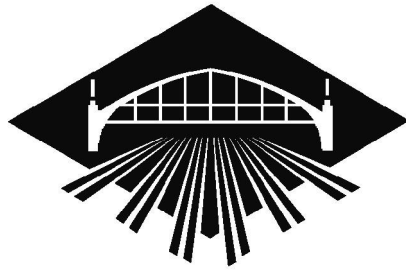


Project Manual
for the
Expansion and Renovation
to the
Pennsylvania Convention Center
1101 Arch Street
Philadelphia, Pennsylvania



Pennsylvania Convention Center Authority
One Pennsylvania Convention Center Place
1101 Arch Street
Philadelphia, Pennsylvania 19107

CONTRACT 3 – TECHNOLOGY SYSTEMS FACILITATOR

JANUARY 29, 2010

Volume 3 of 3 – TECHNICAL SPECIFICATIONS



Expansion and Renovation to the Pennsylvania Convention Center

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Part 1 General

1.1 Summary

- A. This specification describes the operation and functionality of a continuous duty, three-phase, solid-state, static Uninterruptible Power System (UPS) hereafter referred to as the UPS. The UPS shall utilize a rack-mounted N+1 redundant, scalable array architecture. The system power train shall be comprised of user replaceable 10kVA or 20kVA power modules, which shall operate in parallel, and be configured for N+1 redundant operation at rated load. Each 10kVA or 20kVA power module contains a full rated input rectifier / boost converter (hereafter referred to as Input Converter), full rated output inverter, and 10% battery charging circuit. The system shall also comprise of a user-replaceable continuous duty bypass static switch module, user replaceable battery modules, redundant control modules, redundant logic power supplies, and LCD interface display. All of the above system components are housed in a nominal 24 inch wide, 36 inch deep, 81.5 inch high equipment rack (two or more equipment racks may be required based on system capacity).
- B. In addition, this specification describes the performance, functionality, and design of the UPS Maintenance Bypass Cabinet, hereafter referred to as the MBC, the Battery System, and connectivity solutions.
- C. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
- D. All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.

1.2 Standards

- A. UL 1778 Uninterruptible Power Supply Equipment
- B. UL 891 Dead-Front Switchboards
- C. UL 1558 Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
- D. UL60950 Information Technology Equipment

- E. Where applicable, the UPS shall also be designed in accordance with publications from the following organizations and committees:
 - 1. NFPA- National Fire Protection Associations
 - 2. NEMA - National Electrical Manufacturers Association
 - 3. OSHA - Occupational Safety and Health Administration
- F. IEEE 519-1992 Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.
- G. ISO 9001
- H. ISO 14001

1.3 Modes Of Operation

- A. Normal: The input converter and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- B. Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.
- C. Recharge: Upon restoration of the AC input source, the input converter and output inverter shall simultaneously recharge the battery and provide regulated power to the critical load.
- D. Static Bypass: The static bypass shall be used to provide transfer of critical load from the Inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function.
- E. Maintenance Bypass: The system shall be equipped with an external make-before-break Maintenance Bypass Cabinet (MBC) to electrically isolate the UPS during routine maintenance and service of the UPS. The MBC shall completely isolate both the UPS input and output connections.

1.4 Submittals

- A. Proposal Submittals:
 - 1. As bid system bill of materials.
 - 2. Product catalog sheets or equipment brochures.
 - 3. Product guide specifications.
 - 4. System single-line operation diagram.

5. Installation information, including weights and dimensions.
6. Information about terminal locations for power and control connections.
7. Drawings for requested optional accessories.

B. Delivery Submittals:

1. Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
2. User manual, which includes operating instructions.

Part 2 Product

2.1 Design Requirements

- A. 1st Floor Basis of Design: APC Solution Number **ISX651852-002** (complete with 80kW N+1 Symmetra unit with Premium XR Battery Enclosure, power modules, additional 80kw Battery Frame with battery modules, and 80kW PDU (42 pole 208/120V 3 phase 4 wire distribution panel) with Maintenance Bypass and Isolation Transformer. Approved equals are acceptable.
- B. 5th Floor Basis of Design: APC Solution Number **ISX656116-002** (complete with 40kW N+1 Symmetra unit, power modules, additional 40kw Battery Frame with battery modules, and 40kW PDU (2-42 pole 208/120V 3 phase 4 wire distribution panels) with Maintenance Bypass and Isolation Transformer. Approved equals are acceptable.

2.2 System Characteristics

- A. System Capacity: The system shall be rated for full kW output in the following frame size: 80 kVA and 40kVA. System may be rated for 90% or more kW output if the frame size is increased accordingly.
- B. Input:
 1. AC Input Nominal Voltage: 208 V, 3 Phase, 4 wire, 60 Hz.
 2. AC Input Voltage Window: +/- 15% of nominal (while providing nominal charging to the battery system).
 3. Short Circuit Withstand Rating: 30,000 Symmetrical Amperes.
 4. Maximum Frequency Range: 40-70Hz.
 5. Input Power Factor (minimum):
 - a. > .96 at 50% load.
 - b. > .99 at 100% load.
 6. Maximum Input Current Distortion *with no additional filters*:
 - a. < 6% at 100% load.

- b. < 6% at 50% load.
 - 7. Soft-Start: Shall be linear from 0-100% input current and shall not exhibit inrush. This shall take place over a 15 second time period.
- C. UPS Output:
- 1. AC Output Nominal Output: 208V, 3 Phase, 4 wire, 60 Hz.
 - 2. AC Output Voltage Distortion: Max. 3% @ 100% Linear Load.
 - 3. AC Output Voltage Regulation: +/- 1% For 100 % Linear or Nonlinear Load.
 - 4. Voltage Transient Response: +/- 5% maximum for 100% load step.
 - 5. Voltage Transient Recovery within <60 milliseconds.
 - 6. Output Voltage Harmonic Distortion:
 - a. <2% THD maximum and 1% single harmonic for a 100% linear load.
 - b. <5% THD maximum for a 100% non-linear load.
 - 7. Phase Angle Displacement:
 - a. 120 degrees +/- 1 degree for balanced load.
 - b. 120 degrees +/- 1 degrees for 50% imbalanced load.
 - c. 120 degrees +/- 3 degrees for 100% imbalanced load.
 - 8. Overload Rating:
 - a. Normal Operation:
 - 1) 150% for 30 seconds.
 - 2) 105% continuous.
 - b. Bypass Operation:
 - 1) 125% continuous.
 - 2) 1000% for 500 milliseconds.
 - 9. System AC-AC Efficiency: >91.5% at 100% load.
 - 10. Output Power Factor Rating: The UPS output power factor rating shall be 90% or higher.
 - 11. Battery Capacity: Discharge Time to End Voltage: Minimum of 15 minutes, at 77 degrees F, under full load.

2.3 Environmental

- A. Storage Ambient Temperature: -40°F to 158°F (-40°C to 70°C).
- B. Operating Ambient Temperature: +32°F to 104°F (0°C to 40°C). (77°F is ideal for most battery types).
- C. Relative Humidity: 0 to 95% Non-condensing.

- D. Altitude: Maximum installation with no derating of the UPS output shall be 3280 feet (1000m) above sea level. At higher altitudes the following derating shall apply:
1. 1500 m derating factor of .95.
 2. 2000 m derating factor of .91.
 3. 2500 m derating factor of .86.

2.4 Input Power Converter

- A. The input power converters of the system are housed within the parallel connected, removable power modules, and shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and Main Inverter regulated output power.
- B. Input Current Total Harmonic Distortion: The input current THD shall be held to 6% or less at full system, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type.
- C. Soft-Start Operation: As a standard feature, the UPS shall contain soft-start functionality, capable of limiting the input current from 0-100% of the nominal input over a default 15 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation. ($di/dt = \text{constant}$).
- D. Magnetization Inrush Current: The UPS shall provide inrush current limiting as a standard feature. Inrush shall be limited to 8 times the nominal input current of the isolation transformer.
- E. Input Current Limit:
1. The input converter shall control and limit the input current draw from utility to 150% of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation with mains deviation of up to +/-15% of the nominal input voltage.
 2. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current shall not exceed 125% of UPS output current, while providing full battery recharge power and importing necessary power for system losses.
- F. Redundancy: The UPS shall be configured with redundant input converters, each with semiconductor fusing, and logic controlled contactors to remove a failed module from the input bus.
- G. Charging:
1. The battery charging shall keep the DC bus float voltage of +/- 220v, +/-1%.

2. The battery charging circuit shall contain a temperature compensation circuit, which will regulate the battery charging to optimize battery life.
 3. The battery charging circuit shall remain active when in Static Bypass and in Normal Operation.
- H. Back-feed Protection: The above-mentioned logic controlled contactor also provides the back-feed protection required by UL1778.

2.5 Output Inverter

- A. The UPS output inverter shall constantly recreate the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven bi-directional power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output inverters.
- B. Overload Capability: The output power converters shall be capable of 300% for short-circuit clearing. Steady-state overload conditions, of up to 150% of system capacity, shall be sustained by the inverter for 30 seconds in normal and battery operation. Should overloads persist past the outlined time limitation, the critical load will be switched to the automatic static bypass output of the UPS.
- C. Output Contactor: The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be removed from the critical bus.
- D. Battery Protection: The inverter shall be provided with monitoring and control circuits to limit the level of discharge on the battery system.
- E. Redundancy: The UPS shall be configured with redundant output inverters, each with semiconductor fusing, and logic controlled contactors to remove a failed component from the critical bus.

2.6 Static Bypass

- A. As part of the UPS, a system static bypass switch shall be provided. The system static bypass shall provide no break transfer of the critical load from the Inverter output to the static bypass input source during times where maintenance is required, or the inverter can not support the critical bus. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS and static bypass switch shall constantly monitor the auxiliary contacts of their respective circuit breakers, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.
- B. The design of the static switch power path shall consist of Silicon Controlled Rectifiers (SCR) with a continuous duty rating of 125% of the UPS output rating.

- C. Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.
- D. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS display interface.
- E. Overloads: The static bypass shall be rated and capable of handling overloads equal to or less than 125% of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 1000% of system capacity for periods of up to 500 milliseconds.
- F. Modular: The static bypass switch shall be of a modular design.
- G. System Protection:

As a requirement of UL1778, back-feed protection in the static bypass circuit shall also be incorporated in the system design. To achieve back-feed protection, a mechanical contactor in series with the bypass SCR(s) shall be controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring. One such condition could be a result of a shorted SCR.

2.7 Display And Controls

- A. Control Logic: The UPS shall be controlled by two fully redundant, user-replaceable control modules. These modules shall have separate, optically isolated, communication paths to the power and static switch modules. Logic power for the control modules shall be derived from redundant power supplies, each having a separate AC and DC input and output.
- B. Display Unit: A microprocessor controlled display unit shall be located in the front of the system.
- C. Metered Data: The following metered data, shall be available on the alphanumeric display:
 - 1. Year, Month, Day, Hour, Minute, Second of occurring events.
 - 2. Source Input Voltage.
 - 3. Output AC voltage.
 - 4. Output AC current.
 - 5. Input Frequency.
 - 6. Battery voltage.
 - 7. Internal Battery temperature.

- D. Event log: The display unit shall allow the user to display a time and date stamped log of the 64 most recent status and alarm events.
- E. Alarms: The display unit shall allow the user to display a log of all active alarms. The following basis of design set of alarm conditions shall be available:
1. Input Frequency outside configured range.
 2. AC adequate for UPS but not for Bypass.
 3. Low/No AC input, startup on battery.
 4. Intelligence Module inserted.
 5. Intelligence Module removed.
 6. Redundant Intelligence Module inserted.
 7. Redundant Intelligence Module removed.
 8. Number of Batteries changed since last ON.
 9. Number of Power Modules changed since last ON.
 10. Number of Batteries increased.
 11. Number of Batteries decreased.
 12. Number of Power Modules increased.
 13. Number of Power Modules decreased.
 14. Number of External Battery Cabinets increased.
 15. Number of External Battery Cabinets decreased.
 16. Redundancy Restored.
 17. Need Battery Replacement.
 18. The Redundant Intelligence Module is in control.
 19. UPS Fault.
 20. On Battery.
 21. Shutdown or unable to transfer to battery due to overload.
 22. Load Shutdown from Bypass. Input Frequency Volts outside limits.
 23. Fault, Internal Temp exceeded system normal limits.
 24. Input Circuit Breaker Open.

25. System level fan failed.
26. Bad Battery Module.
27. Bad Power Module.
28. Intelligence Module is installed and failed.
29. Redundant Intelligence Module is installed and failed.
30. Redundancy has been lost.
31. Redundancy is below alarm threshold.
32. Runtime is below alarm threshold.
33. Load is above alarm threshold.
34. Load is no longer above alarm Threshold.
35. Minimum Runtime restored.
36. Bypass is not in range (either frequency or voltage).
37. Backfeed contactor stuck in OFF position.
38. Backfeed contactor stuck in ON position.
39. UPS in Bypass due to Internal Fault.
40. UPS in Bypass due to overload.
41. System in Forced Bypass.
42. Fault, Bypass Relay Malfunction.
43. Q001 open/closed.
44. Q002 open/closed.
45. Q003 open/closed.
46. High DC Warning.
47. High DC Shutdown.
48. Low Battery Shutdown.
49. Low Battery Warning.

F. Controls: The following controls or programming functions shall be accomplished by use of the display unit.

1. Silence audible Alarm.

2. Set the alphanumeric display language.
3. Display or set the date and time.
4. Enable or disable the automatic restart feature.
5. Transfer critical load to and from static bypass.
6. Test battery condition on demand.
7. Set intervals for automatic battery tests.
8. Adjust set points for different alarms.
9. Program the parameters for remote shutdown.

G. Potential Free (Dry) Contacts

1. The following potential free contacts shall be available on an optional relay interface board:
 - a. Normal Operation.
 - b. Battery Operation.
 - c. Bypass Operation.
 - d. Common Fault.
 - e. Low Battery.
 - f. UPS Off.

H. Communication Interface Board: A communication interface board shall provide the following communication ports which can be used simultaneously:

1. RS232 Serial Port #1.
2. RJ-45 Interface port for a Remote Display.

2.8 Battery

- A. The UPS battery shall be of modular construction made up of user replaceable, hot swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.
- B. The battery jars housed within each removable battery module shall be of the Valve Regulated Lead Acid (VRLA) type. Provide VRLA batteries that are UL recognized, spill-proof/leak-proof, can be mounted in any orientation and are not restricted when transported by air or surface.
- C. The UPS shall incorporate a battery management system to continuously monitor the health of each removable battery module. This system shall notify the user in the event that a failed or weak battery module is found.
- D. Battery shall be sized at 125 percent of required capacity to provide rated discharge time to end voltage at full load at the end of the warranty.

- E. Float-type warranty shall be minimum of one (1) year covering parts and labor for battery repair and replacement and five (5) years pro-rata. Provide 5 year VRLA batteries with a minimum warranted cycle life of 1,200 - 60 second discharges or 200 - 15 minute discharges at the 15 minute discharge rate to 1.67 volts per cell. Any discharge cycle limitations shall be clearly stated in the proposal.
- F. Battery container, cover and system components shall be flame-retardant conforming to UL 94VO and shall have a Limiting Oxygen Index (LOI) of 28 minimum.

Part 3 Accessories

3.1 Battery Disconnect Breaker

- A. Each UPS system shall have a 250 VDC rated, thermal magnetic trip molded case circuit breaker. Each circuit breaker shall be equipped shunt trip mechanisms and 1A/1B auxiliary contacts. The circuit breakers are to be located within the UPS enclosure or as part of a line-up-and-match type battery cabinet.

3.2 Maintenance Bypass Cabinet (MBC)

- A. The maintenance bypass cabinet shall provide power to the critical load bus from the bypass source, during times where maintenance or service of the UPS is required. The MBC shall provide a mechanical means of complete isolation of the UPS from the electrical wiring of the installation. The MBC shall be constructed in a standard free-standing equipment rack.
- B. As a minimum, the MBC shall contain the following features and accessories:
 - 1. Circuit breakers of the appropriate size, withstand rating (30 kAIC rating), and trip rating for the system.
 - 2. Minimum 1A/1B auxiliary contacts for the purpose of relaying status information of each circuit breaker / switch actuator to the UPS and static bypass.
 - 3. Plated copper bus bar (where applicable), braced for the appropriate withstand rating (30 kAIC rating) of the system.
- C. The following minimum options shall also be available for the MBC:
 - 1. Key interlock to prevent out of sequence transfers of MBC from normal operation to bypass operation.
 - 2. Solenoid Key Release Unit (SKRU).
 - 3. Mimic bus with light indications for power flow.
 - 4. Lights to indicate correct operation of circuit breakers / switch actuators.

D. The MBC shall carry one of the following agency listings:

1. UL 891 Dead-Front Switchboards
2. UL1778 Uninterruptible Power Systems
3. UL60950 Information Technology Equipment

3.3 Software And Connectivity

A. Network Adaptor: The Ethernet Web/SNMP Adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The SNMP interface adaptor shall be connected to the UPS via the RS232 serial port on the standard communication interface board.

B. Unattended Shutdown:

1. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is on reserve mode.
2. The UPS shall also be capable of using an RS232 port to communicate by means of serial communications to gracefully shut down one or more operating systems during an on battery situation.

3.4 Remote UPS Monitoring

A. The following three methods of remote UPS monitoring shall be available:

1. Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
2. RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.
3. Simple Network Management Protocol (SNMP): Remote UPS Monitoring shall be possible through a standard MIB II compliant platform.

Part 4 Execution

4.1 Factory Assisted Start-Up

Factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

A. Visual Inspection:

1. Inspect equipment for signs of damage.
2. Verify installation per manufacturer s instructions.

3. Inspect cabinets for foreign objects.
 4. Inspect Battery Units.
 5. Inspect Power Modules.
- B. Mechanical Inspection:
1. Check all UPS and external maintenance bypass cabinet internal control wiring connections.
 2. Check all UPS and external maintenance bypass cabinet internal power wiring connections.
 3. Check all UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.
- C. Electrical Inspection:
1. Verify correct input and bypass voltage.
 2. Verify correct phase rotation of all mains connections.
 3. Verify correct UPS control wiring and terminations.
 4. Verify voltage of all battery modules.
 5. Verify neutral and ground conductors are properly landed.
 6. Inspect external maintenance bypass switch for proper terminations and phasing.
- D. Site Testing:
1. Ensure proper system start-up.
 2. Verify proper firmware control functions.
 3. Verify proper firmware bypass operation.
 4. Verify proper maintenance bypass switch operation.
 5. Verify system set points.
 6. Verify proper inverter operation and regulation circuits.
 7. Simulate utility power failure.
 8. Verify proper charger operation.
 9. Document, sign, and date all test results.
- E. On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

4.2 Manufacturer Field Service

- A. Worldwide service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.
- B. Replacement parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization shall be capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be delivered to the customer site within 24 hours.

4.3 Maintenance Contracts

- A. Provide a preventive maintenance contract including scheduled preventative maintenance and guaranteed 4 hour emergency response. Contract shall be provided at no additional cost for the first year.
- B. At the time of bidding, submit to the Owner the cost of a second year's preventive maintenance contract.

4.4 Training

- A. Provide a UPS service training workshop, including a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.
- B. Provide 4 hours of on-site instruction to the Owner's personnel at no additional cost to the Owner. Instructor shall be certified by the manufacturer. Coordinate scheduling of training with Owner.

END

Part 1 General

1.1 Summary

- A. This specification describes the operation and functionality of a continuous duty, single-phase, solid-state, static Uninterruptible Power System (UPS) hereafter referred to as the UPS. Install the UPS (quantity of seven complete units as specified) in rack or cabinet locations indicated.
- B. The UPS utilizes double conversion online topology designed to protect electronic equipment by supplying reliable, network-grade power featuring extremely tight voltage and frequency regulation. The UPS also features internal bypass and input power factor correction.
- C. The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverter), bypass and a battery charger. The control of power module and fault detection logic is microcontroller based. Input disconnect and filter stage contains input backfeed relay (in models with an input wire plug), input filter, transient suppression, battery select transfer relays. Input PFC power stage contains non-isolated power factor correcting AC/DC converters. This converter is capable of full power operation in very wide input voltage range or from a nominal DC battery voltage. The energy storage stage is a split DC bus capacitor handling seamless transitions from battery to line and vice versa as well as the low and high frequency power stages ripple. The inverter stage operates directly from the DC bus and produces an AC output voltage of 120VAC. The output of UPS is either connected through a bypass relay to the inverter or to the input filtered line. UPS contains a battery charger, which operates from the DC bus.
- D. The UPS batteries are modular, hot-swappable, user-replaceable.
- E. In addition, this specification describes the performance, functionality, and design of the UPS Service Bypass Panel, hereafter referred to as the SBP, the external Battery Systems, and connectivity solutions.
- F. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
- G. All programming and miscellaneous components for a fully operational system as described in this specification shall be available as part of the UPS.

1.2 Standards

- A. UL 1778 Uninterruptible Power Supply Equipment
- B. CSA
- C. FCC Class A
- D. VCCI
- E. ISO 9001
- F. ISO 14001

1.3 Modes Of Operation

- A. Online: The input PFC power stage and the output power stage (inverter) shall operate in an on-line manner to continuously regulate power to the critical load. The input PFC stage shall be capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- B. On Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output power stage (inverter), which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to online operation.
- C. Bypass: The bypass mode shall be used to provide transfer of critical load from the inverter output to the primary power source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function.

1.4 Submittals

A. Proposal Submittals:

- 1. As bid system bill of materials.
- 2. Product catalog sheets or equipment brochures.
- 3. Product guide specifications.
- 4. System single-line operation diagram.
- 5. Installation information, including weights and dimensions.
- 6. Information about terminal locations for power and control connections.

B. Delivery Submittals:

- 1. Installation manual, which includes instructions for storage, handling, examination, preparation, installation, and start-up of UPS.

2. User manual, which includes operating instructions.

Part 2 Product

2.1 Design Requirements

- A. The UPS is contained in a NEMA 1 steel cabinet.
- B. The UPS dimensions are nominal:
 1. 3000VA unit: 5.1"H x 17"W x 26"D.
- C. Basis of Design:
 1. 3000VA unit: APC SURTA3000RMXL3U. Approved equals are acceptable.

2.2 System Characteristics

- A. System Capacity:
 1. The system is rated to be capable of supporting:
 - a. 3000VA unit: 3000VA or 2100W whichever limit is reached first.
- B. The UPS efficiency is at least 91%, without degradation of output regulation as specified.
- C. Input:
 1. AC input nominal voltage: 120VAC, single phase, 3 wire (L + N + G), connected via NEMA 5-30P connector;
 2. AC input voltage window:
 - a. 90 – 150VAC at full load, while providing nominal charging to the battery system.
 - b. 50 – 150VAC (L-N) at 50% load, while providing nominal charging to the battery system.
 3. Input frequency range: 45-65Hz;
 4. Input Power Factor: Minimum 0.95 lagging at 100% load at nominal voltage;
 5. Input Current Distortion: Maximum 6% at 100% load at nominal voltage;
 6. Crest factor: 3:1.
- D. UPS Output:
 1. AC output nominal voltage: 120VAC, single phase, 3 wire (L + N + G);
 2. Output connectors: 6 NEMA 5-15R; 2 NEMA 5-20R;
 3. Output frequency: 50/60 +/- 3Hz tracking (user selectable);
 4. AC output voltage distortion: Max. 2% @ 100% linear load; Max. 5% @ 100% non-linear Load;
 5. AC output static voltage regulation: +/-1%;

6. AC output dynamic voltage regulation: +/- 8% maximum for 100% load step at less than 10ms recovery time;
7. Overload Rating:
 - a. Online: 105% - infinite; 125% - 1 minute; 150% - 30 seconds;
 - b. In bypass: Overload is limited by the UPS input circuit breaker which is rated 30A;
8. Output Power Factor Rating: 0.2 –1.0 lagging, nominal: 0.7 lagging.
9. Battery Capacity: Discharge Time to End Voltage: Minimum of 15 minutes, at 77 degrees F, under full load.

2.3 Environmental

- A. Storage Ambient Temperature: -4°F to 140°F (-20°C to 60°C).
- B. Operating Ambient Temperature: +32°F to 104°F (0°C to 40°C). (77°F (25°C) is ideal for most battery types).
- C. Relative Humidity: 0 to 95% non-condensing.
- D. Storage altitude: 50,000 feet (15000m) above sea level.
- E. Operating altitude: 10,000 feet (3000m) above sea level. At altitude of 10, 000 feet the UPS must be loaded up to 90% of its nominal capacity only.
- F. Audible noise: less than 55dBA at 3 feet (1 m).

2.4 Input PFC Power Stage

- A. The input PFC power stage of the UPS constantly rectifies the power imported from the mains input of the system, converting input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power.
- B. Input Current Total Harmonic Distortion: The input current THD_I shall be held to 6% or less at full system, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting loads of both a linear or non-linear type.
- C. Input Current Limit:
 1. The input converter shall control and limit the input current draw from utility to 150% of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation with mains deviation of up to +/-20% of the nominal input voltage.

2. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current shall not exceed 130% of UPS output current, while providing full battery recharge power and importing necessary power for system losses.

2.5 Output Power Stage (Inverter)

- A. The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) creates an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages do not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).
- B. Overload Capability: The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for indefinite length of time.
- C. Output Contactor: The output power stage (inverter) is equipped with an output mechanical relay to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be removed from the critical bus.
- D. Battery Protection: The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system.

2.6 Automatic Bypass

- A. As part of the UPS, a system automatic bypass switch is provided. The system automatic bypass shall provide a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS constantly monitors the output current, as well as the bypass source voltage, and inhibits potentially unsuccessful transfers to automatic bypass from taking place.
- B. The design of the automatic bypass switch power path consists of a heavy-duty electromechanical bypass contactor.
- C. Automatic Transfers: An automatic transfer of load to bypass takes place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system. Automatic transfers of load to bypass also take place if for any reason the UPS cannot support the critical bus.
- D. Manual Transfers: Manually initiated transfers to and from bypass may be initiated through the UPS computer interface (via serial or USB communications) or by engaging the bypass switch on the rear panel of the unit.

2.7 Battery

- A. The UPS battery system is comprised of user replaceable, hot swappable, battery modules.
- B. The battery jars housed within each removable battery module are of the Valve Regulated Lead Acid (VRLA) type.
- C. The UPS incorporates the Intelligent Battery Management system to continuously monitor the health of each removable battery module as well as external battery modules installed in extended run battery cabinets. This system shall notify the user in the event that a failed or weak battery module is found.
- D. Charging:
 - 1. The intelligent battery management system contains a temperature monitoring circuit and compensation algorithm that regulates the battery charging current so as to optimize battery life.
 - 2. The battery charging circuit remains active when in bypass and online states.
- E. Additional battery modules may be added to increase runtime. These modules are hot-pluggable, allowing for easy and quick installation or replacement without the need for electrical wiring, electrician services or powering down of the UPS. The number of external battery modules that may be connected to the UPS is unlimited.
- F. The UPS is shipped with battery modules preinstalled but disconnected.

2.8 Display And Controls

- A. Control Logic: The UPS is controlled by an embedded microcontroller which performs functions:
 - 1. Monitoring quality of output voltage;
 - 2. Monitoring vital parameters of the UPS;
 - 3. Executing the state machine;
 - 4. Intelligent battery management;
 - 5. Remaining runtime calculation;
 - 6. Self-diagnostics, self-test and proactive fault detection;
 - 7. Communication to the host server via serial port;
 - 8. Communication to the Network Interface Card or another SmartSlot accessory card.
- B. Display/Control Unit: A display/control comprised of 16 LEDs and 2 pushbutton switches is located on the front side of the UPS. The display/control unit may be turned 90 degrees clockwise or counterclockwise to accommodate for the way the UPS is mounted.

- C. The pushbutton switches located at the Display/Control Unit: The following controls functions can be accomplished by use of the pushbutton switches located at the Display/Control Unit:
1. Turn the UPS on;
 2. Turn the UPS off;
 3. Initiate self-test in order to test battery condition;
 4. Silence audible alarm;
 5. Cold start.
 6. Displaying input RMS voltage on the battery capacity LED bar graph.
- D. EPO switch: The UPS is equipped with Emergency Power Off (EPO) terminal which can be wired so as to provide means to instantaneously de-energize the UPS and its load from a remote location in case of emergency.
- E. Data displayed on the Display/Control Unit: The following indicators are available on the Display/Control Unit:
1. The UPS load LED bar;
 2. The UPS is online;
 3. The UPS is on battery;
 4. The UPS is in bypass;
 5. The UPS is overloaded;
 6. The UPS is in fault state;
 7. The battery needs to be replaced;
 8. The battery capacity/utility voltage LED bar
- F. Audible Alarms: Using audio signal, the UPS will notify the user about important events. The following is the list of distinct audio alarms:
1. The UPS is on battery;
 2. The UPS is on battery and the remaining battery capacity is low;
 3. The UPS has shutdown due to low battery capacity;
 4. The battery needs to be replaced;
 5. The UPS is overloaded;
 6. The UPS is in fault state;

G. Potential Free (Dry) Contacts: The following potential free contacts may be available on an optional SmartSlot Relay I/O Card.

1. The UPS is on battery;
2. The UPS is on battery and the remaining battery capacity is low;
3. The UPS is off;
4. The battery needs to be replaced;
5. The UPS is in bypass;
6. The UPS is overloaded;
7. The UPS is in fault state.

Part 3 Accessories

3.1 Software And Connectivity

A. Network Adaptor: SmartSlot Network Management Card shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments.

B. Unattended Shutdown

1. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems during when the UPS is on battery mode.
2. The UPS is also capable of using an RS232 port to communicate to the host computer by means of serial communications so as to gracefully shut down one or more operating systems during an on battery situation.

3.2 Remote UPS Monitoring, Configuration And Control

A. The following three methods of remote UPS control, configuration and monitoring are available:

1. Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
2. Monitoring, configuration and control via PowerView Remote Display, four line multilingual intelligent alphanumeric LCD (up to 15 feet/5meters away).
3. Dry contact monitoring and control provided the UPS is equipped with a SmartSlot Relay I/O Card.

Part 4 Execution

4.1 Factory Assisted Start-Up

Factory trained service personnel shall perform the following inspections, test procedures, and on-site training:

A. Visual Inspection:

1. Inspect equipment for signs of damage.
2. Verify installation per manufacturer s instructions.
3. Inspect battery modules.

B. Mechanical Inspection

1. Check all UPS internal power wiring connections.
2. Check all UPS terminal screws, nuts, and/or spade lugs for tightness.

C. Electrical Inspection:

1. Verify correct input and bypass voltage.
2. Verify correct UPS control wiring and terminations.
3. Verify voltage of all battery modules.
4. Verify neutral and ground conductors are properly landed.

D. Site Testing:

1. Ensure proper system start-up.
2. Verify proper firmware control functions.
3. Verify proper firmware bypass operation.
4. Verify proper bypass switch operation (where applicable).
5. Verify proper inverter operation and regulation circuits.
6. Simulate utility power failure.
7. Verify proper charger operation.
8. Document, sign, and date all test results.

E. On-Site Operational Training: During the factory assisted start-up, operational training for site personnel shall include key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

4.2 Manufacturer Field Service

- A. Worldwide service: The UPS manufacturer has a worldwide service organization available, consisting of factory trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization offers 24 hours a day, 7 days a week, 365 days a year service support.
- B. Replacement parts: Parts are available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization is capable of shipping parts within 4 working hours or on the next available flight, so that the parts may be shipped to the customer site within 24 hours.

4.3 Maintenance Contracts

- A. Provide a preventive maintenance contract including scheduled preventative maintenance and guaranteed 4 hour emergency response. Contract shall be provided at no additional cost for the first year.
- B. At the time of bidding, submit to the Owner the cost of a second year's preventive maintenance contract.

4.4 Training

- A. Provide a UPS service training workshop, including a combination of lecture and practical instruction with hands-on laboratory sessions. The service training workshop shall include instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls and adjustment, preventative maintenance, and troubleshooting.
- B. Provide 4 hours of on-site instruction to the Owner's personnel at no additional cost to the Owner. Instructor shall be certified by the manufacturer. Coordinate scheduling of training with Owner.

END

Part 1 General

1.1 Summary (Non-inclusive)

- A. Applicable provisions of the Conditions of the Contract and Division 01, General Requirements, govern work in this Section.
- B. Section Includes: The provision of all plant, materials, labor and equipment and the like necessary and/or required for the complete execution of all audiovisual equipment and related work for this project as required by the schedules, keynotes and drawings, including, but not limited to the following:
 - 1. Unless otherwise specified, supply only new equipment, parts and material, and protect all equipment from construction dust and debris until final acceptance. Operate only as required for testing as part of installation procedure. Provision of all manufactured components, installation, wiring, and testing is the responsibility of a single contractor.
 - 2. The system drawings indicate the general layout of the various items of equipment and their functional relationships. However, layout of equipment, accessories, and conduit systems are diagrammatic unless specifically detailed and do not necessarily indicate every item required for a complete installation. Provide any incidental equipment needed in order to result in a complete and operable system even if not specified or shown on drawings without claim for additional payment.
 - 3. Quantities of all major installed and all portable equipment, including any add- or deduct-alternates, are indicated on the system and electrical drawings. Quantities of portable equipment are indicated in schedules contained in the drawings or specifications; quantities of installed equipment are determined by examining the functional diagrams, plans, and riser diagrams.
 - 4. Refer to audiovisual conduit drawings for receptacle backbox location and quantity information. Also refer to architectural reflected ceiling plans for exact location of ceiling-mounted devices.
 - 5. Verify correctness of parts lists and equipment model numbers and conformance of each component with manufacturer's specifications.
 - 6. Obtain all permits necessary for the execution of the work. Comply with all applicable local codes and regulations.
 - 7. Supply and install all miscellaneous conduit and wireways to the extent not included in Contract 2 in order to provide a complete and operable system.

C. Functional Requirements of Systems:

1. Building Audio System:

a. General:

- 1) The system will make use of a building-wide digital networked audio routing and control infrastructure based on the CobraNet standard. Audio interface, processing, and amplification will be distributed in Telecommunications closets throughout the building and linked via Core Ethernet Switches located in the AV Master Control Room. This Audio Network will be fully independent of the building Ethernet in order to reduce network congestion. When, temporary use of CobraNet devices through the building Ethernet network will be possible through a configured Virtual LAN connection. An additional VLAN will be provided for non-audio control data communication between Audio System components.
- 2) The Audio System interface with the building Fire Alarm System to provide Voice Annunciation in the event of an emergency. Emergency paging signals from the Fire Alarm System will override all active speech and program audio in the system for the duration of the emergency condition. Components critical to this functionality will be fully redundant and fault-tolerant, including the core and edge switches, networked power amplifiers and fiber optic interconnecting cabling. Loudspeakers have been configured with sufficient overlap in zoning such that a failure of a single loudspeaker or an entire zone will not critically inhibit paging performance anywhere in the covered areas. The Audio System and associated Control System will constantly monitor system conditions (including device and network failures, power loss, amplifier load monitoring, and UPS status) and report faults to the Fire Alarm System. Audio and control inputs will also be provided to the Fire Alarm System for announcements and paging to Concourse, Pre-function, Atrium, and Back-of-House areas not covered by the Audio System.
- 3) A centralized AV Control System will be included to provide user interface with the Audio System. Primary control and configuration will be through web-based "Virtual Touchpanels" accessible to technicians via network-connected laptops, netbooks, and/or personal communications devices.
- 4) Audio connections to and from the audio system in the existing Convention Center AV Control Room will be provided via a dedicated networked audio digital signal processor and connected to the CobraNet Core Switches.

b. Meeting Room (First Floor):

- 1) Provide a high-output audio system for speech reinforcement and program audio playback through ceiling-mounted loudspeakers.
- 2) Signal interface to the system will be available at integrated Multi-Media Connection Panels ("MM1" on drawings) in each room, providing two microphone-level inputs, one line-level input (for connection of external mixers or other sources), one line-level output (for connection of recording devices) as well as data and general-purpose Unshielded Twisted Pair (UTP) and multimode optical fiber connections.

c. Exhibit Halls (First Floor, Second Floor):

- 1) Provide a high-output audio system for speech reinforcement, paging, and announcements through pendant-mounted loudspeakers.

- 2) Inputs to the system will be provided through VLAN connections in the Exhibit Halls with the use of portable paging stations and audio network interface devices.
 - 3) Loudspeakers in the existing Exhibit Halls (Halls A, B, and C) will be retained for use with the new system, with new amplifiers and cabling provided.
- d. Ballrooms (Fifth Floor):
- 1) Provide a high-output audio system for speech reinforcement and program audio playback through ceiling-mounted loudspeakers.
 - 2) Signal interface to the system will be available at integrated Multi-Media Connection Panels in each room, providing two microphone-level inputs, one line-level input (for connection of external mixers or other sources), one line-level output (for connection of recording devices) as well as data and general-purpose Unshielded Twisted Pair (UTP) and multimode optical fiber connections. Additional microphone, UTP, and optical fiber connections will be provided in floor boxes (“MM2” on drawings).
 - 3) Loudspeakers are to be driven individually, enabling highly flexible routing and delay processing to support large gatherings, and supplement concerts and other events that may utilize portable audio systems.
2. Audio and Video Distribution and Infrastructure:
- a. A centralized AV Distribution system will be provided to facilitate transmission of signals throughout the building. Short-haul links within a room or between adjacent rooms will be possible through installed UTP cabling with patch panels located in Telecommunications equipment closets. Long-haul signal transport will be via multimode optical fiber connections from each Meeting Room and Ballroom wall panel and floor box to the AV Master Control Room. Signals may be patched directly for format-independent point-to-point links or interfaced to a large-scale fiber optic router for distribution and remote signal monitoring. Control of the system will be through the AV Control System and web-based “Virtual Touchpanels”.
 - b. An AV Record Room will be provided for use by Convention Hall personnel and exhibitors for connection of portable AV recording and production equipment. A series of receptacle panels will be provided with audio, video, UTP and optical fiber cross-connections to the AV Master Control Room. Several LCD flat panel displays will be provided for monitoring of video content.
3. Digital Signage System:
- a. The Expansion project will include additional components added to the Digital Signage System in place in the existing Convention Center. Provide Displays, Media Players, and mounting hardware in locations shown on the AV drawings. Coordinate with architectural details. New displays are to be connected to the building Ethernet network and configured on a dedicated Digital Signage VLAN. Provide all software licensing necessary to support the additional displays.

- b. A Video Wall Display will be provided in the First Floor Pre-function area (Broad St. entrance). This will consist of a three high by three wide matrix of 46" LCD flat panel displays mounted to a custom support structure. This will be fed by a Media Player in the AV Master Control Room.

D. Related Work Specified Elsewhere:

1. Telecommunications Cabling: Division 27 (Contract 2).

E. Definitions:

1. XLR Connectors and Receptacles: Connectors and receptacles conforming to proposed E.I.A. Standard RS-297-B referred to as "XLR"-type connectors and receptacles.
2. Units and Symbols: Metric units according to the System of International Units (SI) are used as well as other common units and symbols.
3. Octave and 1/3-Octave Bands: Centered on ANSI preferred frequencies.
4. Sound Level Meter and Filter Set: Calibrated ANSI Type 1 meter with ANSI S1.11-1966 1/3 octave band filters.
5. Pink Noise: Constant energy in constant percentage bands, random or quasi-random noise.
6. Loudspeaker Power Rating: Based on pink noise test signal with 6 dB peak-to-average ratio, bandwidth as stated.
7. Loudspeaker Coverage Pattern: Nominal angular coverage included at -6 dB points relative to axial response, bandwidth as stated.
8. DI: Axial directivity index.
9. Loudspeaker Sensitivity: Axial level in dB with 1 watt input at 1 meter distance.
10. Microphone Sensitivity: Level in dB re 1 milliwatt into rated impedance at 1000 Hz (or as otherwise stated) and 94 dB SPL. (10 dynes/cm² or 1 Pa).
11. SPL: Sound pressure level in dB re 0.00002 Pa (0.0002 microbar).
12. Power Amplifier Output Power Rating: Based on continuous average sine wave test signal. Load impedance and bandwidth as indicated.
13. Amplifiers and Signal Processors: Frequency Response, Distortion, and Hum and Noise re full rated output level.

1.2 Bid Submittals

- A. Instructions to Bidders: To be considered, Bids must be made in accord with the Design Professional's Instructions to Bidders and this Article.

- B. Examinations: Carefully examine the contract documents and the construction site to obtain first-hand knowledge of existing conditions. Contractors will not be given extra payments for conditions that can be determined by examining documents or site and will not be relieved of any obligations with respect to bid.
- C. Questions: Submit all questions about the contract documents in writing. Replies requiring changes to the contract documents will be issued to all bidders as addenda and will become part of the Contract. The Design Professional and Owner may give but will not be responsible for oral clarifications. Questions received less than 10 days before bid date cannot be answered in writing.
- D. Acceptable Products: Model numbers and manufacturers identified herein indicate a standard of quality and performance. Other products will be considered subject to approval of complete technical data, samples and results of independent testing of proposed equipment, submitted in accordance with the "Substitutions" section below.
- E. Substitutions: To obtain approval for substitutions and for items identified as "approved equal", submit written requests at least 10 days before bid date. Requests received after this time will not be considered. Requests shall clearly describe the product for which approval is asked, including all data necessary to demonstrate acceptability. If the product is acceptable, an Addendum may be issued to all bidders.
- F. Equipment Availability: Verify with manufacturers availability and cost of all equipment proposed, including equipment specified herein. No cost increases will be allowed for manufacturers' cost increases, or for substitutions required because of unavailability of proposed equipment.
- G. Basis of Bids:
1. Include a complete itemized list for each base-bid system indicating the manufacturer, model number, unit cost and total costs for all specified items. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
 2. Clearly indicate the total cost, including all expenses, for each individual system to allow the Owner to select any or all to be included in the contract. Itemization of miscellaneous equipment such as cable, switches, and receptacles is not required.
 3. Organize each list with the information presented, in the order that it appears in this specification, in 6 columns from left to right:
 - a. Paragraph number as it appears in this specification.
 - b. Paragraph title as it appears in this specification.
 - c. Manufacturer and model number.
 - d. Quantity.
 - e. Unit Cost.

- f. Extension (unit cost times quantity).
- 4. At the end of each list indicate the cost of all other items such as for miscellaneous equipment, engineering, installation labor, overhead, taxes, etc.
- 5. On a separate list indicate costs of any specified add- or deduct-alternates with the information presented in the same manner as for the base-bid system.
- 6. Include a listing of any voluntary alternates proposed by the bidder as substitutions or additions to the specified systems.
- 7. Include any notes or comments if necessary to qualify the bid.
- 8. Identify any sub-contractors and indicate the work they are to do.
- 9. Provide documentation of ability in installing similar systems. Furnish the names, addresses and telephone numbers of the System Designer, Design Professional, General Contractor and Owner on three projects similar in scope, which the Contractor has installed within the last 5 years.
- 10. Include certification of ownership and full familiarity with the operation of the following minimum test equipment. Provide a list of the manufacturer, model, and serial number for each item of test equipment required.
 - a. Low distortion sine wave oscillator.
 - b. Distortion analyzer.
 - c. AC impedance bridge.
 - d. Oscilloscope.
 - e. Sound level meter, 1/3 octave band real time audio analyzer and pink noise generator.
 - f. Multimeter.
 - g. Cable Tester (suggested: Sescom CT-7).
 - h. Video waveform monitor, vectorscope, and signal generator.
 - i. Photometer with luminance and illuminance probes.
 - j. 1/2" type H (VHS) format videocassette test tape: SMPTE V2-RMS-V.
 - k. Multi-frequency computer RGB test pattern generator (suggested: Extron VTG-300).

1.3 Quality Assurance

- A. Project Management: Maintain the same person in charge of work throughout installation.
- B. Contract Documents: Maintain a complete set of system drawings and specifications at the site at all times during installation.

- C. Fabrication and Installation: Fabricate all equipment racks and subassemblies. Make field connections of all audio, video and control wiring including microphone, line level, loudspeaker, video, and control system circuits to equipment, equipment racks and connection panels. Continuously supervise the installation and connections of cable and equipment.
- D. Contractor Qualifications: To be considered qualified for this work, the contracting firm must be experienced in the provision of audiovisual systems similar in complexity to those required for this project, and meet the following:
1. The Contractor's primary business is the provision, fabrication and installation of professional audiovisual and related systems.
 2. The Contractor has been regularly engaged in the installation and service of professional audiovisual presentation systems for a period of at least five years.
 3. The Contractor is an authorized dealer for the major products furnished.
 4. The Contractor is an authorized dealer for the specified Audiovisual Control System and factory trained in the installation, maintenance and programming of such systems.
 5. The Contractor is, at a minimum, AVSP Sapphire level certified solution provider, with at least 1 CTS-I and 1 CTS (or C-EST) certified employees.
 6. At the request of the Design Professional demonstrate the following capabilities:
 - a. Adequate plant and equipment to complete the work.
 - b. Sufficient staff with appropriate technical experience to oversee and execute the work.
- E. Subcontractors: The Contractor may arrange for sub-contract field and special shop work to be done by others.
- F. Prime Contractors: Any other installer who intends to bid on this work as the Prime Contractor and does not meet the "Contractor Qualifications" described above shall employ the services of a single "Audiovisual Systems Contractor" who does meet these requirements. The Audiovisual System Contractor shall Furnish and Install the equipment. The Prime Contractor shall clearly identify the Audiovisual Systems Contractor and submit complete qualification information for the Audiovisual Systems Contractor in the Bid. Failure to do so will be cause for rejection of the Bid.

1.4 Substitutions

- A. General: The Contractor has the burden of proving, at the Contractor's own cost and expense and to the satisfaction of the Design Professional, that the proposed product is similar and equal to the named product.

B. Basis:

1. Requests for acceptance of proposed equivalents made following the award of bid will be considered by the Design Professional only in the following cases:
 - a. The named products cannot be obtained by the Contractor because of strikes, lockouts, bankruptcies or discontinuance of manufacturer and the Contractor makes a written request to the Design Professional for consideration of the proposed equivalent.
 - b. The proposed equivalent, in the opinion of the Design Professional, is equal or superior to the named product and its use is to the advantage of the Owner.
2. A formal request must be made for the substitution documenting fully the above reason. Include complete data on the proposed substitution substantiating compliance with the Contract Documents including product identification and description, performance and test data, references and samples where applicable, and an itemized comparison of the proposed substitution with the products specified or named by Addenda, with data relating to Contract time schedule, design and artistic effect where applicable, and its relationship to separate contracts. Accompany the request by accurate installed cost data on the proposed substitution in comparison with the product specified.

C. Consideration:

1. A request for substitution is a representation by the Contractor that:
 - a. The Contractor has personally investigated the proposed substitution and determined that it is equal or superior in all respects to that specified.
 - b. The Contractor will provide the same warranty for the substitution that would be for that specified.
 - c. The cost data presented are complete and include all related costs under this Contract, but exclude costs under separate contracts and exclude Design Professional's re-design costs, and that the Contractor waives all claims for additional costs related to the substitution which subsequently become apparent.
 - d. Indicate if there will be any cost impact on work by other trades.
 - e. The Contractor will coordinate the installation of the accepted substitute, making such changes as may be required for the Work to be complete in all respects.
2. An accepted substitution will be documented by Change Order modifying the Specifications. The Contract Price will be changed only if the substitution results in cost savings to the Owner.

1.5 Submittals

A. Shop Drawings and Product Data:

1. The following is required for approval, prior to ordering product, fabrication and installation. Provide three (3) copies unless otherwise specified. Submit complete and at one time. Isolated items will not be considered for approval, except by prior authorization. Rejected items and items requiring correction must be resubmitted at one time, except by prior authorization.
2. The diagrams and details included with these specifications, modified to reflect the stated requirements and to reflect the details of the system as awarded, and including all additional required information, may be used in preparing shop drawings. Drawings that are submitted without the necessary modifications will be rejected.
3. All drawings shall be drawn on a computer-aided drafting (CAD) system.
 - a. Bill of Materials and Catalog Data Sheets of all manufactured items. At the end of the Bill of Materials include Catalog Data Sheets ("cut" sheets) for all product arranged in the order listed in the specifications and in the Bill of Materials. Submit in bound form using a 3-ring, GBC or similar binding, and including a cover page identifying the project and submittal. Organize the Bill of Materials with the information presented in the order that it appears in this specification, in 6 columns from left to right:
 - 1) Paragraph number as it appears in this specification.
 - 2) Paragraph title as it appears in this specification.
 - 3) Manufacturer.
 - 4) Model number.
 - 5) Quantity.
 - 6) Comments (if any are needed).
 - b. Block diagrams indicating proposed connections of all equipment and indicating equipment types and model numbers.
 - c. Equipment/projection/control room layout(s), and equipment rack and cabinet details.
 - d. Video Projectors: Provide plan and section drawings verifying image width, lens-to-screen distances and mounting methods. Provide detailed drawings of custom-fabricated or stock mounts and hardware.
 - e. Video camera, video monitor, and loudspeaker mounting arrangements.
 - f. Shop drawings of any unit, such as control panels, switch panels, or loudspeaker enclosures or grilles, to be fabricated or modified.
 - g. Programming instructions for specified Programming Service Company or for AV control system manufacturer if programming is specified to be done by Manufacturer.

- h. Logic and detailed control panel layouts prepared by specified Programming Service Company. Provide page graphics (including text, buttons, colors, images, backgrounds etc.), as well as page flips, sub-pages and overall page logic flow.
- i. Submittals as required by specifications.
- j. Others as required by Design Professional or Consultant.

B. Samples:

- 1. Finish for control panels, racks, cabinets, and loudspeaker grilles.
- 2. Mechanical connectors for use in wiring.

C. Test Reports: Upon completion of SYSTEM PERFORMANCE TESTS AND ADJUSTMENTS specified in PART 3 - EXECUTION, submit for approval in writing test results including numerical values for all measurements. Also submit written certification that the installation conforms to specifications, is complete and operable, and is ready for FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION. Provide three (3) copies unless otherwise specified.

D. Operation and Maintenance Data:

- 1. Draft Copies: At time of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS specified in PART 3 - EXECUTION, provide draft copies of all specified diagrams, schedules and manuals for inspection during demonstration and acceptance testing. Submit final copies thereafter. All drawings shall be drawn on a computer-aided drafting (CAD) system. For Contractor-prepared drawings, schedules and instructions, provide three (3) draft copies, one (1) final copy for specified mounting, and two (2) final copies for inclusion in specified Complete Instruction and Maintenance Manual, unless a different quantity is otherwise specified.
- 2. Functional Diagrams: Simplified single line block diagram showing interconnection of all major equipment components and functional relationships. Illustrate all receptacles, patch panel jacks, attenuators, transformers, switches, and loudspeakers. Key each patch panel jack to the patch bay by row and jack number. Diagram shall not illustrate terminal or interconnection cable number designations. The Functional Diagram included with these specifications, modified to exclude details, transformer tap designations, etc., and to provide the information described above and any as-built changes, is suitable for this purpose. Complete on a single sheet of minimum size 24" by 36". Mount one photographic, wash-off mylar or rag paper photocopy print of each system behind acrylic at locations to be determined.
- 3. As-Built Diagrams:
 - a. The intent of the diagrams is to provide sufficiently clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation.

- b. Provide drawings showing all terminal blocks, connectors, relays, switches, transformers, attenuators, equipment components, and wires. Label all devices with manufacturer, model number, and reference number (e.g. "SW 15", "TB 6"); reference numbers shall be consistent across all drawings with no repetitions. As a minimum, provide an expanded version of the functional diagrams with cables fanned out at termination points and all labeling as specified above; provide additional drawings where system complexity does not permit complete information to be shown legibly on an individual sheet no larger than the project sheet size. Provide labels for cables continued onto another drawing, indicating termination device, terminal numbers, and drawing sheet on which the termination is shown.
 - c. Provide layout drawings of panels and other custom assemblies containing switches, relays, terminal blocks, receptacles, etc., using reference numbers to identify physical locations of devices or label devices with reference numbers in a location visible while viewing cable terminations. On wiring diagrams, label all conductors within cables for insulation color or other identifier. Label connectors, barrier strips, switches, relay sockets, etc., for terminal number. If device does not provide terminal designations, provide key diagram for reference.
- 4. Receptacle Location Plan: Plan of area showing locations and designations of all receptacles.
 - 5. Building Plan: Plan drawing of the building indicating the areas covered by the various zone volume controls.
 - 6. Patch Panel Assignment Schedule: Mount a typed schedule of patch panel assignments behind acrylic at the equipment racks.
 - 7. Control Setting Schedule: Fully document the settings of all non-user-adjustable controls. This includes power amplifier gain controls, equalizer settings, etc.
 - 8. Complete Instruction and Maintenance Manual: Prepare in the form of an instructional manual for use by Owner's personnel. Provide one (1) draft copy and two (2) final copies unless otherwise specified.
 - 9. Format:
 - a. Size: 8-1/2" x 11", 20 lb. minimum weight white paper for typed pages, either manufacturer's printed data, or neatly typewritten.
 - b. Drawings: Provide reinforced punched binder tab, bind in with text. Fold larger drawings to size of text pages. Clear plastic "binding tape" (not "Scotch" tape) applied to edge of sheet and then punched is acceptable.
 - c. Single-sheet product literature and contractor-prepared pages: Provide reinforced punched binder tab. Clear plastic "binding tape" (not "Scotch" tape) applied to edge of page and then punched is acceptable.

- d. Provide indexed tabs and flyleaf for each separate product, or each piece of operating equipment. Include typed description of product, and major component parts of equipment.
 - e. Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - f. Binders:
 - g. Commercial quality three-ring binders with durable and cleanable plastic covers, 1" minimum, 2" maximum ring size.
 - h. When multiple binders are used, collate the data into related consistent groupings.
10. Content of Manuals:
- a. Neatly typewritten table of contents for each volume, arranged in systematic order. Identify each product by product name and other identifying symbols as set forth in Contract Documents.
 - b. Contractor, name of responsible principal, address and telephone number.
 - c. Certificate of Warranty for the system as a whole as well as copies of the manufacturer's warranty for each equipment item.
 - d. Service Contract. Include a preliminary schedule for the specified semi-annual site visits.
 - e. Complete as-built diagrams for systems.
 - f. Functional Diagram.
 - g. Receptacle Location Plan.
 - h. Patch Panel Assignment Schedule.
 - i. Building Plan.
 - j. Original copies, high-quality laser printer printouts of PDF files, or high-quality photocopies of manufacturers' installation, operation, and service manuals, including schematic diagrams for each equipment item.
 - k. Shop drawings of all custom-fabricated items.
 - l. Control Setting Schedule.
 - m. Audiovisual Control System:
 - 1) Color printouts of touch screens control panel graphic layouts, as installed.
 - 2) Listing of system brand, models and all associated peripherals.
 - 3) CD-ROM containing the master program for the system, the touch screen display program (including all macros), all programming, communication, or other project-specific software required for re-programming, and a limited license agreement for the use and modification of contractor-generated source code in connection with the maintenance and modification of the system for which it was written.

- n. Software for Programmable Devices: Where a computer has been used in programming system components, provide CD-ROM and/or floppy disks containing the software, instructions for making interconnections to the programmed devices for the purpose of modifying the programming, and a limited license agreement for the use and modification of contractor-generated source code in connection with the maintenance and modification of the system for which it was written.

1.6 Job Conditions

A. Sequencing and Scheduling:

1. Coordinate work with adjacent work of other trades to facilitate construction and prevent conflicts.
2. Afford other trades reasonable opportunity for installation of work and for the storage of materials.
3. Staff the job to keep pace with the other Trades; otherwise, the Design Professional will require an increase in force or overtime work without additional expenses to the Owner.
4. Abide by the decision of the Design Professional in case of conflict or interference by other trades.
5. Refuse: Remove all refuse from the job site to the satisfaction of the Design Professional and Owner.

1.7 Warranty

- A. Warrant all equipment to be free of faulty workmanship and defects, and from damage due to contamination by construction dust and debris for a minimum period of one year from date of final acceptance.
- B. Warrant all repairs to "existing" equipment for a period of 90 days.
- C. Emergency service: Within 24 hours of notification, restore the system to operation, replacing defective materials and repairing faulty workmanship. Make temporary repairs and provide loaner equipment at no charge if defective materials cannot be permanently replaced or repaired within this 24 hour time period.
- D. Paint and exterior finishes, fuses, lamps, projection lamps, and video picture tubes excluded from above warranties except when damage or failure results from defective materials or workmanship covered by warranty.
- E. The minimum warranty provisions specified above shall not diminish the terms of individual equipment manufacturers' warranties.

1.8 Service Contract

- A. Provide a one-year service contract to commence after acceptance of installation without additional cost. Service to include two semi-annual visits to the site for routine adjustment and maintenance of all equipment. Provide a preliminary schedule for the semiannual visits.

- B. Towards the end of each year's Service Contract, provide the owner with a proposal for continued service during the next year.

1.9 Training

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.
- C. Provide sufficient training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment. Explain operation of control systems, set-up and operation of individual pieces of equipment and functions of overall systems.
- D. Separate from the bid response quotation, provide an hourly cost for additional training.

1.10 Inspection

- A. Notify the Design Professional of any defects in work by other trades affecting installation.

Part 2 Products

2.1 Audio Products

- A. Digital Audio Signal Processor:
 - 1. CobraNet-based digital signal processor delivering uncompressed, multi-channel, low-latency digital audio via an Ethernet backbone. Flexible analog audio input and output via multi-slot card cage, I/O cards, and network based expansion modules.
 - 2. Features:
 - a. Up to 24 inputs/outputs, any combination by pairs.
 - b. Acoustic Echo Cancellation (AEC) available as separate input module(s).
 - c. Control via: PC/Laptop, remote control panels, and third-party control via RS-232.
 - d. Primary and secondary CobraNet ports.
 - e. Ethernet port.
 - f. Software-based mixing, equalization, filters, crossovers, leveling, compander/limiter, ducking, automatic noise control, routing, delay, remote controls, metering, signal generation, and diagnostics.
 - 3. Minimum Performance Requirements:
 - a. Frequency Response (20-20,000 Hz +4dBu): ± 0.4 dB.
 - b. Total Harmonic Distortion + Noise (20-20,000 Hz +4dBu).
 - c. Line level: <0.006%.

- d. Microphone level: <0.04%.
- e. Equivalent Input Noise (20Hz~20kHz, 66dB gain, 150 ohm): -125dBu.
- f. Dynamic Range (20Hz~20kHz, 0dB): > 107dB.
- g. Sampling Rate: 48kHz.
- h. A/D – D/A Converters: 24-bit.

4. Acceptable Products:

- a. Biamp AudiaFLEX CM with 2-channel audio input cards IP-2 and 2-channel audio output cards OP-2e.
- b. Approved Equal.

B. Remote Audio Device (RAD) Interface:

1. 32x32 digital audio matrix supporting A/D - D/A remote audio devices (RAD) and CobraNet connectivity.

2. Features:

- a. 1 RU rack mountable.
- b. Eight RJ-45 ports for RAD connectivity providing a 16x16 matrix.
- c. Primary and secondary CobraNet ports providing a 16x16 matrix.
- d. EtherNet port.
- e. Front panel LED matrix for RAD, CobraNet, Ethernet, AC power, and device identification status.
- f. PC-based software allowing configuration of RAD settings, and local and CobraNet routing.

3. Minimum Performance Requirements:

- a. A/D – D/A Converters: 24-bit.
- b. Sample Rate: 48kHz.
- c. Ethernet: 100Base Tx.
- d. UL: UL6500.
- e. RAD Parameters.

4. Acceptable Products:

- a. Rane Mongoose.
- b. Approved Equal.

C. Remote Audio Device (RAD):

1. Analog audio input and/or output devices providing digital connections via a single RJ-45 connection; CAT5 cabling up to 150 ft from the interface matrix.

2. Features:
 - a. Available in multiple configurations of 2, 3, and 4-gang Decora style wall plates.
 - b. LED status indicators for power, network communications, signal/overload conditions, and audio transmit/receive with ambient light sensing dimming.
 - c. Available in white, ivory, or black; coordinate color preference with Design Professional.
3. Minimum Performance Requirements:
 - a. Input Impedance:
 - 1) Microphone: 2.16k Ω .
 - 2) Line Input: 22.18k Ω .
 - 3) Line Output: 600 Ω .
 - b. Maximum Input Level:
 - 1) Microphone (Balanced, Gain = 26 dB, <1% THD): -17dBu.
 - 2) Line (Balanced, <1% THD): 23 dBu.
 - c. Maximum Output Level:
 - 1) Line Output (Balanced, <1% THD, Load = 10 k Ω): 18 dBu.
 - d. Dynamic Range:
 - 1) Microphone (0 dBFS, 20 kHz BW, A-weighted, Gain = 26 dB): 98 dB.
 - 2) Line Input (0 dBFS, 20 kHz BW, A-weighted): 102 dB.
 - 3) Line Output (0 dBFS, 20 kHz BW, A-weighted): 103 dB.
 - e. Common Mode Rejection Ratio:
 - 1) Microphone ($R_s = 150 \Omega$, 1 kHz, Gain = 26 dB): -70 dB.
 - 2) Line Input($R_s = 150 \Omega$, 1 kHz): -56 dB.
 - f. Total Harmonic Distortion + Noise:
 - 1) Microphone (@ 1 kHz, 20 kHz BW, $R_s = 150 \Omega$, Output = -6 dBFS, Gain = 26 dB): 0.010%.
 - 2) Line Input (Balanced, @ 1 kHz, 20 kHz BW, $R_s = 150 \Omega$, Output = -6 dBFS, Gain = 26 dB): 0.004%.
 - 3) Line Output (Balanced, @ 1 kHz, 20 kHz BW, Output = -6 dBFS): 0.017%.
 - g. Frequency Response:
 - 1) Microphone (+0, -3dB, At All Gain Settings): 30Hz to 20kHz.
 - 2) Line Input (Balanced, +0, -3dB): 10Hz to 22 kHz.
 - 3) Line Output (Balanced, +0, -3dB): 10Hz to 22 kHz.

4. Acceptable Products:

- a. Rane RAD 1 (Dual Microphone Input) and RAD 23 (Balanced Line Level Input/Output) with custom 6-gang wall plate.
- b. Approved Equal.

D. Network Audio Power Amplifier:

1. Modular, CobraNet-based power amplifier supporting digital signal processing, multiple failover configurations, and enhanced monitoring.

2. Features:

- a. 3 RU rack mountable.
- b. Primary and secondary CobraNet ports.
- c. Ethernet port.
- d. Up to 8 amplifier modules per frame with 100 to 600 Watts per module; maximum 2400 W per chassis.
- e. 70V or 100V with direct drive capability or low-impedance (4 or 8Ω) operation.
- f. LED Indication for: Signal present, Peak present, Clip present, Heat sink temperature fault, Amplifier failure, and Fan stuck-rotor.
- g. Internal amplifier modules or entire device failover modes.
- h. Software Monitoring Features: Peak present, Heatsink temperature (value, warning and fault), Short circuit on output, Amplifier failure, Impedance min/max threshold warning, Excessive clipping, Fan stuck-rotor.

3. Minimum Performance Requirements:

a. Inputs:

- 1) 20-bits.
- 2) Sample Rate: 48kHz.
- 3) CobraNet Latency: 5-1/3, 2-2/3, or 1-1/3ms (software configurable).

b. Outputs:

- 1) Supported Loads: 4Ω, 8Ω, 70V, or 100V.
- 2) Frequency Response: 20 Hz – 20 kHz (+/- 1dB).
- 3) Signal-to-Noise Ratio (unweighted, 22 Hz – 22 kHz) 100-600W:
 - a) 4 Ohm: >95dB
 - b) 8 Ohm: >95dB
 - c) 70V: >100dB
 - d) 100V: >101dB

4. Acceptable Products:
 - a. Biamp AudiaFusion with AM-600 power amplifier modules.
 - b. Approved Equal.

E. Rack Audio Monitor:

1. Two-channel analog audio monitor with dual high-resolution LED meters.
2. Features:
 - a. 1 rack space enclosure.
 - b. Simultaneous VU and Peak Hold display.
 - c. Display Mode, Peak Hold, PPM Ballistics, Alternate Scales, and Phase Correlation adjustable via rear panel and internal DIP switches.
 - d. Output limiter to protect speakers.
 - e. 60 dB meter scale.
3. Minimum Performance Requirements:
 - a. Frequency Response: 80 to 20000 Hz, \pm 5 dB.
 - b. Peak Output: 98dB SPL @ 2 ft.
 - c. Hum and Noise: Better than -68 db below full output.
4. Acceptable Products:
 - a. Wohler AMP1A-30
 - b. Approved Equal.

F. 12" Ceiling Loudspeaker (Type 1):

1. Two-way full-range coaxial ceiling loudspeakers designed for high ceiling applications.
2. Minimum Performance Requirements:
 - a. Frequency Response: 80 to 13000 Hz, \pm 4 dB on axis.
 - b. Sensitivity: 94 dB 1W/1M.
 - c. Power Handling Capacity: 200 watts (70V/100V).
 - d. Voice Coil Impedance: 8 ohms.
 - e. Nominal Dispersion Pattern: 90° H x 90° V (1.6kHz to 12.5kHz).
 - f. Transformer Taps: 25, 50, 100, and 200 watts.
3. Acceptable Products:
 - a. Community Professional Cloud 1299T with a C12BB3 3 cu. Ft. enclosure, a C12SQGRL square grille (white), and a RAIL24-PR channel rails.
 - b. Approved Equal.

G. 12" Ceiling Loudspeaker (Type 3).

1. Two-way full-range coaxial ceiling loudspeakers designed for high ceiling applications.
2. Minimum Performance Requirements:
 - a. Frequency Response: 80 to 13000 Hz, ± 4 dB on axis.
 - b. Sensitivity: 94 dB 1W/1M.
 - c. Power Handling Capacity: 200 watts (70V/100V).
 - d. Voice Coil Impedance: 8 ohms.
 - e. Nominal Dispersion Pattern: 90° H x 90° V (1.6kHz to 12.5kHz).
 - f. Transformer Taps: 25, 50, 100, and 200 watts.
3. Acceptable Products:
 - a. Community Professional Cloud 1299T with a C12BB3 3 cu. Ft. enclosure, a C12SQGRL square grille (white), and custom mounting suspension hardware, as needed.
 - b. Approved Equal.

H. 12" Ceiling Loudspeakers (Type 4):

1. Two-way full-range coaxial ceiling loudspeakers designed for high ceiling applications.
2. Minimum Performance Requirements:
 - a. Frequency Response: 80 to 12500 Hz, ± 4 dB on axis.
 - b. Sensitivity: 97 dB 1W/1M.
 - c. Power Handling Capacity: 200 watts (continuous); 500 watts (program).
 - d. Voice Coil Impedance: 8 ohms.
 - e. Nominal Dispersion Pattern: 60° H x 60° V (1.6kHz to 12.5kHz).
3. Acceptable Products:
 - a. Community Professional Cloud 1266 with a C12BB3 3 cu. Ft. enclosure a C12SQGRL square grille (white), and a RAIL24-PR channel rails.
 - b. Approved Equal.

2.2 Network Hardware

A. 12-Port Layer 3+ Expandable Ethernet Switch:

1. 1 RU rack mountable Advanced Gigabit Layer 3+ Expandable Switch with 1x High Speed expansion bay and 12x combo ports and one fixed AC power supply.
2. Features:
 - a. 1x60Gbps expansion bay.
 - b. 12 x 10/100/1000BASE-T copper or SFP.

c. Front panel has LEDs for each port to show activity.

3. Minimum Performance Requirements:

- a. Operates with 10/100/1000BASE-T Ethernet systems.
- b. Meets all performance standards for Layer3+ managed Ethernet switching.
- c. Connections are RJ-45 for 10/100/1000 connections
- d. Connections are 100TX, 100FX, 1000T, 1000SX, or 1000LX for SFP ports.
- e. Includes power supply.

4. Acceptable Products:

- a. Allied Telesis x900-12XT/S-60 with Telesis AT-SPSX.
- b. Approved Equal.

B. 24-Port Gigabit Ethernet Switch:

1. 1 RU rack mountable web managed switch supporting: port-based VLANs, IEEE 802.1p QoS, port trunking/link aggregation, port mirroring and IEEE 802.1x security.

2. Features:

- a. 24 x 10/100/1000BASE-T copper.
- b. 2 SFP combo ports.
- c. Front panel has LEDs for each port to show activity.

3. Minimum Performance Requirements:

- a. Operates with 10/100/1000BASE-T Ethernet systems.
- b. Connections are RJ-45 for 10/100/1000 connections.
- c. Connections are 100TX, 100FX, 1000T, 1000SX, or 1000LX for SFP ports.
- d. Includes power supply.

4. Acceptable Products:

- a. Allied Telesis AT-GS950/24-10.
- b. Approved Equal.

C. 48-Port Gigabit Ethernet Switch:

1. 1 RU rack mountable web managed switch supporting: port-based VLANs, IEEE 802.1p QoS, port trunking/link aggregation, port mirroring and IEEE 802.1x security.

2. Features:

- a. 48 x 10/100/1000BASE-T copper.
- b. 4 SFP combo ports.
- c. Front panel has LEDs for each port to show activity.

3. Minimum Performance Requirements:
 - a. Operates with 10/100/1000BASE-T Ethernet systems.
 - b. Connections are RJ-45 for 10/100/1000 connections.
 - c. Connections are 100TX, 100FX, 1000T, 1000SX, or 1000LX for SFP ports.
 - d. Includes power supply.

4. Acceptable Products:
 - a. Allied Telesis AT-GS950/48-10 with Telesis AT-SPSX.
 - b. Approved Equal.

D. Digital Signage Media Player:

1. Network-based media player with HDMI output.
2. Acceptable Products:
 - a. Cisco DMP 4400G with DMP-SW5.1-K9 Full Node License, CON-SAS-DMP5K Digital Signage software, and DMP-PRCASE-4400-S1 Protective Case/Mount.

E. Digital Signage Server Software:

1. Digital Media Manager for up to 150 Digital Media Players.
2. Acceptable Products:
 - a. Cisco DMP-FL-50DMP Feature License for Up To 50 DMPs.

2.3 Fiber Optic Hardware

A. Modular Fiber Optic Matrix Switcher:

1. 16x16 to 144x144 configurable within a single 8 RU chassis with 16x16 multimode I/O boards.
2. Features:
 - a. 8 RU rack mountable.
 - b. Field-upgradeable and hot-swappable I/O cards.
 - c. Dual redundant and hot-swappable power supplies.
 - d. 24-hour self-diagnostics of input/output boards, primary and secondary power supply voltages, fiber links, and overall functional status.
3. Minimum Performance Requirements:
 - a. RS-232 control via third-party control system.
 - b. RJ-45 Ethernet control port.
 - c. LC connectors on input/output boards.
 - d. Nominal peak wavelength 850 nm for multimode (MM), 1310 nm for singlemode (SM)

- e. Transmission power: -5 dBm, typical.
- f. Maximum receiver sensitivity: -12 dBm, typical.
- g. Optical loss budget: 7 dB, maximum.
- h. Maximum channel data rate 4.25 Gbps

4. Acceptable Products:

- a. Extron FOX-4G-Matrix-14400 with Extron FOX 4G Matrix I/O 1616 Boards – MM.
- b. Approved Equal.

B. HD-SDI Fiber Transceiver:

1. Fiber optic extender for multi-rate SDI.

2. Features:

- a. Extends SDI, HD-SDI, and 3G-SDI signals very long distances over a single multimode fiber.
- b. Input equalization and reclocking on buffered outputs.
- c. Dual buffered outputs.
- d. Daisy-chain capability.
- e. Real-time status LED indicators for troubleshooting and monitoring.

3. Acceptable Products:

- a. Extron FOX HD-SDI MM with rack-mount hardware, as required.
- b. Approved Equal.

C. DVI , Audio, and RS22 Fiber Transmitter:

1. Features:

- a. Extends single link DVI-D, stereo audio, and RS-232 control signals very long distances over a single fiber.
- b. All digital, zero compression technology provides pixel-for-pixel performance with signals up to 1920x1200, including HDTV 1080p/60.
- c. EDID emulation.
- d. Daisy-chain capability.
- e. Real-time status LED indicators for troubleshooting and monitoring.
- f. Alarm notification for fiber link loss.

2. Acceptable Products:

- a. Extron FOXBOX 4G Tx DVI Plus MM with rack-mount hardware, as required.
- b. Approved Equal.

D. DVI, Audio, RS232, Fiber Receiver:

1. Features:

- a. Extends single link DVI-D, stereo audio, and RS-232 control signals very long distances over a single multimode fiber.
- b. All digital, zero compression technology provides pixel-for-pixel performance with signals up to 1920x1200, including HDTV 1080p/60.
- c. EDID emulation.
- d. Daisy-chain capability.
- e. Real-time status LED indicators for troubleshooting and monitoring.
- f. Alarm notification for fiber link loss.

2. Acceptable Products:

- a. Extron FOXBOX 4G Rx DVI Plus MM with rack-mount hardware, as required.
- b. Approved Equal.

E. VGA, Audio, RS232, Fiber Transmitter:

1. Features:

- a. Extends VGA, stereo audio, and RS-232 control signals very long distances over a single multimode fiber.
- b. All digital, zero compression technology provides pixel-for-pixel performance with signals up to 1600x1200.
- c. Daisy-chain capability.
- d. Available as an 850 nm multimode model for moderate-range transmissions, and a 1310 nm singlemode model for extreme distances up to 30 km (18.75 miles).
- e. Real-time status LED indicators for troubleshooting and monitoring.
- f. Alarm notification for fiber link loss.

2. Acceptable Products:

- a. Extron FOXBOX 4G Tx VGA MM with rack-mount hardware, as required.
- b. Approved Equal.

F. VGA, Audio, RS232, Fiber Receiver:

1. Features:

- a. Extends VGA, stereo audio, and RS-232 control signals very long distances over a single multimode fiber.
- b. All digital, zero compression technology provides pixel-for-pixel performance with signals up to 1600x1200.

- c. Daisy-chain capability.
- d. Available as an 850 nm multimode model for moderate-range transmissions, and a 1310 nm singlemode model for extreme distances up to 30 km (18.75 miles).
- e. Real-time status LED indicators for troubleshooting and monitoring.
- f. Alarm notification for fiber link loss.

2. Acceptable Products:

- a. Extron FOXBOX 4G Rx VGA MM with rack-mount hardware, as required.
- b. Approved Equal.

G. Video, Audio, and RS-232 Fiber Transmitter:

1. Features:

- a. Extends standard definition video, stereo audio, and RS-232 control signals very long distances over a single multimode fiber.
- b. Accepts component video, S-video, and composite video signals.
- c. All digital, zero compression technology provides pixel-for-pixel performance.
- d. Auto Input Format Detection.
- e. Picture and audio adjustments.
- f. Internal transcoding with selectable output format.

2. Acceptable Products:

- a. FOX 2G Tx AV MM with rack-mount hardware, as required.
- b. Approved Equal.

H. Video, Audio, and RS-232 Fiber Receiver:

1. Features:

- a. Extends standard definition video, stereo audio, and RS-232 control signals very long distances over a single multimode fiber.
- b. Accepts component video, S-video, and composite video signals.
- c. All digital, zero compression technology provides pixel-for-pixel performance.
- d. Auto Input Format Detection.
- e. Picture and audio adjustments.
- f. Internal transcoding with selectable output format.

2. Acceptable Products:

- a. FOX 2G Rx AV MM with rack-mount hardware, as required.
- b. Approved Equal.

2.4 Video Hardware

A. 15" Rackmount LCD Monitor:

1. High Definition 15" Rack Mount or Desktop LCD Monitor with all Digital/Analog HD/SD inputs.
2. Features:
 - a. 1024 x 768 RGB Dots with 2.4 million pixels.
 - b. 16.7 million colors.
 - c. 450:1 contrast ratio.
 - d. 4:3 and 16:9 screen aspect ratios for DTV applications in HD and SD formats.
 - e. Standard Multi-format inputs including: HD-SDI, SDI, Component Analog HD/SD, Composite Video PAL/NTSC, DVI-I, and SXGA.
 - f. Built-in Color Bar generator.
3. Acceptable Products:
 - a. Marshall V-R151DP-AFHD.
 - b. Approved Equal.

B. Dual 10" LCD Monitors:

1. TFT-MegaPixel SDI Multiformat Dual Screen 10.4-Inch Monitor Set.
2. Features:
 - a. Large 10.4-inch screens 800x600 Dots (1.44 million RGB pixels).
 - b. Match Color Conversion.
 - c. Adjustable Color Temperature.
 - d. 5 Year / 50,000 hour backlight life.
 - e. 10-bit Analog to Digital conversion.
 - f. High resolution scaling.
 - g. Wide viewing radius - 130° horizontal and vertical provides superior visibility.
 - h. 600 candelas per square meter (cd/m²) luminance produces enhanced image quality in varying light and viewing conditions.
 - i. 500:1 ratio of contrast between black and white luminance values.
 - j. 4:3 and 16:9 screen aspect ratios for DTV applications.
 - k. Direct access for all adjustments.
3. Acceptable Products:
 - a. Marshall V-R102DP-SD.
 - b. Approved Equal.

C. 46" Digital Signage LCD Displays:

1. Thin-bezel design with multiple input formats and a built-in expansion slot for future third-party components.
2. Features:
 - a. Native Resolution: 1366x768 (min).
 - b. Contrast Ratio: 1800:1.
 - c. Inputs Connectors: DVI-D, Analog D-sub, Analog BNC, Composite (shared RCA & BNC), S-Video, Component, HDMI, and RCA.
 - d. Optional stereo speakers and optional internal TV tuner.
3. Acceptable Products:
 - a. NEC LCD4620-2-AV with a Chief Fusion LTM-series mount.
 - b. Approved Equal.

D. 52" Digital Signage LCD Displays:

1. Thin-bezel design with multiple input formats and a built-in expansion slot for future third-party components.
2. Features:
 - a. Native Resolution: 1920x1080 (min).
 - b. Contrast Ratio: 2000:1.
 - c. Inputs Connectors: DVI-D, Analog D-sub, BNC, S-Video, and HDMI.
 - d. Optional stereo speakers and optional internal TV tuner.
3. Acceptable Products:
 - a. NEC LCD5220-2-AV with a Chief Fusion LTM-series mount.
 - b. Approved Equal.

E. Video Wall:

1. 3x3 video display matrix (138" Diagonal Overall).
2. Features:
 - a. 1360 x 768 WXGA native resolution in true 16:9 aspect ratio, maximum brightness of 700 cd/m2 and typical contrast ratio of 3000:1.
 - b. Ground-breaking ultra-narrow bezel of 7.3 millimeters (screen-to-screen).
 - c. TileMatrixTM technology (up to 100 displays).
 - d. Built-in expansion slot.
 - e. Optional SpectraViewIITM Color Calibration Solution.

- f. Network Control and Communication.
 - g. Optional Wall-calibrator video wall calibration solution.
 - h. Ultra-narrow bezel.
 - i. Ethernet monitor and control.
 - j. Commercial-grade sealed panel with advanced cooling system for 24/7 operation.
 - k. Provide with custom mounting assembly with swing-out panel access and cable management.
 - l. Provide with 12-output DVI distribution amplifier mounted behind display.
3. Acceptable Products:
- a. Displays: NEC X461UN.
 - b. Mounting Assembly: RP Visuals 3x3 Panel Mount (Ref. # ACE-RPPM111709-A).
 - c. 1x12 DVI Distribution Amplifier: Kramer VM-12HDPC.

2.5 Control Hardware

A. AV Control Processor:

- 1. 2-Series engine with Dual-bus architecture, 4GB Compact Flash memory card slot ,and Cresnet port - master/slave selectable.
- 2. Features:
 - a. 10/100 Ethernet capable | SSL encryption.
 - b. e-Control 2 and RoomView enabled.
 - c. SNMP support | Built-in firewall, NAT and router.
 - d. 6 Com ports, 8 IR/serial ports, 8 Versiport I/O ports, 8 Relay ports.
 - e. 3 Y-Bus / 1 Z-Bus control card expansion slots.
 - f. Internal power supply | 2-Space EIA rack-mountable.
 - g. Front control panel with LCD display.
- 3. Acceptable Products:
 - a. Crestron Pro2 with auxiliary power supplies and accessory components, as required.
 - b. Approved Equal.

B. 8.4" Touch Panel:

- 1. 8.4" WiFi Wireless Touchpanel. Includes power supply/battery charger.

2. Acceptable Product:
 - a. Crestron TPMC-8X.
 - b. Approved Equal.

C. DSP / Audio Monitoring PC:

1. System specification TBD.
2. Acceptable Products:

- a. Dell Precision XXX with Dell E2010H 20" monitor.

2.6 Audiovisual Pool Equipment

Qty.	Manufacturer	Model	Description
A. (1)	Yamaha	LS9-16	16-channel Digital Mixer
B. (1)	Yamaha	LS9-32	32-channel Digital Mixer
C. (2)	Yamaha	MY16-CII	16-channel CobraNet I/O Card
D. (2)	Anvil	Custom	Console Roadcases
E. (2)	Whirlwind	DS168T	16x8 Digital Snake Input Box, w/ CobraNet
F. (1)	Whirlwind	DS168R 16x8	Digital Snake Output Box, w/ Cobranet
G. (1)	Whirlwind	DS328T 32x8	Digital Snake Input Box, w/ Cobranet
H. (2)	Anvil	Custom	3RU Portable Rack
I. (1)	Anvil	Custom	4RU Portable Rack
J. (4)	Biamp	NPS-1	Network Paging Station, PoE
K. (2)	Rane	NM-1	Network Mic Preamp, Monitor, PoE
L. (4)	Shure	UR4D	Dual UHF-R Receiver - L3 Band
M. (8)	Shure	UR2/SM87	Handheld microphone/transmitter
N. (8)	Shure	UR1	UHF-R Bodypack
O. (8)	Shure	WL183	Omni-directional Lavliere lapel microphone
P. (4)	Middle Atlantic	D2	2RU rackmount drawer
Q. (4)	Anvil	Custom	4RU Portable Rack
R. (20)	Shure	SM58-LC	Handheld dynamic mic, cardioid
S. (50)	Whirlwind	MKQ25	Mic cable, quad, 25'

T. (25)	Whirlwind	MKQ50	Mic cable, quad, 50'
U. (5)	Whirlwind	MKQ100	Mic cable, quad, 100'
V. (15)	Atlas	MS-12CE	Microphone Stand
W. (15)	Atlas	TEB-E	Microphone Stand, tripod w/ boom
X. (8)	Extron	FOX HD-SDI MM	HD-SDI Fiber Transmitter/Receiver, Multimode
Y. (4)	Extron	FOXBOX 4G Tx DVI Plus MM	DVI Fiber Transmitter, Multimode
Z. (4)	Extron	FOXBOX 4G Rx DVI Plus MM	DVI Fiber Receiver, Multimode
AA. (4)	Extron	FOXBOX 4G Tx VGA MM	VGA Transmitter, Multimode
BB. (4)	Extron	FOXBOX 4G Rx VGA MM	VGA Fiber Receiver, Multimode
CC. (4)	Extron	FOX 2G Tx AV MM	AV Fiber Transmitter, Multimode
DD. (4)	Extron	FOX 2G Rx AV MM	AV Fiber Receiver, Multimode
EE. (16)	Pelican	1120	Molded Carrying Case, 8"x6"x4"
FF. (4)	Extron	MVGA-A M-M/6	VGA/Audio Cable, M-M, 6'
GG. (4)	Extron	MVGA-A M-M/12	VGA/Audio Cable, M-M, 12'
HH. (8)	Extron	MHR-5 BNC/12	RGBHV Cable, BNC, 12'
II. (8)	Extron	MHR-5 BNC/25	RGBHV Cable, BNC, 25'
JJ. (4)	Extron	RG6-5 BNC/50	RGBHV Cable, BNC, 50'
KK. (4)	Extron	SYM BNC/1	RGBHV Cable, VGA-BNC (F), 1'
LL. (4)	Extron	SYM BNC/1	RGBHV Cable, VGA-BNC, 1'
MM. (4)	Extron	SYM BNC/6	RGBHV Cable, VGA-BNC, 6'
NN. (4)	Extron	SYM BNC/12	RGBHV Cable, VGA-BNC, 12'
OO. (8)	Extron	DVID DL Pro/6	Dual Link DVI Cable, 6'
PP. (4)	Extron	DVID DL Pro/12	Dual Link DVI Cable, 12'
QQ. (4)	Extron	DVID DL Pro/25	Dual Link DVI Cable, 25'
RR. (8)	Extron	HDMI M-DVI-D M/3	HDMI-DVI Cable, 3'
SS. (8)	Extron	HDMI M-DVI-D M/6	HDMI-DVI Cable, 6'
TT. (4)	Extron	HDMI M-DVI-D M/12	HDMI-DVI Cable, 12'
UU. (4)	Extron	HDMI M-DVI-D M/25	HDMI-DVI Cable, 25'

VV. (10)	Extron	RG6 BNC/3	Video/SDI Cable, RG6 BNC, 3'
WW. (20)	Extron	RG6 BNC/6	Video/SDI Cable, RG6 BNC, 6'
XX. (20)	Extron	RG6 BNC/12	Video/SDI Cable, RG6 BNC, 12'
YY. (10)	Extron	RG6 BNC/25	Video/SDI Cable, RG6 BNC, 25'
ZZ. (10)	Extron	RG6 BNC/50	Video/SDI Cable, RG6 BNC, 50'
AAA. (4)	Extron	RG6 BNC/100	Video/SDI Cable, RG6 BNC, 100'
BBB. (25)	Custom		MM Fiber Cable, Duplex LC-LC, 6'
CCC. (25)	Custom		MM Fiber Cable, Duplex LC-LC, 12'
DDD. (25)	Custom		MM Fiber Cable, Duplex LC-LC, 25'
EEE. (8)	Custom		MM Fiber Cable, Duplex LC-LC, 50'
FFF. (8)	Custom		MM Fiber Cable, Duplex LC-ST, 6'
GGG. (8)	Custom		MM Fiber Cable, Duplex LC-ST, 12'
HHH. (4)	Custom		MM Fiber Cable, Duplex LC-ST, 25'
III. (4)	Custom		MM Fiber Cable, Duplex LC-ST, 50'
JJJ. (8)	Custom		MM Fiber Cable, Duplex LC-SC, 6'
KKK. (8)	Custom		MM Fiber Cable, Duplex LC-SC, 12'
LLL.(4)	Custom		MM Fiber Cable, Duplex LC-SC, 25'
MMM. (4)	Custom		MM Fiber Cable, Duplex LC-SC, 50'

2.7 Equipment Racks, Panels, And Miscellaneous Accessories

A. Equipment Racks:

1. General:

- a. Verify all rack sizes, types and finishes with design professional or project manager before ordering.
- b. Verify and coordinate all blocking and clearance requirements before ordering.
- c. Equipment rack for standard 19" wide panels. Minimum 16 gauge cold rolled steel construction with louvered sides. Mounting rails with tapped 10-32 threaded holes on EIA spacings. Welded construction.
- d. Each rack furnished with permanently-mounted AC power 3 conductor grounded stripline rated for 15 amperes, with outlets on 6" centers, extending full height of rack, and with incandescent illumination attached for ease in servicing.

B. Free-Standing Equipment Racks:

1. Features:

- a. Welded floor rack assembly, fixed side panels, solid front and solid, lockable rear door and adjustable mounting rails.
- b. Overall depth 24" to 26.5", height as indicated or required.
- c. Lacing Bars: (1) vertical, (4) 'L' shaped straight, and (2) 4" offset.
- d. Integrated fan top with three 4-1/2" fans.
- e. One 20-Amp vertical outlet strip w/ twenty 5-20R outlets.
- f. Provide caster bases where necessary for service access.

2. Acceptable Products:

- a. Middle Atlantic Products ERK-4425AV with ERK-RR44 rear rack rails.
- b. Approved Equal.

C. Gangable Equipment Racks:

1. Features:

- a. Welded floor rack assembly, fixed side panels, lockable rear door, and adjustable mounting rails.
- b. Overall depth 30" to 32", height as indicated or required.
- c. Lacing Bars: (1) vertical, (4) 'L' shaped straight, and (2) 4" offset.
- d. Integrated fan top with one 10" fan.
- e. One 20-Amp vertical outlet strip w/ twenty 5-20R outlets.
- f. Provide caster bases where necessary for service access.

2. Acceptable Products:

- a. Middle Atlantic Products MRK-4431AV (includes side panels) or MRK-4431AV-AB (without side panels); each with ERK-RR44 rear rack rails.
- b. Approved Equal.

D. Blank Panels:

1. 16-gauge flanged solid steel with black smooth ended for or textured enamel finish.

2. Acceptable Products:

- a. Middle Atlantic SB series.
- b. Atlas/Soundolier S19 series.

E. Equipment Rackmount:

1. Custom fabricated rackmount system for use with equipment, such as consumer VCRs, that are not provided with integrated rackmount ears. Increases the height of the device to the next larger rack unit size, eliminating unsightly gaps and providing complete trim. Includes custom faceplate with ears, and rackshelf with ventilated bottom.
2. Black brushed and anodized faceplate finish.
3. Acceptable Products:
 - a. Middle Atlantic Products RSH-4A with faceplate and shelf size as required.
 - b. Lowell RMK Series rackmount kit.
 - c. Approved equal.

F. Rack Drawers:

1. Pull-out steel storage drawers with latching pull handle designed to mount in standard 19" EIA equipment racks.
2. Features:
 - a. Inside dimensions 15-7/8" wide x 14" deep.
 - b. Fully enclosed top.
 - c. Full extension ball-bearing glides.
 - d. Laser knockout in rear for cables.
 - e. Keylock option.
 - f. Black brushed anodized finish.
3. Acceptable 2-Space Products:
 - a. Middle Atlantic D-2.
 - b. Raxxess SDR-2.
 - c. Lowell L-18 193.
4. Acceptable 3-Space Products:
 - a. Middle Atlantic D-3.
 - b. Raxxess SDR-3.
 - c. Lowell L-18 195.

G. Power Conditioner/Surge Protector:

1. One rack-space unit in a magnetic shielding steel enclosure. Operation from 120 volts AC with a 9-foot, grounded, 3-wire #12 line cord. Eight 15-Amp rear-panel outputs. Front-panel courtesy outlet and self-test circuit with visual indicator.
2. Features:
 - a. Load rating of 20 amps @ 120 volts, and provide advanced Impedance Tolerant™ EMI/RFI filtering.
 - b. Meets Federal Grade A, Class 1, Mode 1 Guidelines (CID A-A-55818) for powerline surge suppressors.
 - c. Three limiter circuits: a series surge reactor current limiter, a cascaded auto-tracking dual-polarity voltage limiter, and dual pulse inverters.
 - d. Onset clamping voltage shall be 172 volts, nominal, and the unit shall have an instant reacting snubber to protect against fast-rising surges generated within the installation location.
 - e. Unlimited Current Surge and Joule Limitation ratings (8 x 20 μs) and shall withstand at least 1000 occurrences of Surge Pulse Voltages up to 6000 volts.
3. Acceptable Products:
 - a. SurgeX SX1120-RT.
 - b. Approved Equal.

H. Rack Light/Power Module:

1. Rack-mounted unit with 2 slide-out light fixtures to illuminate the face of an equipment rack, high-voltage surge and transient suppresser with multi-stage RFI and EMI filter, and 8 switched outlets with total 15 amp capacity.
2. Acceptable Products:
 - a. Furman Sound PL-Plus C.
 - b. Approved equivalent.

I. Gooseneck Light Rack Panel:

1. Rack-mounted unit with recess containing two 12" miniature gooseneck LEDs with on/off switch and solid state power supply.
2. Acceptable Products:
 - a. Littlite RL-10D-LED.
 - b. Furman RL-1.
 - c. Approved Equal.

J. Rack Work Light:

1. Moveable work light with switch, interchangeable articulating arm with magnet and clamp for mounting, and a choice of two reflectors.
2. Acceptable Products:
 - a. Atlas Sound RWL2.
 - b. Equivalent.

2.8 General Equipment And Miscellaneous (All Rooms)

A. Programming:

1. Control System Programming:
 - a. Touch panel graphic design, page and button logic, and code programming to be provided by one of the following professional programming companies.
 - b. The control system programming subcontractor is required to work directly with the owner to provide sample panel layouts submittals coordinated with the general AV submittals for review by the AV consultant.
 - c. Menus to be arranged for user access via a PIN number, with a separate PIN and more comprehensive controls for technician access.
 - d. Control systems programming to include all network interface work required to complete and verify centralized AV control (Crestron RoomView).
 - e. For systems with touch panels, the control system programming subcontractor shall provide PDF simplified user operational manuals conforming to the final, accepted functional operation of the AV systems.
 - f. Acceptable Programming Subcontractors:
 - 1) Control Concepts, Inc. (www.controlconcepts.net).
 - 2) PepperDash (www.pepperdash.com).
 - 3) ICD (www.icdsystems.com).
 - 4) Approved equals.

B. Cabling and Miscellaneous Products:

1. Cables (Non-Plenum Applications):
 - a. Microphone and Line Level Lines:
 - 1) Twisted pairs of color-coded stranded conductors with overall foil shield, stranded tinned copper drain wire, and jacket.

- a) AWG #22, maximum diameter .175 inches.

Acceptable Products:

Belden 8761.

West Penn 291.

Alpha 2401.

- b. Loudspeaker Lines:

- 1) Twisted color-coded stranded and paired conductors with overall jacket. Gauge as shown on drawings.
- 2) NEC FPLP Listed for fire alarm use.
 - a) AWG #14, nominal diameter .332 inches.

Acceptable Products:

Belden 5100UL.

Or equal.

- c. Precision Video Lines (use for all discreet video connections and in-rack wiring):

- 1) Low-noise coaxial cable with polyethylene dielectric, foil-plus-copper-braid shield, and overall PVC jacket.
- 2) Nominal Attenuation: .87 dB/100 ft. at 10 MHz.
- 3) Nominal Impedance: 75 ohms.
- 4) #20 AWG solid bare copper center conductor, nominal cable O.D. .235 inches.
- 5) Acceptable Products:
 - a) Belden 1505A.
 - b) West Penn 819.
 - c) CommScope 5565.
 - d) Equivalent.

- d. Precision Video Lines (use for all RGBHV combination runs.)

- 1) Low-noise coaxial cable with polyethylene dielectric, foil-plus-copper-braid shield, and overall jacket containing all 5 individually contained coaxial cables.
- 2) Nominal Impedance: 75 ohms.
- 3) Five (5) #20 AWG solid bare copper center conductors, nominal cable O.D. .595" inches.
- 4) Acceptable Products:
 - a) West Penn WP 258195.
 - b) Equivalent.

e. Remote Control Lines:

- 1) Color-coded stranded copper conductors with overall jacket.
- 2) AWG #18, with number of conductors as specified.
- 3) Provide plenum-rated equivalent where required.
- 4) Acceptable Products:
 - a) Alpha 5062 to 5070.
 - b) Equivalent.

f. Category Five Data Cable:

- 1) Four-pair unshielded twisted pair cable, AWG#24, nominal diameter 0.365"x0.165". Exceeds requirements for Category Five applications.
- 2) Minimum Performance Requirements:
 - a) Nominal Capacitance: 15 pF/ft at 1 KHz.
 - b) Impedance: 100 ohms \pm 12%, 0-350 MHz.
 - c) Return Loss: 20 dB, 0-200 MHz.; 17 dB, 0-350 MHz.
 - d) Delay Skew: 18 ns/100m max.
 - e) Capacitance Unbalance: 49.2 pF/100m max.
- 3) Acceptable Products:
 - a) Belden MediaTwist 1872A.
 - b) Approved equal.

g. Cable Markers:

- 1) High-grade PVC clip-on or permanent-type cable markers with permanent markings, or printed vinyl tape protected by clear shrink tubing or adhesive wrap.
- 2) Acceptable Products:
 - a) Electrovert Type C or Z.
 - b) Brady B-702 with Alpha FIT-221 series clear tubing.
 - c) Thomas & Betts EZCODER.

2. Portable Cables:

a. Microphone Cables:

- 1) 25': Whirlwind MKQ25 black.
- 2) 50': Whirlwind MKQ50 black.

b. Loudspeaker Cables:

- 1) 25': Rapco 12 AWG commercial series with Neutrik NL4 and ¼" phone connectors.

c. Production Communication Cables:

- 1) 25': Whirlwind MKQ25 blue.

- 2) 50': Whirlwind MKQ50 blue.
3. Microphone and Line-Level Line Terminal Blocks:
 - a. Insulation displacement "punch" block.
 - b. Contact Construction: Insulation displacement phosphor bronze contact, with plastic insulator, for AWG #22, #24, and #26 solid or stranded wire, allowing 100 insertions/withdrawals, and accepting four wires total for each connection point.
 - c. Acceptable Products:
 - 1) ADC Products UP3 with UP-W or UP-R mounts as required with one Q-814-804 wire insertion tool.
 - 2) Siemon Multiflex block with one 714 insertion tool with cutting blade.
 4. Connectors:
 - a. Microphone and Line Connectors (Panel Mount):
 - 1) Unbalanced Cable-End: Two-conductor RCA plug or jack connector with steel shell and internal cable clamp. Provide with minimum 2" of rubberized shrink-wrap strain relief at each connector.
 - a) Acceptable Products:

Switchcraft 3502 or 3503 as required.

Equivalent.
 - 2) Balanced Input Receptacles: female gender "XLR"-type receptacles.
 - a) Acceptable Products:

Switchcraft C3F or D3F.

Equivalent.
 - 3) Balanced Output Receptacles: Male gender "XLR"-type receptacles.
 - a) Acceptable Products:

Switchcraft C3M or D3M.

Equivalent.
 - 4) Dual Format Line Input Receptacles: Balanced input receptacle accepting both male gender "XLR"-type connectors and 1/4" TRS phone plugs.
 - a) Acceptable Products:

Neutrik NCJ6FK-V.

Equivalent.

5) Unbalanced Input and Output Receptacles: Two-conductor 1/4" phone jacks with type J-4 single-closed circuit schematic, molded plastic enclosure, and insulating molded nylon bushing.

a) Acceptable Products:

Switchcraft N112A or NL112A as required.

Equivalent.

6) Locking 1/4" Receptacles: Two- or three-conductor 1/4" phone jacks with locking tab to prevent accidental removal of plug.

a) Acceptable Products:

Switchcraft E111L (2-cond.) or E112BL (3-cond.) as required.

Neutrik NJ3FP6C.

Equivalent.

7) Unbalanced Input and Output Receptacles: Female gender phono jacks (RCA jack) with closed circuit switching and non-grounding mount.

a) Acceptable Products:

Switchcraft 3512.

Equivalent.

8) 1/8" Mini Stereo Phone Jack: Female gender, 3-conductor, open-circuit, enclosed, panel-mount, 1/8" phone jack.

a) Acceptable Products:

RS 274-249.

Equivalent.

b. Microphone and Line Connectors (Cable Mount):

1) Balanced Input Connectors: female gender "XLR"-type connectors.

a) Acceptable Products:

Switchcraft A3F.

Neutrik NC3FX.

2) Balanced Output Connectors: male gender "XLR" type connectors.

a) Acceptable Products:

Switchcraft A3M.

Neutrik NC3MX.

3) 1/4" Phone Plug: Two- or three-conductor 1/4" phone jacks.

a) Acceptable Products:

Switchcraft 184 (2-cond.) or 190 (3-cond.) as required.

Neutrik NP-2C (2-cond.) or NP-3C (3-cond) as required.

c. Video Receptacles:

1) Insulated, feed-through BNC panel jack with beryllium copper outer conductor spring for use with RG-59/U-type cables.

2) Cable termination: BNC.

3) Acceptable Products:

a) Trompeter UBJ28.

b) Kings KC-99-54.

c) ITT Pomona 3846.

d) Canare BCJ-JR with IU-7/16 panel isolation bushing.

d. Recessed Video Receptacles:

1) Insulated, feed-through BNC panel jack in recessed housing to resist damage to connector.

2) Impedance: 75 ohms.

3) Cable Termination: BNC

4) Acceptable Products:

a) Canare BCJ-JRU.

e. BNC Video Cable Connectors:

1) BNC type for terminating video cable in conduit or video extension cables. Crimp connector with beryllium copper outer conductor spring and captive center pin, exceeding MIL-C-39012,A.

2) For Belden 8281 type cable.

a) Acceptable Products:

Kings KC-59-299 (use KTH-1000 crimp tool, KTH-2012 die, and KTJ-43 and KTD-30 trim jigs).

Belden BNC0081 (use 9CRT012 crimp die).

Trompeter UPL-220-016.

3) For Belden 8281A type cable.

a) Acceptable Products:

Kings 755-48-9 (use KTH-1000 tool, KTH-2178 die, and KTJ-43 and KTD-406 trim jigs).

Belden BNC0082 (use 9CRT078 crimp die).

4) For Belden 8279 type cable.

a) Acceptable Products:

Kings KC-59-397 (use KTH-6000 crimp tool, KTH-6029 die, and KTJ-134 and KTD-26 trim jigs).

Belden BNC0079 (use 9CRT026 crimp die).

Trompeter UPL-220-019.

5) For RG 59/U type cable.

a) Acceptable Products:

Kings KC-59-294.

Belden BNC0041 (use 9CRT0022 crimp die).

Trompeter UPL-220-013.

Canare BCP-C4 with one TC-0 crimp tool and TC-D-4C die.

6) For Belden 1505A type cable.

a) Acceptable Products:

Kings 2025-51-9.

Trompeter UPL-220-014.

7) For Belden 1506A type cable.

a) Acceptable Products:

Kings 2025-53-9.

Trompeter UPL-220-023.

f. RCA type connector for RG-59/U Type Video Cables:

1) 75 Ohm true impedance matched RCA type connector.

2) Crimps to any RG-59 type cable.

3) VSWR 1.1 or less to 200 MHz.

4) Fully captive gold plated center pin.

5) Nickel plated brass body with Beryllium copper outer contacts.

6) Acceptable Products:

a) Canare RP-C4 series with TC-1 Crimp tool and TCD-series crimp die.

g. Normalled Video Receptacle:

1) BNC panel jack with built-in switch activated by insertion of BNC connector.

2) Impedance: 50 ohms.

3) Acceptable Products:

a) Black Box Corp. NP-WP360 (jacks remounted on wall plate).

- h. S-Video To Y/C Adapter:
 - 1) Adapts din-type S-Video output cable to separate Y/C coaxial video cables.
 - 2) Acceptable Products:
 - a) Panasonic ET-100YC S-Video adapter.
- i. Heavy-Duty RJ-45 Connectors:
 - 1) Standard CAT 5e RJ-45 connectors housed in XLR-type connector shell for physical protection.
 - 2) Acceptable Products:
 - a) Neutrik NE8FAV-Y110 panel connector, NE8MC cable connector, and BSE and ACRF color-coded accessories.

2.9 Patch Panels, Terminal Blocks, And Connectors

A. Audio Patching Equipment:

1. Audio Patch Panel:

- a. 2RU assembly with 48 jacks in two rows of 24 each in a black plastic front panel, and insulation-displacement quick-connect panel contacts and insulators mounted to rear of metal chassis. Continuous horizontal designation strip for each row of jacks, and vertical designation strips for left and right sides.
- b. All jack openings provided with jacks. Each jack factory-wired with 2-conductor shielded cable to each set of connectors on the rear terminal block.
- c. Jack Circuit Type: 3-conductor, 1/4" diameter double closed circuit long-frame telephone jacks wired to allow normaling to be selected at the terminal block.
- d. Jack Construction: Cadmium-plated steel frames with nickel silver springs and gold-plated contacts.
- e. Terminal Block Circuitry: Separate tip, ring, sleeve, ring normal, tip normal, and sleeve normal contacts for each jack.
- f. Terminal Block Contact Construction: Split cylinder insulation-displacement phosphor bronze contact with plastic insulator for AWG #22, #24, and #26 solid or stranded wire, allowing 100 insertions/withdrawals, and accepting two wires on each side (four wires total for each cylinder); or split terminal to accept up to four AWG #20 wires.
- g. Acceptable Products:
 - 1) ADC Products PPA3-14 MKIVSN with vertical designation strips and one wire insertion tool.
 - 2) Approved equal.

2. Audio Patch Cords:

- a. Two-conductor plus shield, with braided nylon jacket and single plug at each end.

- b. Plugs: Nickel-plated 3-conductor, 1/4" diameter, ring-tip-sleeve plugs with machined brass parts and plastic handles.
- c. Acceptable Products – 2 Foot:
 - 1) ADC Products BK2.
 - 2) Neutrik NKTB05-BLK.
 - 3) Approved equal.

B. Video Patching Equipment:

1. Video Patch Panel:

- a. 2RU jack panel of insulated construction with two rows of 24 jack positions each. Continuous designation strips at top and bottom of each panel, clearly labeled according to function or to assignment schedule if shown.
- b. Normalled through jacks vertically adjacent and looping jacks horizontally adjacent.
- c. Unused jack positions closed with plastic plugs.
- d. Jack Circuits: 2 conductor, WECO compatible, 75 ohm coaxial jacks with open, self-terminating, normalled through non-terminating, and normalled through self-terminating circuits as shown.
- e. Jack Sleeves and Frames: Brass.
- f. Center Conductor: Beryllium copper.
- g. Conductor Surfaces: Gold plated.
- h. Cable Connector: BNC.
- i. Acceptable Products:
 - 1) ADC PPI-2224RS with SJ 2000G, SJ 2000G75, and CJ-1011G jacks as shown.
 - 2) Canare 242U-DVJW-C with DVJ-W and DVJ-S jacks as shown.

2. Video Patch Cords:

- a. 75-ohm coaxial patch cords with RG59/U cable and WECO compatible plugs at each end.
- b. Acceptable Products:
 - 1) ADC BK2V.
 - 2) Canare VPC002FB.

3. Looping Plug:

- a. Acceptable Products:
 - 1) Trompeter LPW-75.
 - 2) ADC CP1063G or CP1063N.

4. Looping Plug with Test Point:
 - a. Acceptable Products:
 - 1) Trompeter LPWTP-75.
 - 2) ADC CP1043G or CP1043N.
- C. Patch Cord Holder:
 1. Cable holder accepting max. 0.32" diameter cables and designed to mount to vertical surface.
 2. Acceptable Products:
 - a. ADC ProPatch PPH Series.
 - b. Audio Accessories "Maxi" PCH Series (audio) and VPCH series (video).
 - c. Trompeter CH50.
- D. Patch Bay Labels:
 1. Permanent patch bay labeling shall not be supplied until the owner has operated the facility for 30 days. Temporary labeling must be typewritten or computer printed on full length label strips.
 2. After 30 days, the contractor shall ascertain any changes to the patch bay layout.
 3. Install permanent label strips.
 4. Permanent strips shall be washable shrink resistant and fade resistant plastic. Letters shall be black on white and/or white on black. Use both types to break up patch labeling into functional groups.
 5. Lettering shall be photo-composited.
 6. Label strips shall be protected by clear plastic or acetate protector strips.
 7. Colored transfer color such as pantone may be applied over areas with black lettering on white background to further differentiate functional groups.
 8. Acceptable Products:
 - a. Patch Bay Designation Company, Division of Glendale Rubber Stamp Co. Patch Prints.
 - b. Approved equal.
- E. Microphone and Line-Level Line Terminal Blocks:
 1. Insulation displacement "punch" block.
 2. Contact Construction: Insulation displacement phosphor bronze contact, with plastic insulator, for AWG #22, #24, and #26 solid or stranded wire, allowing 100 insertions/ withdrawals, and accepting four wires total for each connection point.

3. Acceptable Products:

- a. ADC Products UP3 with UP-W or UP-R mounts as required with one Q-814-804 wire insertion tool.
- b. Simon Multiflex block with one 714 insertion tool with cutting blade.

F. Connectors:

1. Microphone and Line Connectors (Panel Mount):

- a. Unbalanced Cable-End: Two-conductor RCA plug or jack connector with steel shell and internal cable clamp. Provide with minimum 2" of rubberized shrink-wrap strain relief at each connector.
 - 1) Acceptable Products:
 - a) Switchcraft 3502 or 3503 as required.
 - b) Equivalent.
- b. Balanced Input Receptacles: female gender "XLR"-type receptacles.
 - 1) Acceptable Products:
 - a) Switchcraft C3F or D3F.
 - b) Equivalent.
- c. Balanced Output Receptacles: Male gender "XLR"-type receptacles.
 - 1) Acceptable Products:
 - a) Switchcraft C3M or D3M.
 - b) Equivalent.
- d. Dual Format Line Input Receptacles: Balanced input receptacle accepting both male gender "XLR"-type connectors and 1/4" TRS phone plugs.
 - 1) Acceptable Products:
 - a) Neutrik NCJ6FK-V.
 - b) Equivalent.
- e. Unbalanced Input and Output Receptacles: Two-conductor 1/4" phone jacks with type J-4 single-closed circuit schematic, molded plastic enclosure, and insulating molded nylon bushing.
 - 1) Acceptable Products:
 - a) Switchcraft N112A or NL112A as required.
 - b) Equivalent.

- f. Locking 1/4" Receptacles: Two- or three-conductor 1/4" phone jacks with locking tab to prevent accidental removal of plug.
 - 1) Acceptable Products:
 - a) Switchcraft E111L (2-cond.) or E112BL (3-cond.) as required.
 - b) Neutrik NJ3FP6C.
 - c) Equivalent.
 - g. Unbalanced Input and Output Receptacles: Female gender phono jacks (RCA jack) with closed circuit switching and non-grounding mount.
 - 1) Acceptable Products:
 - a) Switchcraft 3512.
 - b) Equivalent.
 - h. 1/8" Mini Stereo Phone Jack: Female gender, 3-conductor, open-circuit, enclosed, panel-mount, 1/8" phone jack.
 - 1) Acceptable Products:
 - a) RS 274-249.
 - b) Equivalent.
 - i. Multipin Receptacles:
 - 1) Multipin connectors compatible with microphone snakes supplied. Gender and channel capacity as shown on drawings and/or equipment schedule.
 - 2) Acceptable Products:
 - a) Whirlwind or Wireworks as required.
 - b) Approved equal.
2. Microphone and Line Connectors (Cable Mount):
- a. Balanced Input Connectors: female gender "XLR"-type connectors.
 - 1) Acceptable Products:
 - a) Switchcraft A3F.
 - b) Neutrik NC3FX.
 - b. Balanced Output Connectors: male gender "XLR" type connectors.
 - 1) Acceptable Products:
 - a) Switchcraft A3M.
 - b) Neutrik NC3MX.
 - c. 1/4" Phone Plug: Two- or three-conductor 1/4" phone jacks.
 - 1) Acceptable Products:
 - a) Switchcraft 184 (2-cond.) or 190 (3-cond.) as required.

b) Neutrik NP-2C (2-cond.) or NP-3C (3-cond) as required.

3. Loudspeaker Connectors and Receptacles (4 conductor):

a. General: Connector system specifically designed for high power loudspeaker signal distribution, with twist type locking device. Contacts nickel-gold alloy, 250 VAC, 30 amps continuous per contact.

b. Cable Connectors: Four contacts, wired separately per manufacturer's recommendation for bi-amplified applications, or with pins 1+ and 1- (pins 2+ and 2- not used) for single channel applications. Cable strain-relieved with chuck type retainer for cable diameters 5-15mm (.2-.6 inch). Cable conductors attached with screws (not soldered) to facilitate field repair. Cable conductor size AWG #10 maximum. Each pair for extension cables supplied complete with one in-line coupler to permit cable linking.

1) Acceptable Product:

a) Neutrik "SPEAKON" Model NL4FC with NL4MM coupler.

b) Wall or Panel Receptacles: Airtight connector compatible with above cable connectors, size 26mm W x 3mm H. Contacts wired with Faston connectors (not soldered).

2) Acceptable Product:

a) Neutrik "SPEAKON" Model NL4MP with Faston connectors.

4. Video Receptacles:

a. Insulated, feed-through BNC panel jack with beryllium copper outer conductor spring for use with RG-59/U-type cables.

b. Cable termination: BNC.

c. Acceptable Products:

1) Trompeter UBJ28.

2) Kings KC-99-54.

3) ITT Pomona 3846.

4) Canare BCJ-JR with IU-7/16 panel isolation bushing.

5. Recessed Video Receptacles:

a. Insulated, feed-through BNC panel jack in recessed housing to resist damage to connector.

b. Impedance: 75 ohms.

c. Cable Termination: BNC

d. Acceptable Products:

1) Canare BCJ-JRU.

6. BNC Video Cable Connectors:
 - a. BNC type for terminating video cable in conduit or video extension cables. Crimp connector with beryllium copper outer conductor spring and captive center pin, exceeding MIL-C-39012,A.
 - b. For Belden 8281 type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-299 (use KTH-1000 crimp tool, KTH-2012 die, and KTJ-43 and KTD-30 trim jigs).
 - b) Belden BNC0081 (use 9CRT012 crimp die).
 - c) Trompeter UPL-220-016.
 - c. For Belden 8281A type cable.
 - 1) Acceptable Products:
 - a) Kings 755-48-9 (use KTH-1000 tool, KTH-2178 die, and KTJ-43 and KTD-406 trim jigs).
 - b) Belden BNC0082 (use 9CRT078 crimp die).
 - d. For Belden 8279 type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-397 (use KTH-6000 crimp tool, KTH-6029 die, and KTJ-134 and KTD-26 trim jigs).
 - b) Belden BNC0079 (use 9CRT026 crimp die).
 - c) Trompeter UPL-220-019.
 - e. For RG 59/U type cable.
 - 1) Acceptable Products:
 - a) Kings KC-59-294.
 - b) Belden BNC0041 (use 9CRT0022 crimp die).
 - c) Trompeter UPL-220-013.
 - d) Canare BCP-C4 with one TC-0 crimp tool and TC-D-4C die.
 - f. For Belden 1505A type cable.
 - 1) Acceptable Products:
 - a) Kings 2025-51-9.
 - b) Trompeter UPL-220-014.
 - g. For Belden 1506A type cable.
 - 1) Acceptable Products:
 - a) Kings 2025-53-9.
 - b) Trompeter UPL-220-023.

7. RCA type connector for RG-59/U Type Video Cables:
 - a. 75 Ohm true impedance matched RCA type connector.
 - b. Crimps to any RG-59 type cable.
 - c. VSWR 1.1 or less to 200 MHz.
 - d. Fully captive gold plated center pin.
 - e. Nickel plated brass body with Beryllium copper outer contacts.
 - f. Acceptable Products:
 - 1) Canare RP-C4 series with TC-1 Crimp tool and TCD-series crimp die.

8. RJ-45 type connector for control:
 - a. Panel mount RJ-45 connector in color selected by Design Professional.
 - b. Meets or exceeds CAT5E specifications.
 - c. Acceptable Products:
 - 1) Hubbell HD5EB6.
 - 2) Panduit Powersum Series.
 - 3) Leviton 56108 Series.

9. RF Plug connector:
 - a. 75 Ohm RJ-6 compression type connector.
 - b. Crimps to specified RG-6 cable.
 - c. Acceptable Products:
 - 1) Gilbert UltraSeal Series.
 - 2) Thomas & Betts (LRC) Snap-N-Seal Series.
 - 3) Blonder Tongue equivalent.

Part 3 Execution

3.1 General

- A. All types of equipment installed by competent workers at locations shown on the drawings in strict accordance with approved shop drawings and manufacturer's instructions.
- B. All delivered equipment, except portable equipment, firmly fastened or held in place. "Delivered equipment" includes loudspeakers, enclosures, amplifiers, cables, etc. Apply a minimum safety factor of four (4) times the load for all equipment fastenings and supports.
- C. Take necessary precautions to prevent and guard against electro-magnetic and electro-static hum and to install the equipment to provide safety for the operator.
- D. Protect all equipment, including patch panels, connectors, receptacles, racks, consoles, and video projectors, from construction dust and debris until final acceptance of the system.

3.2 Integration/Installation

A. Conformance to Existing Standards:

1. Wherever possible provide equipment, finishes, and interfaces similar in nature to systems already in use by the Owner. Provide uniform functionality and operation to enhance ease of use and minimize instruction. Provide uniform finish and equipment to enhance the aesthetic unity of systems facility wide, and to improve end-user familiarity with equipment.

B. Labels:

1. Dry transfer, "Dymo", or other types of adhesive labels are not acceptable.
2. Except where otherwise specified, label as shown on drawings each item of rack-mounted equipment and all switches, controls, and receptacles.
3. Switch and Control Panels: Constructed of engraved and filled anodized aluminum plates. Minimum 1/8" plate thickness. Dry transfer or other types of adhesive labels not acceptable.
4. Rack-Mounted Equipment: Labels constructed of engraved and filled plastic laminate engraving stock. Designate function and input and output line(s) or loudspeaker(s) served by labeled equipment. Key all designations to system functional and patch panel diagrams. Where possible, mount labels on blank panel directly above corresponding component. For modular equipment, provide label on inside of mainframe door identifying type of module for each slot (unless there is only one type) and gain setting as established at final checkout.
5. Identification Panel: See drawings for layout and nomenclature. AV Contractor is responsible for completing all bracketed items with the appropriate project-specific information.
6. Branding and Recognition: Identification of the contractor, or use of contractor logos or similar "trademarks" or "signatures" (including but not limited to touchpanel graphics and color schemes, silk-screened or engraved corporate logos, copyrighted fonts, and/or custom emblazoned panels) is strictly forbidden except where explicitly indicated within the bid documents. Any unauthorized use of these marks will be rejected.
7. Receptacles: Engrave and fill receptacle label directly on mounting plate as indicated on drawings.
8. Identify all wires and cables at every termination and connection point with the specified cable markers. Use a numbering scheme that identifies all cables terminating at patch panel jacks with the patch bay row and jack designation; use A, B, and C suffixes to distinguish multiple cables terminating at the same jack.
9. Identify switches, relays, terminal blocks, etc., with reference numbers keyed to the as-built wiring diagrams.

10. Room numbers appear on the contract documents for reference only. All labels shall reflect the Owner's final room designations.
11. All labels and legends shall be as approved on shop drawings.

C. Microphone Equipment:

1. General:

- a. Excluding wireless microphones, each portable microphone provided with case, stand adapter and min. 15-ft. cable with attached XLR-type connector.

2. Wireless Microphone System:

a. General:

- 1) Verify that selected operating frequencies are free of interference from external sources.
- 2) Orient antennas as recommended by manufacturer. Locate in positions shown on drawings.
- 3) Terminate all unused RF inputs and outputs.
- 4) Except for transmitter equipment, all equipment including preamps and active combiners requiring DC power provided with power supplies or powered by receivers (battery operation is not acceptable).
- 5) Do not mount antennas or attached preamplifiers directly to any metal structure. Mount at least 3 ft. from any large metal object.
- 6) Verify antennas receive maximum reception of signals. If little or no reception is available, relocate antennas to new location where adequate reception can be achieved. Coordinate new location with Design Professional and Consultant prior to relocating.

- b. Antenna Cables: Use specified low-loss 6/U (75 ohm) or 8/U (50 ohm) cable, impedance as required.

D. Amplifiers and Signal Processors:

1. Gain Control Security:

- a. Amplifiers and Signal Processing Equipment: Power amplifiers and signal processing equipment with front panel controls or power switches which are to be permanently adjusted (not normally adjusted by the operator), such as equalizers, distribution amplifiers, limiters, and audio delays, shall be furnished with security panels or subpanel mounted behind blank panels.

2. Overall Gain:

- a. Program control system and DSP to provide that the overall volume level will remain constant when switching between all audio sources.

E. Loudspeaker Equipment:

1. Coordinate installation of ceiling mounted loudspeakers with Design Professional and with other trades as required.
2. Provide loudspeaker mounting as shown or required on or by AV system drawings and this specification. Provide mounting details to Design Professional and Consultant prior to fabrication or installation. Mounting hardware to be ATM flyware or approved equal.
3. Provide and install safety cables to individually secure all components and mountings from independent suspension points.
4. Provide all rigging, structure and framework as required to properly support the loudspeakers. Provide shop drawings of proposed structure to Design Professional and Consultant for review prior to fabrication or installation. Obtain the stamp of a structural engineer registered in the same state as the construction site on shop drawings which depict loudspeaker cluster structure, rigging, framework and support system(s).
5. Provide all loudspeakers and associated loudspeaker hardware/equipment with finishes according to the Design Professional.
6. Verify locations, angles, and elevations for each speaker. Final locations may deviate from consultant's drawings to accommodate building circumstances not within control of Consultant or Contractor. Overall, aesthetics and the symmetry of the acoustical image should be preserved.
7. Verify all loudspeakers are delayed and equalized properly.

F. Ceiling Loudspeakers:

1. Locate loudspeakers as indicated on AV drawings.
2. Refer all questions and/or decisions regarding installation and finish methods to the Design Professional and Consultant.

G. Digital Processor Programming:

1. Program digital signal processors so that all amplifiers receive the appropriate signal, delay, equalizations, etc.
2. Provide presets for control by AV control system.
3. Provide functionality as described elsewhere in this specification and on the AV drawings.
 - a. As indicated elsewhere in the contract documents or as required.
 - b. Provide source code of processors configuration to Consultant for approval prior to programming system as directed under Section 1.5 – Submittals.

H. LCD Monitors:

1. Verifications:

- a. Verify locations and elevations shown on drawings.

2. Submittals:

- a. Provide detailed drawings of hardware.

3. Mounting:

- a. DO NOT DISCARD ANY MONITOR OR PROJECTOR SHIPPING OR PACKING MATERIALS. SHIPPING CONTAINERS AND MATERIALS SHOULD BE TURNED OVER TO OWNER.
- b. Install display mount at location and elevation indicated on approved shop drawings.
- c. Display mounts must meet all applicable safety and code requirements for wall mounted equipment.
- d. Fixed display mounts must be rigid and completely free of sway or rotation deviation.
- e. Wherever possible, minimize hardware and cables visible from audience seating and presenter area view points.
- f. Paint exposed mounting hardware to match room interior or as instructed by Design Professional.
- g. Where others provide structural mounts or millwork openings, verify correct positioning and dimensions before mounting projector. Provide written notification to the Owner or Design Professional of any discrepancies in mount positioning or stability deficiencies before projector installation.
- h. Provide all necessary display brackets, fittings, miscellaneous hardware and wireways.

4. Alignment, focus, and electronic testing:

- a. Adjust focus for distortion free text.
- b. Adjust gain and equalization for cable losses and to meet production requirements.
- c. For computer sources use VTG-300 or other approved test pattern generator.
- d. Verify color uniformity.

I. Ethernet Connectivity:

1. Coordinate Ethernet connectivity and IP addressing of AV equipment with Electrical Contractor and the Communications/Technology management of the facility.
2. Co-ordinate with end-user, and Communications/Technology management of the facility, on POP-3 email notification of system service issues where desired and/or where possible.

J. Control Equipment:

1. Programming Rights:

- a. Provide all Control System Programming to the end users upon completion and approval of system installation and integration.
- b. Freely share programming graphics and blocks with the owner to ensure consistent facility-wide standards and system support. Project specific programming and graphics are not the exclusive property of the AV system contractor or programmer.

2. Audiovisual Control System:

- a. Carefully coordinate the dimensions and mounting conditions of all items with manufacturer and with Owner or Design Professional.
- b. Provide all required cable, relays, and miscellaneous hardware to interface the audiovisual control system with projection screens and other equipment indicated.
- c. Install all components so as to use the maximum amount of any tally signals provided by the controlled equipment.
- d. Provide sketches for all panels with shop submittals and prior to programming.
- e. Verify font size and type with button sizes and styles.
- f. Enhancements and/or augmentation of control parameters is acceptable with approval.
- g. Program control system to recover from any loss of power without operator or contractor service.
- h. Provide all hardware, software and programming required for a complete and fully functional system as intended and identified in this specification.

3. Audiovisual Control System Programming:

- a. Refer to system drawings for logic, layout and other programming routines.
- b. Program system as indicated below and on system drawings so that all devices are controlled in a logical manner, and to take full benefit of the capabilities of the Control System.
- c. Notify the consultant of any software/hardware conflicts and provide written documentation from the control system manufacturer of any software or hardware incompatibilities or interface restrictions.
- d. Defer to the Consultant's judgment for all alternative user-interface solutions.
- e. Button text to be provided as shown on drawings.
- f. LED indicators to indicate current function status.

4. Ethernet/IP/Local Area Network Accessibility and Control:

- a. Coordinate Ethernet connectivity and IP addressing of control devices with Electrical Contractor and the Communications/Technology management of the facility.

- b. Provide end-user with remote control and management interfacing via Local Area Network access from a PC to any IP addressed control devices.
 - c. Co-ordinate with end-user, and Communications/Technology management of the facility, on POP-3 email notification of system service issues where desired and/or where possible.
5. Local Area Network Management Programming:
- a. Room by room AV system control:
 - 1) Use included Ethernet connectivity hardware of control systems.
 - 2) For “Crestron” format systems: Provide additional “Enterprise” software for implementation of large-scale systems only where the quantity of IP controllable hardware exceeds 25 facility-wide AND no previous large-scale management software exists. Coordinate with consultant and Communications/Technology management of the facility to verify large-scale systems management needs. New control programming should be integrated with any pre-existing and compatible facility-wide IP control management software.
 - 3) For “AMX” format systems: Provide site/system license for each additional (discreet) IP controllable system. Coordinate with consultant and Communications/Technology management of the facility to verify large-scale systems management parameters. New control programming should be integrated with any pre-existing and compatible facility-wide IP control management software.
 - 4) Remote site portal replicates the appearance and function of installed button control panels and touch-screen hardware where applicable.
 - 5) Can be launched locally from designated AV technician computer as stand-alone “.exe” Windows-based executable file.
 - b. Remote System Status Monitoring and Management Programming:
 - 1) Use included software and Ethernet connectivity hardware of control systems.
 - 2) Provide system wide and room specific monitoring and management including:
 - a) System power status including power status of rack-mounted AV equipment and ceiling mounted display equipment.
 - b) Projector Lamp status, including estimated lamp life.
 - c) Room activity and system shut-down scheduling.
 - c. POP-3 Email Notification Programming and Set-up:
 - 1) Provides service issue notification via pre-programmed email messages to designated service accounts ONLY if requested by end-user AV support technicians and ONLY if control system includes POP-3 mail server.
 - 2) Co-ordinate with AV Consultant, AV support staff, and Communications/Technology management of the facility to determine proper conditions and destinations for email service.

6. LCD Touch-Panels:

a. General:

- 1) Owners with prior touch-panel operated systems: Panel layouts are to be programmed according to the Owner's established layout standards and shall include a graphic layout and require approval before installation.
- 2) Owners without any prior touch-panel systems: Panel layouts are to be programmed for real-time demonstration and testing with end-user prior to control system installation. Help the end-user develop logical system behavior and page layouts, and incorporate any trademarks or institutional graphics into control pages as directed.

b. Button Interface:

- 1) Utilize visual cues to indicate button functions and states: Programmer should adorn buttons with both a unique graphic symbol and text designation wherever possible. 3D buttons verify selection by changing to a virtual "depressed" state, indicators change color or intensity when engaged, etc.
- 2) Optimize icons and pages for aesthetics: Graphics should be higher than 8-bit, with alpha channels where appropriate. Programmer should limit text to three unique fonts or fewer. Consult a color wheel to minimize discordant color schemes, and maintain a uniform layout throughout all pages.
- 3) Optimize control logic and layout for usability: Minimize the use of industry specific language (i.e. "Balanced input 3b" instead of "Lectern Mic") and avoid confusing or limiting macros (i.e. the screen automatically comes down when the user intends to use the DVD player to play a Compact Disc). Optimize the Graphical User Interface for logical and intuitive operation by first-time users.

K. Racks, Cables, Connectors, and Miscellaneous Equipment:

1. Wiring and Interconnections:

a. General:

- 1) Exercise care in wiring to avoid damage to cables and equipment.
- 2) Make all joints and connections with rosin-core solder or approved mechanical connectors, except mechanical connectors are NOT acceptable on microphone lines. Connections to transformer leads for distributed loudspeakers may be made using properly-sized wire nuts or nylon-insulated pigtail crimp connectors such as Waldom CE series. Wire nuts are not acceptable except at individual loudspeakers.
- 3) All connections to screw-type terminals shall be made using spade lugs. Bare or tinned wire is not acceptable.
- 4) All connections to lugless compression-type screw terminals shall be made using bare wire only. Do not tin wire.
- 5) All wiring executed in strict adherence to standard broadcast practices. This includes:
 - a) Dress cables in conveniently sized bundles, combed into parallel runs, either laced or banded with sufficient plastic ties.

- b) For equipment mounted on glides, or otherwise requiring servicing from the front of the rack incorporate a cable "service loop" of sufficient length to permit the equipment to be pulled forward from the rack for servicing.
 - c) Support cables and bundles with sufficient plastic ties and support bars to ensure that no strain is placed on any connections or connectors.
 - d) Organize cables and cable bundles behind patch bays to permit easy access to the patch panels to add or remove cables.
 - e) Place cable markers 3"-5" back from video connectors to permit easy viewing. Do not bind markers into cable bundles.
- 6) All audio signal lines carried by twisted-pair cable and switched with two poles per line unless noted otherwise. Do not tie one side of audio line to other audio lines.
- b. Grounding:
- 1) Ground equipment, racks, and audio line shields to independent audio system ground ONLY as shown on drawings. If not shown on drawings, ground case of power striplines in equipment racks to the racks and directly to isolated ground buss in the power panel or to power system ground at the building AC service entry only.
 - 2) Ground all conduits ONLY to power system ground. Insulate all conduits and electrical boxes from sound system, including equipment racks and audio system ground.
 - 3) Insulate all conductors in conduit, including shields, from the conduit, back boxes, and from each other for the entire conduit length.
- c. Equipment Racks:
- 1) Install equipment in racks to permit access to all equipment for service. Transformers, relays, terminal blocks, etc., mounted in rear of racks behind other equipment shall not prevent access to equipment connections or shall be mounted on hinged panels to permit access.
 - 2) Wire all racks completely in the shop. No internal rack wiring to be done on the job site.
 - 3) Install equipment in racks with ventilating panels as required to provide adequate ventilation and according to equipment manufacturer's recommendations.
 - 4) Connect all microphone, DC control, and line level cables to equipment racks via specified audio terminal blocks. External lines to patch bay terminated directly on patch bay terminal blocks.
 - 5) Connect loudspeaker lines with equipment racks via specified terminal blocks. Use spade lugs if barrier strips are used. Do not buss commons together. Do not ground.
 - 6) No signal or control lines shall leave a rack without connecting via terminal blocks.
 - 7) Provide unused panel space with blank or ventilating panels as shown on drawings.
 - 8) Locate free-standing racks as indicated and to provide access to rear.
- d. Conduit:
- 1) Run all lines in metallic conduit or wireways unless otherwise indicated. Run microphone level, line level, loudspeaker level, and DC control wiring each in separate conduit.

- 2) Do not locate AC power lines in conduit containing audio or video lines.
 - 3) Do not splice lines in conduit.
- e. Exposed Cables:
- 1) Line level or mic level lines exposed above countertops (such as those lines serving mixing consoles, program source equipment, etc.) shall be rubber-jacketed, AWG #20 two conductor with braided shield such as Belden 8412 or equivalent. Plastic or vinyl jacketed cables are not acceptable.
- f. Receptacles:
- 1) Provide finish sample for approval by Design Professional.
 - 2) Wall-mounted receptacles in metal boxes at building standard receptacle height unless otherwise indicated.
 - 3) Floor-mounted receptacles in flush floor boxes with flush lids.
- g. Unbalanced Receptacles:
- 1) Install 1/4" phone or RCA jacks to mounting plates with insulating washer and sleeve to electrically isolate the jack from the electrical box and conduit.
- h. Video Receptacles:
- 1) Install feed-through BNC receptacles to mounting plates with insulating washer and sleeve to electrically isolate the receptacle from the electrical box and conduit.
 - 2) Punch receptacles with "D" hole to prevent receptacle rotation within hole.
- i. Loudspeaker Wiring:
- 1) Loudspeaker lines installed outside of conduit use UL listed Teflon cable. Lines installed loosely or otherwise on top of ceiling tiles, ductwork, etc., are NOT ACCEPTABLE.

3.3 System Performance Tests And Adjustments

- A. Test all equipment to verify conformance with manufacturer's performance specifications and with this specification.
- B. Audio Systems:
1. Absolute Impedance:
 - a. Set any loudspeaker level controls at zero attenuation. Measure absolute impedance value of each loudspeaker line at 250, 1000, and 4000 Hz, without amplifier connected but with all loudspeakers connected. Impedance shall be at least 90% of rated load impedance of respective amplifier. Check resistance of lines to all loudspeaker and microphone receptacles, with receptacles open and short-circuited.

2. Hum and Noise Level:
 - a. Adjust gain controls for optimum signal-to-noise ratio and full amplifier output with -55 dBm level at a microphone input and 0 dBm at line-level input.
 - b. Without changing gain, terminate microphone and line-level inputs with shielded resistors of 150 and 600 ohms, respectively.
 - c. Measure overall hum and noise level at each power amplifier output for each input channel. Level shall be at least 80 dB below rated power output of amplifier over a bandwidth of 20-20,000 Hz.
3. Electrical Distortion:
 - a. Load power amplifiers with resistors matching nominal impedance of output terminals used in system in place of actual loudspeaker loads.
 - b. Adjust gain controls as for hum and noise level tests.
 - c. Apply 1000 Hz sine-wave signal from an oscillator having less than 0.1% total harmonic distortion to each microphone and line-level input at level required to produce measured full amplifier output.
 - d. Distortion shall measure less than 0.1%.
4. Parasitic Oscillation and RF Pickup:
 - a. Set up system for each specified mode of operation.
 - b. Use 50 - 100 MHz bandwidth oscilloscope and loudspeaker monitoring.
 - c. Check to ensure that system is free of spurious oscillation and RF pickup in the absence of any input signal and also with system driven momentarily to full output at 160 Hz.
5. Buzzes, Rattles, Distortion:
 - a. Apply high-quality music signal to the system. Adjust the system for frequent peaks at its specified maximum sound pressure level.
 - b. Apply sine-wave sweep from 50-50,000 Hz at 6 dB below full amplifier power.
 - c. In both cases, listen carefully for buzzes, rattles, and objectionable distortion.
 - d. Correct all causes of such defects. If cause is outside the system, promptly notify the Owner or Owner's authorized representative and his Consultant, indicating cause and suggested corrective procedures.
6. Level Balance: Adjust level controls for all items of similar equipment for identical measured voltage gain.

7. Measure system acoustical performance using a sound level meter set for "slow" meter damping except as otherwise noted, and flat response with random incidence at a height of 4 to 5 feet. All interior finishes and furnishings shall be in place, and system gain shall be adjusted to provide levels of 70 to 80 dB and at least 10 dB above background noise at the measuring locations for these tests, except as otherwise noted. Include the following tests and adjustments:
 - a. Frequency Response:
 - 1) Measure loudspeaker frequency response with all control equalization set for flat response, using 1/3-octave bands of filtered pink noise centered on ANSI preferred frequencies, or broadband calibrated pink noise measured in 1/3-octave bands using a calibrated real-time analyzer.
 - 2) Adjust equalization to provide average system response within ± 3 dB of a response (0 dB) which is flat from 63-2500 Hz and slopes uniformly from 0 dB at 2500 Hz to -5 dB at 10,000 Hz.
 - b. Uniformity of Coverage:
 - 1) Use 4000 Hz octave band of random noise as test signal output to loudspeakers.
 - 2) Lateral Uniformity: ± 2 dB at all positions equidistant from front of hall.
 - 3) Front-to-Back Uniformity: Decreasing linearly within ± 2 dB from 0 dB at front of hall to -6 dB at rear as measured on the hall center line.
 - c. Maximum Output Level:
 - 1) Measure with standard "fast" meter damping.
 - 2) Loudspeaker Cluster: Capable of providing 95 dB SPL in the audience area on axis of any high-frequency horn and employing wideband recorded music as a test signal.
 - 3) Distributed Loudspeaker Systems: Capable of providing 95 dB SPL on axis of any loudspeaker and using wideband recorded music as a test signal.
- C. Video Systems: Test the video system following the approved Proof-of-Performance Test Plan to verify that it meets these minimum performance requirements. Video tape machines are exempt from these system requirements.
 1. Video Standards:
 - a. Frequency Response: ± 0.5 dB, 60 to 4.18 MHz.
 - b. Crosstalk: -40 dB at 3.58 MHz.
 - c. S/N Ratio: 45 dB, DC to 4.18 MHz, unweighted, peak to RMS.
 - d. Hum: <10 mV peak to peak.
 - e. Line and Field Tilt: 2% with 60 Hz square wave.
 - f. Differential Gain: 1% at 3.58 MHz, 10-90% APL.
 - g. Differential Phase: $\pm 1^\circ$ at 3.58 MHz, 10-90% APL.
 - h. Envelope Delay: ± 0.1 microseconds, 0.2 to 2.1 MHz; ± 0.05 microseconds at 3.58 MHz.

- i. Color Production: Primary and Complementary Colors (R, G, B, Cy, Yl, Mg) at 75% saturation within inner 50% of the of inner boxes ($\pm 2.5^\circ$) when viewed on vectorscope.
- j. Signal Levels: 1 V p-p, ± 1 IRE, at 100% peak white color bar.

2. Audio Standards:

- a. Frequency Response: ± 1 dB, 30-15,000 Hz.
- b. Hum and Noise: -80 dBu, 30-15,000 Hz, unweighted.
- c. Distortion: 0.25% THD, 30-15,000 Hz.
- d. Signal Levels: +4dBu.

D. Remote Control Systems:

- 1. Test each function of each control station to verify proper operation and that each illuminated switch and indicator operates properly when the associated function is selected. Provide written report identifying each function and verifying operation of all functions on all panels in the following manner:

Room	Location	Panel Type	Screen	Button	Operation
Conf. Rm. 148	Lectern	TPS-6000	Slide Ctl.	Power ON/OFF	OK
"	"	"	"	FWD	OK
"	"	"	"	REV	OK
"	"	"	"	Focus In	OK

E. Test Reports and Certificates:

- 1. Submit results of all tests and adjustments conducted above and certification that the installation is complete and ready for checkout as specified under SUBMITTALS in PART 1 - GENERAL.

3.4 Final Adjustments And Acceptance Tests

- A. Upon approval of the contractor's test report, and at a time set by the Owner or Owner's authorized representative, assist the Consultant(s) in performing final system adjustments and acceptance tests. Provide all labor, material, tools, and measurement equipment necessary for these tests and adjustments, including the test equipment and material specified in Article 1.1, except as otherwise specified.
- B. The contractor's representatives assisting in performance of these tests shall be thoroughly familiar with all details of the system, and shall include the field supervisor in overall charge during the course of the installation work.

- C. Budget 16 working hours for the performance of these tests and adjustments. If final acceptance is delayed beyond this period because of installation not in accordance with these specifications, pay for all additional time and expenses of Consultant(s) during any resultant extension of the acceptance testing period.
- D. Acceptance tests may include speech intelligibility surveys and subjective evaluations by observers listening at various positions under various operating conditions, using speech, music, and live or recorded effects material.
- E. Measurement of frequency response, distortion, noise, or other characteristics may be performed on any item or group of items deemed necessary to determine conformity with specifications.
- F. Adjustments: Adjust the system as instructed by the Consultant. Adjustments may be required to any portion of the system including:
 - 1. Equalization and level balance.
 - 2. Changes to or installation of resistive pads and R/C networks.
 - 3. Timing and programming of the audiovisual control system.

3.5 Training

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. During tests and adjustments, permit the Owner's personnel to observe. When feasible explain the significance of each test.
- C. After the completion of FINAL ADJUSTMENTS AND ACCEPTANCE TESTS, provide on-site training to the end-user to instruct them on the proper use of each system, including:
 - 1. Conduct a separate training session for each discreet system type installed.
 - 2. Explain operation of control systems and overall function of installed systems to staff selected by the Owner as "requiring general instruction".
 - 3. Explain operation of control systems, set-up and operation of individual pieces of equipment (including booth equipment), functions of overall systems, and rudimentary service guidelines to staff selected by the Owner as "requiring technician level instruction".
 - 4. After successful training, a repair sequence (schedule of responsibility, response tree, etc.) should be established with any "technician level" staff, designated by the Owner as responsible for audiovisual systems operation and maintenance, to expedite service calls.

END

Part 1 General

1.1 Summary (Non-inclusive)

A. Section Includes: Components and subsystems indicated for a complete and operable Security System as indicated and specified and as follows:

1. Security System shall include the following sub-systems:
 - a. Access Control System.
 - b. Internet Protocol Video Surveillance System (IPVS).
 - c. Intercom System.
2. In order to provide proper coordination, uniform quality and system integrity, equipment and installation specified within this Section shall be provided and installed by a single Contractor having been involved with sale, installation and servicing of similar systems of size, scope and complexity of this Project for past five (5) years.
3. At time of bidding Contractor shall submit a list of manufacturers' equipment intended for use for each sub-system specified for this Project.
4. Systems which integrate security with fire alarm or facility management system functions are not acceptable.

1.2 Related Work Specified Elsewhere (Non-inclusive)

- A. Applicable Sections: Division 01.
- B. Finish (Door) Hardware: Division 08 (Contract 2).
- C. Sleeves, Inserts and Openings for Electrical Work: Division 26 (Contract 2).
- D. Conduit: Division 26 (Contract 2).
- E. Wires and Cables: Division 26 (Contract 2).
- F. Junction and Pull Boxes: Division 26 (Contract 2).
- G. Outlet Boxes: Division 26 (Contract 2).

1.3 Submittals

- A. Submit per the requirements of Division 01.

- B. All Drawings and Product Data required for the security system shall be provided in one package. Drawings submitted without Product Data or Data submitted without Drawings will be rejected without review. Failure to provide complete documentation as indicated shall be cause for immediate rejection without comment.
- C. Shop Drawings: To Design Professional for approval.
1. Before construction related to this Project is started, the security system provider shall meet with the installing Electrical Contractor to develop Shop Drawings for the Project. Shop Drawings submitted to the Design Professional for approval shall include point-to-point wiring diagrams for each new component of the security systems specified in this Section. Point-to-point wiring diagrams shall detail each device location and all wire runs between the device, all other equipment and all proposed wire runs to central systems equipment. Shop Drawings shall detail all connections between all new and all existing equipment and devices. Point to point drawings shall consist of one of the two following methods:
 - a. Method No. 1: Computer generated floor plan drawings shall be provided for each area where work associated with this Project is occurring. The floor plan drawings shall detail each system device at its proposed location. Each device indicated on the floor plan drawings shall be assigned an identification number. This method would also include an accompanying riser diagram showing all new devices and all proposed wiring between devices. Devices on the riser drawing shall be keyed to the device locations and device identification numbers indicated on the floor plan drawings.
 - b. Method No. 2: Computer generated floor plan drawings shall be provided for each area where work associated with this Project is occurring. The floor plan drawings shall show each device location and on the same drawing, wiring that has been added to outline the proposed wiring that is planned for this Project.
 - c. Actual conduit and wire routing is not required to be detailed on point to point drawings.
 2. Security riser diagrams provided shall detail the number of Access Control Panels (ACPs), power supplies and other equipment at each associated ACP location. All riser drawings submitted shall also include all cabling, wiring and all components proposed to be provided for all security related equipment and shall detail the connections between new security related devices and the central Access Control and Security Monitoring System equipment.
 3. IPVS riser diagrams provided shall detail exact IPVS equipment and wiring at each IPVS component location. All IPVS related riser drawings submitted shall also include all cabling, wiring and all components proposed to be provided for head end IPVS equipment.
 4. Coordination Details: Show all details required to demonstrate that all related equipment and other related systems have been coordinated with Finish (Door) Hardware: Division 08 Contractor and shall properly function as a complete Security System.

5. Shop Drawings shall include a complete bill of materials for the Project. The bill of materials submitted shall identify exact model numbers and the quantity of devices provided for each device type planned for this Project.
- D. Product Data: To Design Professional for approval. This shall include a complete bill of materials for each system, data sheets on all systems and components, block diagrams of their inter-relationships, power and standby battery requirement calculations, and specific operational theories as they relate to Project Specifications. Manufacturer's product data sheets provided shall be clearly marked to indicate the exact product/device and model of the equipment being provided for this Project.
- E. Closeout Submittals:
1. Operation and Maintenance Manuals: As indicated.
 2. Warranty: As indicated.
 3. Service Contract: As indicated.
 4. Record Documents:
 - a. A separate set of Drawings shall be maintained during Construction Phase of this Project. These Drawings shall be kept neat and up to date and shall be used as the basis for Record Drawing Set.
 - b. Deliver Record Drawing documentation for all sub-systems of Security System before requesting Final Acceptance of system.
 - c. All original submittals shall be resubmitted. Resubmitted Drawings shall show actual installed wiring and labeling information and shall include any device or component changes made during Construction Phase of Project.
 - d. Testing documentation outlined in Specifications shall be submitted with Record Documents Package.
 - e. Manufacturer's published installation and instruction manuals for equipment shall also be included with Record Documents Package.
 - f. Submit Record Documents documentation in accordance with Division 01.

1.4 Quality Assurance

- A. Referenced Codes and Standards: Comply with the following in accordance with Division 01.
1. Factory Mutual Global (FMG)

Listing Requirements
 2. National Fire Protection Association (NFPA)

70 National Electrical Code
 3. Underwriters Laboratories, Inc. (UL)

Labeling and Listing Requirements for Security Use

1.5 Design and Performance Criteria

- A. General: All systems provided shall have a record of successful operation of not less than one (1) year on applications similar to this Project, unless otherwise indicated, and shall be specifically designed for security applications. Adaptation of equipment designed for other purposes are not acceptable.

Part 2 Products

2.1 Access Control System

- A. Approved Manufacturers, Special Requirements: The Access Control System shall be manufactured by Software House, AMAG Technology or Schneider Electric (formerly TAC Andover Controls) and shall integrate with the IVPS for alarming and camera call-ups. All new Access Control System devices and equipment installed as part of this Project shall be compatible with and will be connected to the system server via local area network. The existing card readers were manufactured by HID. All new card readers and cards provided shall be compatible with the existing readers and cards.
- B. Access Control and Security Monitoring System Server Hardware
 - 1. The Access Control and Security Monitoring System Server for this project shall be located in equipment rack in the MDF.
 - 2. Central System Hardware
 - a. System hardware for server shall be PC based.
 - b. The central computer provided with the system shall perform all functions and calculations associated with the control of the system.
 - c. Minimum system hardware requirements for each computer shall be as recommended by the system manufacturer.
 - d. Central computer shall contain a network interface card capable of supporting 1000 Base T Ethernet communications.
- C. Access Control and Security Monitoring System Server Software
 - 1. General: Server Software shall be Software House CCure 9000, AMAG Symmetry Enterprise or Andover Continuum.
 - a. System operating software for the server shall be designed as multi-operator and multi-tasking.
 - b. The software shall integrate with the IPVS software for map based camera call-ups and alarming functions.
 - c. Central server shall be designed to perform alarm history logging functions and individual reports based on any or all of the system database parameters.
 - d. Central system software for the server shall also be designed such that all alarm and trouble conditions are instantly and individually reported.
 - e. All system alarm and trouble conditions shall be reported in real time while any other system functions, such as generation of reports, are in progress or while operator input functions are occurring.

- f. Ethernet network communications between the server and each ACP and other components in the system shall be fully supervised and constantly tested for wiring faults and network communications failures.
 - g. System trouble conditions such as, but not limited to, communication failure to one or more ACPs, shall be displayed on all central system equipment and printed on system printer.
 - h. In the event of a loss of communications between the acting primary server and one or more system ACPs, the primary server shall continue to monitor the data communications lines and shall automatically return to the normal mode of operation, without operator intervention, when communications with the ACP or ACP(s) has been restored.
 - i. When communications have been restored, the server shall direct the affected ACP(s) to upload any system alarm or trouble conditions received during the non-communicating period.
 - j. Central system software shall be structured such that all device or building information displayed on system terminals or printed on the system printer is non-abbreviated, full-English type.
2. User Interface:
- a. The system shall provide the ability to assign multiple security levels for front-end system access. The levels shall vary from basic view-only capability, to full administrative functionality depending on the system access level and password. Individual security levels shall, as a minimum, (based on specific access levels) provide the ability to:
 - 1) Acknowledge system alarms
 - 2) Generate system reports
 - 3) Override door locking device states.
 - 4) Modify database entries
 - 5) Create and modify graphic displays
3. System Graphic Displays:
- a. Provide custom graphic displays which shall enable an operator to view and assess the status of all door hardware, including locks, readers, door contacts, etc. throughout the building. All graphic presentations shall provide the ability for the operator to return to the main administrative main menu display. Graphic displays shall include, but not be limited to:
 - 1) Main Menu: The main menu graphic shall contain active icons which, when selected, will lead to all building/site overview graphic displays within the system.
 - 2) A graphic display for every floor or location within the building which has access control equipment associated with it. Every display shall have detailed placement of all access control equipment. The display shall be based on the building's floor plan drawings, with animated active controls placed on its foreground.
 - 3) All access control equipment shall change its color based on its state, and include the ability to distinguish open and closed, as well as normal and alarm states.
 - 4) Several graphic displays shall be developed for each floor in the building, as required, in order to fit all information graphically within the individual display area. Every display shall have detailed and accurate placement of all access control equipment associated with the area.

4. Event Logging and Archiving:

- a. Activity Log: System software shall provide an activity log which shall store information regarding all system activity (events). The system shall provide the ability to search the activity log by types of activity, date ranges, personnel, hardware, status, etc. System activity logs shall include logging on and off functions, modifying system values, overriding system operations, modifying adding or deleting system objects and devices. All activity logs shall be available for viewing and printing.
- b. Error/Trouble Log: System software shall provide an error/trouble log which shall store information regarding all error/trouble events which occur within the system. The system shall provide the ability to search the error/trouble log by types of errors, times of errors, and cause of errors. All error/trouble logs shall be available for viewing and printing.
- c. Alarm Log: System software shall provide an alarm log which shall store information regarding all alarm events which occur within the system. The system shall provide the ability to search the alarm log by types and levels of alarms, times of alarm occurrences, personnel acknowledging alarms, etc. All alarm logs shall be available for viewing and printing.

5. Alarm Processing:

- a. Alarm processing software provided with the system shall contain a minimum of ten (10) user defined alarm priority levels, each with it's own definable colors, annunciation and output and routing parameters. System administrator level users shall be able to define a minimum of 1000 system alarm types, each of which may be assigned to any available alarm priority level.
- b. Any system device or object shall have the ability to be assigned multiple alarm types, based on tracking and performance requirements.
- c. The system shall provide an active alarms screen which shall display all currently active alarms. The active alarms screen shall automatically pop up upon the receipt of a new alarm.

6. Employee Badging System:

- a. Access Control system shall include an integrated digital photo identification and badging system.
- b. System shall integral to the access control software.
- c. Provide the ability to create custom card layouts for printing onto badges, duplicating the existing card layout.
- d. Badging system shall include a USB camera, tripod and badge printer. Badge printer shall be a Fargo DTC550 printer/encoder.

D. Client Workstation: Client Workstations shall be provided that shall be part of the access control system. Client workstation hardware shall be as recommended by the system manufacturer. In addition to the manufacturer's recommended system requirements, the client workstations shall support 4 RGB or DVI monitors. Four client workstations shall be provided. Coordinate the location of the workstations with the Owner.

E. Access Control Server: Server shall be provided that shall be part of the access control system. Server hardware shall be as recommended by the system manufacturer. One Access Control server shall be provided. Server shall be located in security equipment racks in the MDF.

F. Access Control Panels (ACPs):

1. Each ACP provided shall be microprocessor-based intelligent devices and shall be interconnected with the system server via local area network (LAN) as specified and indicated on system details.
2. Each ACP unit shall be housed in a common NEMA 1 enclosure with hinged door and key lock along with ACP modules. The mounting of exposed equipment directly to walls or backboards or the use of multiple enclosures is not acceptable.
3. ACPs shall control access to given areas of the facility by authorized cardholders. Each individual card number that is required to be used at the ACP shall be stored locally in the ACP database.
4. Each ACP within the system shall contain its own microprocessor, real-time clock, memory and other hardware required such that each ACP within the system shall process data received from connected ACPs and related input devices, and make output decisions based on the processed data. Systems which are designed to make access decisions at the server level for locally controlled functions in lieu of at the ACP level are not acceptable.
5. Adequately sized low voltage power supplies shall be provided at each location where combination ACP units are located. Power supplies shall be capable of providing power to all components of the ACP unit. All power supplies shall be configured for direct hardwired connection to a 120VAC circuit. Power supplies provided with electrical plugs or transformers designed for duplex receptacle mounting are not acceptable.
6. ACP shall contain 4MB of Random Access Memory and shall hold in memory a database of a minimum of 250,000 individual card numbers.
7. ACP shall activate door locks and other card reader related system outputs based on any or all of the following:
 - a. Time-of-day schedule.
 - b. Input switch or contact closure.
 - c. Access card presentation.
 - d. Manual command from a security workstation.
 - e. Alarm input from the building fire alarm system.
8. Under normal conditions, the ACP shall report all alarm or transaction information directly to the existing Card Access and Security Monitoring System server in an immediate real-time mode.
9. ACP shall include a buffer, which shall store a minimum of 1 million events for periods when the ACP loses communication with the security system server.
10. Provide with each ACP a network interface module for connection of the ACP to the local area network. Interface module shall be as recommended by the access control system manufacturer.

11. Whenever communications with the server has been resumed after a communications failure or power loss, ACP shall automatically transmit all alarm messages accumulated in its buffer to the server for processing.

G. Proximity Card Readers:

1. Card readers shall utilize dual smart card and proximity-type technologies. Card readers utilizing any other form of technology are not acceptable.
2. Proximity card-reading sensor shall be a sealed unit with no moving parts. Sensor shall connect to ACP via cable as specified by manufacturer. Sensor shall detect coded information on card and send information to ACP for processing. As a minimum, sensor shall detect command codes when a card is not less than 2 inches of its surface.
3. No special housing or treatment shall be required for outdoor use. Sensors shall be factory-sealed, weatherproof and vandal-resistant.
4. Card readers installed as part of this project shall be HID RP15 or RP40, as applicable for the installed location.
5. Back boxes for all card readers are provided under Contract 2.

H. Locks, Boosters and Electric Operators:

1. Electric locks, power boosters, electric door operators, request-to-exit devices and power transfer hinges are provided under Contract 2.
2. Security equipment supplier shall coordinate with hardware supplier required electric lock voltages and maximum current levels of all equipment requiring interface with Card Access and Security Monitoring System.
3. Power boosters supplied under Contract 2 shall be used to provide power for certain high-current door locks as indicated on floor plans. Location of each booster and interface requirements for all power boosters shall be coordinated with Finish Hardware Contractor.
4. It shall be responsibility of access system supplier to provide adequately-sized output relays and power supplies to meet all power booster, electric lock and motor-operated door requirements.

I. Magnetic Personnel Door Switches:

1. Door switches used on personnel doors are provided under Contract 2.

J. Request-To-Exit (REX):

1. Request-to-exit shall be provided by way of micro-switch integral to door hardware, provided under Contract 2, for certain facility doors as shown on Drawings and Details.

2. All devices shall be specifically designed for request to exit applications. Devices specifically designed for other security related applications shall be unacceptable.

K. System Cable: System Contractor shall provide cable recommended in writing by Card Access and Security Monitoring System manufacturer. No substitutions.

2.2 IP Video Surveillance System

A. Approved Manufacturers; only one approved manufacturer may be used for all cameras.

1. Panasonic.
2. Sony.
3. IqinVision.
4. Sennetech.

B. Interior Fixed Position Cameras:

1. Interior Fixed Cameras shall be native Internet Protocol (IP) Power over Ethernet (POE) type. Fixed cameras shall be VGA resolution (640x480) or Megapixel resolution (1280x960) as indicated on floor plans. Cameras shall be equipped with electronic sensitivity enhancement to increase clarity, color and detail. Each camera shall be provided with a varifocal, auto-iris lens with a range of 2.8mm to 9mm. Each camera shall operate on a voltage source from POE Ethernet switch. Interior fixed cameras shall be Panasonic model WV-NF302 (Megapixel fixed) or Panasonic model WV-NF284 (VGA fixed) or equivalent Sony model or equivalent IQinVision Model.

C. Interior PTZ Cameras:

1. Interior PTZ cameras shall be native IP POE type with VGA resolution (640x480) where indicated on floor plans. Cameras shall be equipped with electronic sensitivity enhancement to increase clarity, color and detail. Each camera shall be provided with an auto-iris lens with a range of 3.8mm to 83mm. Interior PTZ cameras shall have a zoom capability of 22x optical and 10x digital. Each camera shall operate on a voltage source from POE Ethernet switch. Interior PTZ cameras shall be Panasonic model WV-NS202A or equivalent Sony model or equivalent IQinVision Model.

D. Exterior PTZ Cameras:

1. Exterior PTZ cameras shall be native IP 24VAC type at VGA resolution (640x480) where indicated on floor plans. Cameras shall be equipped with electronic sensitivity enhancement to increase clarity, color and detail. Each camera shall be provided with an auto-iris lens with a range of 3.8mm to 114mm and exterior rated enclosure including heater and blower. Exterior PTZ cameras shall have a zoom capability of 30x optical and 10x digital. Exterior PTZ cameras shall be Panasonic model WV-NS202A or equivalent Sony model or equivalent IQinVision Model.

E. Camera Power Supplies:

1. Outdoor IP PTZ camera power supplies shall be outdoor rated 24VAC 100VA with a single fused 4A output.

F. Network Video Recorders (NVR):

1. Provide Network Video Recorders in the rack, where indicated. NVRs shall be designed to allow a minimum of 64 cameras per NVR. NVR Model shall be Panasonic Model WJ-ND400 with 120 terabyte total storage capacity. Provide rack mounting brackets, cables and other components required for each NVR.
2. NVR management software shall be provided to integrate all NVR's to operate as a single system. Management software shall be Panasonic WV-ASM100 and shall integrate with the access control system software allowing automated camera call-ups.
3. Rack and hardware to mount the NVRs and camera power supplies will be provided under Contract 2 in the MDF room where shown.

G. IPVS Client software shall be install on access control workstations and other as indicated on drawings. Provide software for 6 workstations.

H. IPVS Power Wiring and Video Ethernet Cable

1. IPVS power wiring and video Ethernet cabling will be provided under Contract 2.

I. Ethernet Video Encoders

1. Provide Video Ethernet Encoders and rack cages to allow customer's existing analog camera video signals to be recorded on NVR. Encoders shall provide RS-485 communication for existing PTZ control. PTZ control of existing analog cameras shall be connected and tested. Each encoder module shall encode 4 cameras. Provide (25) four channel encoders.
2. Encoders shall be Sony Model SNTEX154 (4) Channel Full Function Encoders. Rack cage shall be Sony model SNTRS3U.

J. Ethernet Video Decoders

1. Provide Video Ethernet decoders to allow up to 6 IP cameras to be shown on the large format displays. Decoders shall be wall mounted behind large format displays. Provide 4 decoders.
2. Decoders shall be Panasonic model WJ-GXD400.

K. Large Format Displays

1. Provide (4) 42" LCD or LED displays with the following requirements:
 - a. Display size: 42" diagonal
 - b. Number of Pixels: 1920 x 1080

- c. Video Input: 2x (BNC)
- d. DVI / HDMI: 1 / 1
- e. RGB Video: 1x 15pin mini D-sub

L. PTZ Control Converters

- 1. Provide (1) Sennetech SCT-100 series translator for each existing PTZ camera to be connected to NVR. Each translator shall be matched to each existing PTZ camera's protocol, enabling PTZ control through new NVR system.

2.3 Video Intercom System

- A. Provide video intercom master stations and video intercom remote stations at each location indicated. Each exterior video remote intercom station provided shall be weather proof and vandal resistant.
- B. Video remote intercom station shall be a single call button, hands free type device with color camera, and illumination LEDs.
- C. Each remote station shall be equipped with a vandal resistant, push button which shall automatically initiate a call and connect the caller to a video intercom master station located inside the building.
- D. Video intercom master and remote stations shall be manufactured by Aiphone. Master station shall be Model MK-1GD. Remote station shall be Model MK-DVF.
- E. Video intercom remote station output contacts shall be interconnected with the applicable card access door interface to allow the door to be unlocked by pressing the unlock button on the master.
- F. Provide a low voltage power supply and mounting hardware for each video intercom system.
- G. Video intercom system wiring shall be as recommended by Aiphone.

Part 3 Execution

3.1 Installation

- A. Provide complete installation of components, unless specified as being installed by Others, as follows:
 - 1. Provide, in accordance with each manufacturer's written instructions, installation, enclosures, conduit, wireways, junction boxes, wiring (including power wiring) and connections for all equipment and products specified in this Specification so that each system is complete and fully operational. All wiring for this Project shall be placed in conduit or MC cable, unless otherwise indicated.
 - 2. Install all IPVS and Security System related wiring in its own dedicated conduit. Color coding shall be used throughout. Low-voltage cable and wiring shall not be run in same conduit as power wiring.

3. Card access and security equipment including, but not limited to, ACPs, power supplies, transformers, security monitoring panels, relays and terminal strips shall be cabinet-mounted and shall be placed in MDF, IDF and other designated spaces as specified and indicated.
4. Wiring run within equipment enclosures, wireways or cabinets shall be neatly bundled and permanently attached to cabinet interior.
5. Suppliers of all equipment in this Section shall provide factory-trained field technicians to supervise final connections to all Central System equipment.
6. Card Access System supplier shall be responsible for initial and final generation, loading and checking of system database for entire card access and security monitoring system. This Work shall be performed with assistance of Owner's personnel who shall act in a coordinating role for Owner to assure that input parameters, names and information are as desired by Owner, and that information is correctly entered. Database loading and checking is defined as anything required to permit proper and complete system operation, including copying of the existing card database and photo images from the existing access control system. This development shall include, but not be limited to, card database entries, report formats, necessary program time and date interval programming, time codes, access levels, required sequences, and alarm outputs to system terminals and printers. Owner shall be notified thirty (30) days before date that input procedure is started.
7. IPVS System supplier shall be responsible for initial and final generation, loading and checking of IPVS DVR database. This Work shall also be performed with Owner's assistance specified above. This development shall include IPVS initial camera/monitor sequences, camera on-screen identification labeling and recording parameters.
8. All power, control and video work required by this Specification shall be done in accordance with Electrical: Division 26 requirements (issued in Contract 2).

3.2 System Labeling

- A. Provide labeling and numbering required for components and wiring.
- B. Each terminal block and terminal in each cabinet, rack or panel shall be individually labeled.
- C. Each wiring conductor connected to terminal blocks and each final device shall be individually labeled at each end. Each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be individually labeled with number or name of particular device at each end of cable or wiring group.
- D. Each wire conductor connected to a building-mounted device shall not be required to be numbered at device end if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

- E. Labels utilized for this Project shall be permanent type and shall be designed for intended use. Painting of numbers on panels or equipment is not acceptable.
- F. Use of embossed stick-on labels is not acceptable.

3.3 Testing

A. General System Testing:

1. Field tests shall be performed by factory-trained field technicians with Owner's Representatives in attendance.
2. Tests shall be performed on each circuit and component of each system.
3. On circuit where malfunctions occur, each component within malfunctioning circuit shall be repaired and thoroughly retested.
4. Each circuit or component that could possibly be related to malfunctioning circuit shall also be retested.
5. Submit field test report to the Owner's Representative at completion of each day's testing outlining tests performed and verifying completion or problems incurred with each test. Report shall be prepared by Security Contractor's technical personnel after each day's testing is complete.
6. Contractor shall continue test procedures until all devices and sequences are complete and functioning properly, and until all system testing has been completed.
7. Contractor shall demonstrate to Owner's Representative that all sequences operate correctly, and that all products, devices and system software operates as designed and specified.

3.4 Training And Acceptance

A. Operator Training:

1. Two (2) training sessions, each being a minimum of eight (8) hours in length, shall be held by Security Contractor at Project Site at mutually-agreed-upon times between Owner and Supplier. Training shall be individually provided for each system specified in this Specification Section. Manufacturers of each major system shall provide a trained representative to conduct actual training session(s) for each system. Owner shall notify Contractor at least two (2) weeks prior to agreed-upon training dates for each system of names of each attendee. Security Contractor shall provide each attendee with a Basic System Operations Manual for each installed system. Ten (10) operations manuals for each system shall be supplied at no additional cost.
2. All operator training shall be given in a formal classroom-type atmosphere. Field setup time, startup time and testing time shall not be considered as training time.

3. Provide two (2) additional eight (8) hour refresher operator training sessions three (3) months after system acceptance. Training format shall be similar to original training format.
 4. Provide operator training for ten (10) operators.
 5. Operator training shall be conducted at Project Site, unless another location is approved by Owner.
- B. Maintenance Technical Training:
1. Those maintenance personnel who shall be responsible for day-to-day maintenance of systems shall be provided with three (3) 8 hour on Project Site training sessions in addition to operator training specified above.
 2. Maintenance training shall include:
 - a. Physical layout of each piece of hardware related to each system.
 - b. Location of equipment enclosures, panels and major components of each system.
 - c. General replacement procedures for system components, such as card readers, magnetic status switches, local alarm devices, motion sensors, IPVS cameras and other similar type equipment.
 - d. Preventative maintenance procedures for each system.
 3. In addition to above training for general maintenance personnel, supplier of card access and security monitoring system and supplier of IPVS system shall provide formal technician-type training for each system for two (2) maintenance management personnel.
 4. Above technician-type training shall be conducted at individual manufacturer's facility and each training session shall be conducted over a minimum of a five (5) day period. This higher-level training shall be arranged to train attendees to repair and diagnose applicable security and IPVS system problems down to board level.
 5. On Project Site maintenance training session format shall be formal classroom-type as specified for operator training above.
 6. Items taught in operator training sessions shall not be repeated in on Project Site maintenance training sessions, unless specifically requested by Owner.
 7. Each system manufacturer/supplier shall provide each attendee with a maintenance manual for each installed system.
 8. Provide two (2) additional 8 hour refresher maintenance training sessions three (3) months after system acceptance for normal maintenance personnel. Training format shall be similar to that provided initially.
 9. Provide on Project Site technical training for six (6) maintenance personnel.
- C. System manufacturer's standard catalog cuts shall not be acceptable for use as training or Operation and Maintenance Manuals.

D. Contractor shall submit, at time of bidding, hourly cost of extra operator and technical training if desired by Owner.

3.5 Warranty And Service Contract

A. Contractor shall guarantee wiring and equipment for this system to be free of defects in workmanship and material for a period of one (1) year from Date of Acceptance by Owner. Beneficial use of any system shall not be considered as acceptance.

B. Furnish to Owner's Representative a Preventative Maintenance Contract covering system equipment four (4) hour guaranteed emergency response service and Scheduled Preventive Maintenance at time of system acceptance. Four (4) hour response time shall be provided during normal working hours only. During non-normal working hours, 12 hour response is acceptable. This contract shall be provided at no additional cost for first year.

C. Contractor shall, at time of bidding, include cost of a full-coverage Preventative Maintenance Contract similar to above Contract for second year.

END