet the requirements of ANSI/EIA/TIA-526-7.
- .5 The optical fibre launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests as detailed below.

- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

3.8.4. Optical Fibre Cabling Performance Test Parameters

- .1 ANSI/TIA/EIA Standard 568-C3 prescribes that the single performance parameter for field testing of optical fibre links is link attenuation when installing components compliant with this Standard.
- .2 The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA 568-B:

.3	Link Attenuation =	.4	Cable_Attn + Connector_Attn + Splice_Attn
.5	Cable_Attn (dB) =	.6	Attenuation_Coefficient (dB/km) * Length (Km)
.7	Connector_Attn (dB) =	.8	Number_of_connector_pairs * connector_loss (dB)
		.9	(Maximum allowable connector_loss = 0.75 dB)
.10	Splice_Attn (dB) =	.11	Number of splices (S) * splice_loss (dB)
		.12	(Maximum allowable splice_loss = 0.3 dB)

- .13 The values for the Attenuation_Coefficient are listed in the table below:

Type of Optical Fibre	Wavelength (nm)	Attenuation Coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5
	1300	1.5
Multimode 50/125 µm	850	3.5
	1300	1.5
Single-mode (Inside plant)	1310	1.0
	1550	1.0
Single-mode (Outside plant)	1310	0.5
	1550	0.5

- .14 Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- .15 The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these Standards or application notes to accurately conduct performance testing.
- .16 The Horizontal Link (multimode): acceptable link attenuation for a multimode horizontal optical fibre Cabling Solution is based on the maximum 90 m (295 ft) distance. The horizontal optical fibre cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling [90 m (295 ft) or less], attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, and One Reference Jumper. The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. This value is based on the loss of two (2) connector pairs, one (1) pair at the telecommunications outlet/connector and one (1) pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fibre cable.
- .17 The Backbone Link (multimode) shall be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.
- .18 Multimode Backbone Links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A. Because backbone length and the potential number of splices vary

- depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
- .19 Singlemode Backbone Links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, and One Reference Jumper. All singlemode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm (See Note below).
- .20 Notes:
- .1 Link attenuation has been based upon the use of a light source categorised by a Coupled Power Ratio (CPR) of Category 2, Underfilled, per Annex B of ANSI/EIA/TIA-526-14A. The use of a light source categorised as Category 1, Overfilled, may provide results higher than the 2.0 dB limit. A field test tool based on LED (light emitting diode) light sources is a Category 1 device and typically yields high attenuation results.
- .2 Links destined to be used with network applications that use laser light sources (underfilled launch conditions) shall be tested with test equipment based on laser light sources. This rule should be followed for Cabling Solutions to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources.
- .3 For Gigabit Ethernet compliant certification (IEEE STD 802.3z application), use test equipment which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and a FP laser at 1310 nm (compliant with 1000BASE-LX).
- .21 Each optical fibre link terminated with an optical adapter system which does not impose a transmission direction because the adapters are not or cannot be ganged should be tested and documented in both direction since the direction of the signal transmission cannot be predicted at the time of installation.
- 3.8.5. Test each strand of fibre with an Optical Time Domain Reflectometer for length and attenuation. Performance test must be below the total return loss budget for the cable connectors/balun. Provide comprehensive optical time domain reflectometry (OTDR) testing for all fibre runs. Include a hard copy chart recording with the test documentation.
- 3.9. FIRE STOPPING
- 3.9.1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire stopping in accordance with manufacturer's installation instructions and technical information
- 3.9.2. Examine sizes and conditions of voids to be filled to establish correct thickness and installation of Fire Stop Materials.
- 3.9.3. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion
- 3.9.4. Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to manufacturer's instructions. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
- 3.9.5. The Communications Contractor shall install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.
- 3.9.6. In all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials shall be dry and free of other contaminants before, during and after installation of sealant Fire Stop Materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.
- 3.9.7. Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required and / or specifically designated, the passage of fluids.
- 3.9.8. Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to smooth, neat and tidy finish.
- 3.9.9. Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of work in this document.

- 3.9.10. In Combustible Construction (membrane GWB type) where the framing members are wood or where paper faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings which have been formed and sleeved.
- 3.9.11. Where the bottom of a Fire Stop System is exposed, seal bottom side of the assembly with a fire rated elastomeric Fire Stop sealant.

END OF SECTION

27 51 50.00 Audiovisual Networking

1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform with Section 27 40 10.00 – General Instructions for Audiovisual Systems
- 1.2. CODES, STANDARDS AND CERTIFICATION
- 1.2.1. Data communication network shall be in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A, and TBITS 6.9.
- 1.2.2. Equipment shall meet all applicable FCC/CRTC Regulations.
- 1.3. DEFINITIONS
- 1.3.1. Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).
- 1.3.2. Critical Cyber Assets: Those cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
- 1.3.3. Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
- 1.3.4. Cybercrime: to be any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
- 1.3.5. Cyber Hygiene: is a reference to the practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
- 1.3.6. Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
- 1.3.7. Cyber Security: refers to the body of technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
- 1.3.8. Cyber Threat or Cyber Security Threat: is a malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS/DoS) attacks and other attack vectors.
- 1.3.9. Cyber Threat Actors: is a broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
- 1.3.10. Network Certificates: are also known as a Digital Certificates, which are an electronic "password" that allows a person, organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
- 1.3.11. Secure Socket Layer Certificate (SSL) Digi-SSL
- 1.3.12. Software Signing (Code Signing Certificate) Digi-Code
- 1.3.13. Client Certificate (Digital ID) Digi-ID
- 1.3.14. Social Engineering: are exploitation methods that target human vulnerabilities, such as carelessness and trust.
- 1.3.15. Technical Vulnerabilities: are weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 1.3.16. Power-Over-Ethernet (POE)

1.3.17. Next Generation Firewall (NGFW)

1.3.18. Transport Layer Security (TLS)

1.4. DESCRIPTION

1.4.1. Network Switch

- .1 Network Switch shall support Layer-3 Gigabit Ethernet switching.
- .2 Network Switch shall provide Power Over Ethernet (PoE) on all ports and to provide wattage as required for the project.
- .3 Network Switch shall be managed.
- .4 Network Switch shall allow for a minimum of ten (10) configurable VLANs.
- .5 Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.
- .6 Network Switch shall have sufficient host ports to accommodate all system AV devices, with an additional 4-ports for expansion.
- .7 Network Switches that have more than eight (8) host ports shall be network stackable using a single IP management and have uplink ports.
- .8 Network Switch with uplink ports shall have a minimum of four (4) uplink ports that support 1000BaseSX, 1000BaseLX, 10GBase-SR and 10GBase-LR.
- .9 Network Switch shall be compatible with all digital audio and video multicast protocols and products required as part of the project. Refer to Scope of Work 27 41 00.
- .10 Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.
- .11 Network Switch shall be rackmountable.

1.4.2. Firewall

- .1 Firewall shall have a minimum NGFW throughput of 3.5 Gbps.
- .2 Firewall shall have a minimum Threat Protection throughput of 3 Gbps.
- .3 Firewall shall have a SSL inspection throughput of 4 Gbps.
- .4 Firewall shall have a maximum latency of 5 microseconds.
- .5 Firewall shall support a minimum of 100 VLANs.
- .6 Firewall shall support a minimum of 20 concurrent users.

1.4.3. PoE Injector

- .1 PoE injector shall feature two RJ45 connections.
- .2 PoE Injector shall support IEEE 802.3af Class 0 PoE Power Sourcing Equipment.

1.5. COORDINATION

1.5.1. IP Addressing

- .1 Do not use default IP addresses for configuration, all systems shall be configured based on the Owner's preferred method of either assigned static IP addressing or DHCP reservation scheme. In cases that the network shall be standalone, assigned static IP addressing shall be used.

1.5.2. Cyber Security

- .1 Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.

- 2. Products
 - 2.1. NETWORK SWITCHES
 - 2.1.1. Acceptable manufacturers are Cisco, HP Aruba, Extreme Networks and NetGear. Any other brand/model must be approved by AV Consultant.
 - 2.2. FIREWALLS
 - 2.2.1. Acceptable manufacturers are Fortigate and Palo Alto. Any other brand/model must be approved by AV Consultant.
- 3. Execution
 - 3.1. INSTALLATION
 - 3.1.1. Install equipment and components in accordance with applicable standards and manufacturer's recommendations.
 - 3.1.2. Install components securely, properly aligned, and in locations as shown on drawings or as determined by site conditions.
 - 3.1.3. Enable authentication and encryption TLS 1.2 (128kbit) technology for all network attached equipment.
 - 3.1.4. Employ network security best practices when programming and configuring network equipment:
 - .1 Configure dedicated VLAN's for each protocol such as control, digital audio, digital video, etc.
 - .2 Restrict access on network switch ports to assigned device addresses.
 - 3.1.5. Employ network security best practices when programming and configuring workstations:
 - .1 Restrict the use of external memory.
 - .2 Set up all security features on client software including passwords, user profiles, and operator action logging.
 - .3 Enable password change on scheduled interval.
 - .4 Enable auto-logoff timer.
 - .5 Enable and configure anti-virus software.
 - 3.1.6. Setup a domain for all audiovisual systems on the network. Coordinate with Owner if the network shall be part of the Owner's corporate network.
 - 3.1.7. Provide certification of vulnerable-free devices for all active equipment.
 - 3.1.8. Provide end-of-life information, including an anticipated timeline of ending security support for active equipment.
 - 3.1.9. Provide notice of a security incident within 24 hours of becoming aware of any incident as it relates to the active equipment supplied.
 - 3.2. DOCUMENTATION
 - 3.2.1. Provide a full design architecture design during the shop drawings process.
 - 3.2.2. Provide a full device schedule for the entire network listing each device, including but not limited to:
 - .1 Device manufacturer and model
 - .2 Device ID
 - .3 Device Host Name
 - .4 Device IP
 - .1 Provide multicast address if applicable

- .5 Device serial number
- .6 Device MAC address
- .7 Device VLAN assignment (name and number)
- .8 Last firmware version number running
- .9 Device location, including room or rack number
- .10 Connected switch number/name and port
- .11 Port Required
- .12 Device Username and Password
- .13 Any additional notes to provide better support

3.3. CYBER SECURITY

3.3.1. Cyber Security Measures

- .1 The following multi-layered Cyber Security measures shall be implemented at minimum to limit and or reduce the Owner's potential risk from a cyber threat event; Such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
 - .1 Employ password management best practices such as:
 - .1 All device access and configuration passwords for devices shall be changed from default to a custom password.
 - .2 Use strong and unique passwords for all applications. Where there is no password policy inherent in the software use a minimum of 8 characters; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ?]).
 - .3 Reset passwords at regular intervals.
 - .4 Configure two-factor authentication for all accounts where possible in the system software.
 - .5 Do not use System Admin logins for simple tasks, Create separate User accounts with rights levels appropriate for the job function. These user accounts can be defined and created in many ways such as Role based, Individual logins or assigned roles.
 - .6 Use different passwords for every account
 - .7 Enforce secure password policies within the business environment.
 - .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
 - .1 Employ Port Management techniques such as:
 - .1 Restrict access on network switch ports to assigned devices addresses.
 - .2 Be sure to lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
 - .3 Shut off all unused communication services and hardware interfaces.
 - .4 The use of 3rd party port security monitoring such as Solarwinds should be investigated and is highly recommended.
- .4 Physical and Virtual Networks
 - .1 Where a dedicated LAN has not been provided a dedicated VLAN for the audiovisual system is required.
- .5 Encryption

- .1 Minimum TLS 1.2 should be used and where available use most current version of TLS encryption for all network attached equipment.
- .6 Network Certificates
 - .1 Make sure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
 - .1 Be sure to have the latest stable Firmware / Software version on all devices/ equipment/ as well as implement a Firmware/Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
 - .1 Be sure to have the Manufacturers System hardening guides provided for the equipment being installed and implement as many recommendations/features as practical to do so.
- .9 External Memory
 - .1 Restrict the use of external memory. The use of devices such as external USB Thumb drives should be restricted or not used at all unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
 - .1 Enable auto-logoff timer. Be sure to have the local Workstation being used to access the equipment has an auto-logoff timer set with a reasonable timer in the case that the employee leaves it unattended for any amount of time.
- .11 Anti-Virus Software
 - .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.
- .12 Filtering Techniques
 - .1 There are many types of filtering techniques and filters that can be applied and should be investigated for specific project requirements. Some of these filtering techniques are:
 - .2 Web Filtering: A Web filter adds another layer to your anti-phishing defences by blocking the web based component of phishing and malware attacks.
 - .3 Multicast Message Filtering: Filters the packets sent to multicast groups they are not subscribed to.
 - .4 Content Filtering: is the use of a program to screen and or exclude access to web pages or email deemed objectionable. A content filter shall then block access to this content
- .13 Back up Regularly
 - .1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible. Regularly back up important files either manually or through a scheduled backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

3.3.2. IT Devices and Systems

- .1 The above listed Cyber security measures can be applied in part or in full to a wide range of Information Technology (IT) Devices. A list of some of these device types are:
 - .1 Firewalls
 - .2 Routers
 - .3 Network switches (Core and Edge Devices)
 - .4 Servers and databases
 - .5 Workstation computers
 - .6 Network connected system devices and controllers
 - .7 Wireless Access Points and wireless controllers

- .8 Mobile phones and tablets
- .9 Any IT System or endpoint connected to the network can have some form of Cyber security measure applied to it.

3.3.3. OT Devices and Systems

- .1 These Cyber security measures can also be applied in part or in full to a wide range of Operational Technology (OT) Network devices.
 - .1 AV Control System Processors and Touch Panels
 - .2 Digital Signal Processors
 - .3 Digital Signage Players
 - .4 Collaboration/conferencing codecs
 - .5 Industrial Control Systems such as:
 - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
 - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
 - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.

3.3.4. Report Cybercrime

- .1 When performing any work on a network connected system advise the Owner and or their representatives of any indication of a Cyber Incident of a criminal nature.

3.3.5. Cyber Security Report Letter

- .1 When implementing any and or all of the Cyber Security Measures mentioned in this Specification, be sure to include a Report letter in the closeout documents to the client stating which Cyber Security measures have been implemented.

END OF SECTION