

SECTION 27 40 00 - AUDIO-VIDEO COMMUNICATIONS

PART I - GENERAL

1.1 SUMMARY

- A. The work covered under this Section consists of furnishing all labor, material and services to install a complete audiovisual system as indicated on the Contract Documents.
- B. The scope of work covered under this Section includes but is not limited to:
 - 1. Equipment and installation labor as noted on the Contract Documents for a fully functional system. Miscellaneous components, hardware, interconnections and terminations required for proper operation of all systems.
 - 2. All components or systems indicated on the Contract Documents.
 - 3. The Installing Contractor shall be responsible for the following:
 - a. Verification of accuracy and completeness of equipment lists, dimensions, mounting details and equipment compatibility
 - b. Accurate documentation of the system operation and installation.
 - c. One year warranty of the equipment and installation.
 - d. Test equipment, tools, ladders, lifts and scaffolding required for installation.
 - e. Daily and final cleanup of debris caused by installation.
 - f. Quality Control / Commissioning of system
 - g. End user training and training manuals

1.2 SYSTEM(S) DESCRIPTION *[by AE]*

1.3 INSTALLING CONTRACTOR

- A. Certification:
 - 1. The Installing Contractor shall have a current INFOCOMM's "Audio Visual Solutions Provider" (AVSP) certification. The certifications shall match the level and complexity of the scope of work as follows:
 - a. System Category One (\$10,000 to \$49,000)
 - (1) AVSP Sapphire status will be preferred as a minimum status for this work.
 - b. All Other System Categories
 - (1) AVSP Emerald status will be a minimum status for this work.

1.4 INSTALLING CONTRACTOR PERSONNEL QUALIFICATIONS

- A. Summary: The Installing Contractor shall assign at least one full-time employee to the work whose qualifications meet the following minimum requirements.
 - 1. On-Site AV Supervision
 - a. Certifications:
 - (1) Shall have a current INFOCOMM Certified Technology Specialist certification with an installation endorsement (CTS-I) in good standing
 - b. Qualifications:
 - (1) Shall be capable of supervising a turn-key audiovisual system installation including, but not limited to, all cabling, loudspeakers, projection equipment, mounting hardware and electrical components including the necessary

equipment, interconnections, transducers, labor, and services required to meet the functional requirement outlined in the Contract Documents.

- (2) Shall provide all quality control (QC) and safety inspections as needed throughout installation.
- (3) Shall conduct all AV system commissioning tests, and proof-of-performance testing/demonstration in accordance with the Contract Documents.

2. Other Installation Personnel:

a. Certification:

- (1) Must have a CTS certification
- (2) No more than four (4) CTS certified installers for every CTS-I certified installer on-site.

b. Qualifications:

- (1) Shall be capable of working within industry standards with minimal supervision. The work shall include, but is not limited to, cabling, loudspeakers, projection equipment, mounting hardware and electrical components including the necessary equipment, interconnections, and transducers and the downloading, or installation, of pre-developed control programs in the field.

3. On-Site Support Personnel:

a. Certification:

- (1) CTS Preferred

b. Qualifications:

- (1) Has a good general knowledge of AV installation procedures and standards, and must be trained in construction site safety. Performs support work under direct supervision of CTS and CTS-I installers.

4. AV Control Programmer: AV control and DSP programming for system equipment includes recommendations for control system features and functionality; input to AV system design; control system logic diagram, control system performance specification, block diagrams, control system program and user interface, system debug, program and source code and other system documentation as required.

a. Certification

- (1) Must have a CTS certification, CTS-I or CTS-D certification preferred
- (2) Individuals performing the AV control programming shall have manufacturer's control system programming training and certification for the specified AV control system
- (3) Individuals performing AV-DSP programming and setup shall have manufacturer's system programming training and certification from the manufacturer for specified equipment.

5. Commissioning Personnel

a. Shall have a current AQAV Certified Quality Technician (CQT) certification in good standing.

- (1) Qualifications: Shall be capable of performing commissioning tests during staging and final commissioning of the system according to the Av 9000: Quality management System For the Audio Visual Technology Industry.

6. Sub-contracting of AV work

a. Conditions: Sub-Contractors must conform to the same certification standards listed above, and have prior approval.

1.5 INSTALLING CONTRACTOR REGULATORY REQUIREMENTS

- A. All equipment and installations under this contract shall conform to the following:
 - 1. ANSI/NFPA 70 National Electrical Code.
 - 2. ANSI/IEEE C2 National Electrical Safety Code TIA/EIA Standards 568 A (including TSB 67), and 607.
 - 3. IEE/ANSI 142 1982 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 4. *ANSI/TIA-569B Commercial Building Standard for Telecommunications Pathways and Spaces*
 - 5. NFPA 72-2010; *National Fire Alarm and Signaling Code [intelligibility requirements]*
 - 6. *Illinois Accessibility Code*
- B. Refer to *U of I Facilities Standards* for regulations and requirements.

1.6 INSTALLING CONTRACTOR REFERENCES/GUIDES

- A. Infocomm International, (2009) *AV Installation Handbook* (2nd ed.)
- B. Giddings, P. (1990). *Audio Systems Design and Installation*. Boston: Focal Press.
- C. AQAV, (2015) *AV 9000:2015 Quality management System for the Audio Visual Technology Industry*.
- D. ANSI/INFOCOMM 1M-2009, *Audio Coverage Uniformity in Enclosed Listening Areas*
- E. ANSI/INFOCOMM, *Networked AV Systems*

1.7 WORK PRODUCT OWNERSHIP

- A. Throughout the course of the project, all supporting documentation, work-in-progress, programed source code and software, written and electronic files, including all documentation and software necessary to edit and adapt the system, shall remain the property of the University and shall be provided to the University upon project completion and/or at any time during the course of a project upon request in an unsecured, unencrypted and easily modifiable format as prescribed by the University.
 - 1. All deliverables to be supplied to the University on compact disc media, and/or printed materials when requested
- B. Software – Control System, DSP, and All Other Applicable Equipment
 - 1. The software developer shall retain intellectual property rights to the operation software. The Owner shall be granted a license in perpetuity for use. The following requirements shall apply.
 - a. All source code becomes the exclusive property of The Owner.
 - b. All source code changes must be fully documented.
 - c. All custom programs for remote control system touch panels, and other programmed devices, shall become the property of the Owner and shall be submitted with the final systems documentation, and/or as requested in the DVD/CD-ROM and USB solid state media.
 - d. Subsequent to system certification, source code changes and/or additional programming, whether requested by the Owner or performed by the Installing Contractor, will be warranted by the Installing Contractor for a period of one (1) year, with the Installing Contractor responsible for the diagnosis and repair.
 - e. The vendor shall ensure that the current program is saved to CD-ROM and/or USB-solid state media, and backed up on electronic hard-disc/server.

- f. No program resident in a control system shall be overwritten until a back-up of the resident program is made.
 - g. All documentation, not residing in the code, must be provided on CD-ROM and/or USB-solid state media in Adobe PDF and Microsoft Office format.
2. The Installing Contractor shall also offer an annual "Software Maintenance" contract.
- A. This shall cover all software provided as part of this system and/or written for this system, and shall include both routine upgrades to applications and operating systems, as well as any modifications to software that may be required by Any Company.
 - B. The Software Maintenance contract shall commence immediately after expiration of the warranty period, and continue for three (3) years.
3. Written Release:
- A. A written release will be given by the Installing Contractor for all control programming done by the Installing Contractor's personnel or sub-contractors. The release shall acknowledge the University's ownership and right to modify programming directly, or to have the programming modified by others on the University's behalf.
 - B. A CD shall be supplied with the written release that includes the program and source code for the system in an unencrypted format.

1.8 CONTRACTOR SUBMITTALS

- A. Prior to fabrication, the Contractor shall submit to the Consultant and CCME, for approval, any custom designs pertaining to the systems. Contractor is to provide six (6) sets of all documentation. Drawing submittals shall be submitted electronically on CD-ROM, DVD-ROM or USB-solid state media. These designs include, but are not limited to, the following:
 - 1. Complete system construction and point to point wiring schematic drawings, including all component values, and showing complete letter and number identification of all wire and cable as well as jacks, terminals and connectors. All connections types are to be shown.
 - 2. Provide ~~hard~~ technical specification details (cut sheets) on all equipment required to complete this project.
 - 3. All control system pages, both touch panel based and control computer based along with UofI exhibit 27 40 00-15 located at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>.
 - 4. All control system front panel layouts, where applicable.
 - 5. All panels, plates, and designation strips, including details relating Terminology, engraving finish and color.
 - 6. All custom designed consoles, tables, carts, support bases, and shelves. Schematic drawings of all custom components, assemblies, and circuitry, including wall and/or floor plates.
 - 7. All unusual equipment modifications,
 - 8. Run sheets or field wiring details.
 - 9. Patch panel assignment layout drawings.
 - 10. Front mechanical drawings of each equipment rack.
 - 11. Complete spreadsheet lists of IP network devices, protocols used, and IP and MAC Address lists and required ranges for coordination with the Owner's IT department.

12. Lists shall include information regarding location on the Owner's network or dedicated audiovisual physical subnet, VPN requirements, and other pertinent information for integration of IP networked audiovisual equipment into the Owner's Enterprise network.
13. All items of equipment, whether a stock manufactured item or custom-built item, shall be supported by complete and detailed schematic drawings and replacement parts lists. No "black boxes" or unidentified components shall be acceptable under this specification.
14. Verification of the focal lengths of projection lenses to achieve the specified image sizes.
15. Verification of audio uniformity coverage and speaker coverage layout.
16. A site RF wireless frequency spectrum analysis of RF spectrum to be used by any specified equipment. A spectrum analyzer shall be used with software and recording of results on a typical weekday during normal anticipated hours of use. Results shall be submitted with a frequency analysis and assignment plan.
17. Proposed commissioning and testing procedures and processing, including testing documentation and results to be provided to the Consultant prior to Consultant's Punch list checkout. Refer to UofI exhibits 27 40 00-1, 27 40 00-12 & 27 40 00-14 located at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>.
18. Proposed training programs, including schedule, component-level and systems-level training sessions, and Staff who will be conducting the training, along with qualifications and resumes.
19. If the Contractor will be providing manufacturer training, then the submittal shall include component or systems training by each manufacturer, along with the manufacturer's training staff and their qualifications.
20. This information shall be provided prior to commissioning, for the Owner and Consultant's review and approval.
 - a. End-user guides, subject to Consultant and Owner review and approval, which are "function-oriented" in showing a step-by-step operation process for the main startup and functions of each room system. The end-user guides must be comprehensive in scope and cover each user application of the room capabilities. User-guides of the "traditional" laminated sheet of user-interface photos with tagged annotations will NOT be accepted.
21. Close Out Submittals
 - a. At the completion of the installation, the Contractor shall electronically provide six (6) copies each of the following:
 - b. Test results, in "spreadsheet" format, of electrical audio and/or video performance testing for all systems end-to-end in every room and/or between rooms as applicable. See exhibit 27 40 00-11, 12 & 14 located at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>.
 - c. Total equipment database. See exhibit 27 40 00-13 located at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>.
 - d. NOTE: It is the sole responsibility of the Contractor to fully test the audiovisual systems prior to Consultant check-out and verification. Until these test results are provided, no audiovisual systems check-out or verifications (functional or otherwise) will be performed by the Consultant. If any anomalies in system performance are detected, the Contractor shall correct these before performing any other tests.
 - e. Equipment manufacturer's operation manuals for each piece of equipment.
 - f. "As-built" drawings. A final, approved copy shall be placed in a metal pocket mounted on the inside of the rear door of the rack.

- g. System functional block drawing identical to the specification drawing with the addition of all input and output circuit cable and terminal block numbers as well as all jack field circuit I.D. designations. A copy of this drawing shall be framed in protective plastic and mounted near the equipment racks.
- h. A System Operation and Maintenance Manual. This manual shall be produced by the Contractor especially for the systems detailed herein. The "Operation" section shall describe all typical procedures necessary to activate each system to provide for the functional requirements as listed under the Detailed Specifications. Manuals will use graphical representation of touch panel screens, as to easily be identified by user. Owner's Manuals and/or Operations manuals supplied by manufacturers for a given piece of equipment, though required, are not acceptable substitutes for these materials.
- i. The reader of this manual shall be assumed to be technically competent, but unfamiliar with this particular facility. Additionally, the Contractor shall provide a single page of basic operating instructions for each room, and other audio-visually equipped spaces.

1.9 WARRANTY

- A. The warranty period shall start after final checkout and signed off by the owner or owner's representative. The warranty shall cover 365 calendar days starting on the day of acceptance.
- B. To maintain certain manufacturer's warranties, equipment must be installed, aligned and serviced by those installers authorized by that manufacturer to perform those duties. If the Installing Contractor is not authorized, by the manufacturer, it is the Installing Contractor's sole responsibility to make the appropriate arrangements and bear all cost and consequences
- C. In cases where the manufacturer's warranty period is greater than specified in the Contract Documents, the Installing Contractor shall provide that warranty for the full extent of the manufacturer's warranty period.
- 2. The Installing Contractor shall exclude any labor costs incurred by removing and re-installing the defective items after the system's one-year warranty.
- D. In cases where the manufacturer's warranty period is less than 12 months, the Installing Contractor shall warrant the system(s) in accordance with the Contract Documents.
- E. *** Optional*** The system warranty shall include a minimum of four (4) preventive maintenance visits, to perform operation checks of the equipment, screens, projector lenses and other critical surfaces, to lubricate moving parts as recommended by the respective manufacturers and to adjust and align projector to maintain optimum registration and focus.
- F. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of Substantial Completion.
- G. In the case of Installing Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the Installing Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
- H. In the event of malfunction or failure of any audiovisual equipment provided by the Installing Contractor, the Installing Contractor shall be responsible for replacement of faulty equipment, or providing "loaner" equipment at no cost to the Owner for the duration of the repairs. In the event that "loaner" equipment is provided, said equipment shall meet or exceed the original equipment specifications until the original equipment is replaced.
- I. In cases where the Installing Contractor is providing and installing audiovisual equipment and/or hardware to be integrated with equipment furnished by others, it shall be the responsibility of the Installing Contractor to warrant their equipment as described in the

Contract Documents unless said equipment shows misuse and or abuse by others during re-installation or connection of equipment by others.

J. Telephone Support

1. The Installing Contractor shall respond via telephone within two (2) hours to any request for service.
2. This first contact should outline the nature of the problem or functional anomaly.
3. The Installing Contractor shall make available personnel knowledgeable with the installed system who can address specific system issues described by the system operators.
4. Telephone support shall be available between normal business hours, Monday through Friday.

K. On-Site Support

1. The warranty shall be an "on-site" warranty, with a twenty-four (24) hour response time.

PART 2 - PRODUCTS

2.1 GENERAL

2.2 OWNER-FURNISHED EQUIPMENT

- A. *[Note to AE: Identified by Owner]*

2.3 SYSTEMS

- A. Description, this section should match the system description from the Basis of Design (BOD) document provided by the consultant. Refer to UofI Facilities Standards Exhibit 27 40 00-02, AV Basis of Design.
- B. Operation Sequences
- C. Performance
- D. Manufacturers
 1. Substitution Limitations
 2. Product Options

2.4 Control System Programming

- A. Required Deliverables
 1. In Microsoft Excel, a page by page, button by button list will be provided for system commissioning. This should include the function of each button, page flips, popup pages etc.
- B. Touch Panel Layout
- C. Program Requirements

2.5 DSP (DIGITAL SIGNAL PROCESSING) PROGRAMMING

- A. Required Deliverables
- B. Program Requirements

2.6 MATERIALS

- A. Cable
 1. Audio

- a. Fixed Installation
 - (1) Speaker Cable
 - a. 18/2 Twisted Pair Cable with Overall Jacket
 - 1. Non-Plenum
 - a. Manufacturer: Extron, Model: SPK18, 22-150-03
 - b. Manufacturer: Gepco 1800
 - c. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Extron, Model: SPK18P, 22-153-03
 - b. Manufacturer: Gepco 1800HS
 - c. Or pre-approved equal
 - b. 16/2 Twisted Pair Cable with Overall Jacket
 - 1. Non-Plenum
 - a. Manufacturer: Extron, Model: SPK16, 22-151-03
 - b. Manufacturer: Gepco 1600
 - c. Manufacturer: Liberty 16-2C-COM
 - d. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Extron, Model: SPK16P, 22-154-03
 - b. Manufacturer: Gepco 1600HS
 - c. Manufacturer: Liberty 16-2C-P
 - d. Or pre-approved equal
 - c. 14/2 Twisted Pair Cable with Overall Jacket
 - 1. Non-Plenum
 - a. Manufacturer: Extron, Model: SPK14, 22-152-03
 - b. Manufacturer: Gepco 1400
 - c. Manufacturer: Liberty 14-2C-GRY
 - d. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Extron, Model: SPK14P, 22-155-03
 - b. Manufacturer: Gepco 1400HS
 - c. Manufacturer: Liberty 14-2C-P-BLK
 - d. Or pre-approved equal
 - d. 12/2 Twisted Pair Cable with Overall Jacket
 - 1. Non-Plenum
 - a. Manufacturer: Gepco 1200
 - b. Manufacturer: Liberty 12-2C-GRY
 - c. Or pre-approved equal

- 2. Plenum
 - a. Manufacturer: Gepco 1200HS
 - b. Manufacturer: Liberty 12-2C-P-BLK
 - c. Or pre-approved equal
- (2) Microphone
 - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
 - 1. Manufacturer: Gepco XB201M
 - 2. Manufacturer: Belden 8451
 - 3. Or pre-approved equal
- (3) Line Level Balanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
- (4) Line Level Unbalanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
- b. Portable/Lectern/Flexible
 - (1) Microphone
 - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
 - 1. Manufacturer: Gepco XB201M
 - 2. Manufacturer: Belden 8451
 - 3. Or pre-approved equal
 - (2) Line Level Balanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal
 - (3) Line Level Unbalanced
 - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
 - 1. Manufacturer: Gepco 61801EZ
 - 2. Manufacturer: Extron STP22, 22-156-03
 - 3. Or pre-approved equal

2. Video

- a. Fixed Installation

- (1) Baseband Video
 - a. RG6 Single 18AWG Single conductor, 75ohm.
 - 1. Non-Plenum
 - a. Manufacturer: Extron RG6, 22-098-02
 - b. Manufacturer: Gepco VSD2001
 - c. Manufacturer: Liberty RG6-CCTV-CM-BLK
 - d. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Extron RG6P, 22-164-02
 - b. Manufacturer: Gepco VSD2001TS
 - c. Manufacturer: Liberty RG6-CCTV-PL-BLK
 - d. Or pre-approved equal
- (2) RGBH&V
 - a. Mini-High resolution 5-Core Coaxial Cables, 25 or 26 AWG
 - 1. Non-Plenum
 - a. Manufacturer: Extron MHR-5, 22-020-02
 - b. Manufacturer: Gepco RGBSC250
 - c. Manufacturer: Liberty RGB5C-PVC
 - d. Or pre-approved equal
 - 2. Plenum
 - a. Manufacturer: Extron MHR-5P, 22-103-02
 - b. Manufacturer: Gepco RGBSC20CS
 - c. Manufacturer: Liberty RGB5C-PLN
 - d. Or pre-approved equal
 - b. High resolution 5-Core Coaxial Cables, 20 – 18 AWG
 - 1. Non-Plenum
 - a. Manufacturer: Extron RG6-5, 22-100-02
 - b. Manufacturer: Gepco VS-52000
 - c. Manufacturer: Liberty RGB5C-20-CMR
 - d. Or pre-approved equal
- (3) Digital Video
 - a. Serial Digital interface cable, RG6, 75 Ohm Coaxial Cable.
 - 1. Non-Plenum
 - a. Manufacturer: Extron RG6, 22-098-02
 - b. Manufacturer: Gepco VSD2001
 - c. Manufacturer: Liberty RG6-CCTV-CM-BLK
 - d. Or pre-approved equal
 - 2. Plenum

- a. Manufacturer: Extron RG6P, 22-164-02
 - b. Manufacturer: Gepco VSD2001TS
 - c. Manufacturer: Liberty RG6-CCTV-PL-BLK
 - d. Or pre-approved equal
- b. HDMI, 1.3 Category 2, Supports data rates up to 4.95 GBPS, 1080p and WUXGA @ 60hz without cable equalizer.
- 1. Non-Plenum
 - a. Manufacturer: Extron HDMI M-M Pro series cables.
 - b. Manufacturer: Liberty E-HDM-M series cables.
 - c. Or pre-approved equal
 - c. DVI Dual Link, Supports Dual Link DVI D signals up to 2560x1600 @ 60hz, including HDTV 1080p
 - 1. Non-Plenum
 - a. Manufacturer: Extron DVID DL series cables.
 - b. Or pre-approved equal
 - d. DVI Single Link, Supports 1080p/60 verified, 24 or 22 AWG.
 - 1. Non-Plenum
 - a. Manufacturer: Extron DVID SL series cables.
 - b. Or pre-approved equal
 - e. Shielded Twisted Pair, certified to 475 MHz bandwidth at distances up to 330 feet (100 meters), Engineered and tested to exceed HDMI error rate specifications of less than one pixel per billion & SF/UTP design with four unshielded twisted pairs inside an overall braid and foil shield.
 - 1. Non Plenum
 - a. Manufacturer: Belden 10GX62F.
 - b. Manufacturer: Liberty 24-4P-L6ASH.
 - c. Or pre-approved equal.
 - 2. Plenum
 - a. Manufacturer: Belden 10GX63F
 - b. Manufacturer: Liberty 24 4P-P-L6ASH
- b. Portable/Lectern/Flexible
- (1) Baseband Video
- a. RG6 Single 18AWG Single conductor, 75ohm.
 - 1. Non-Plenum
 - a. Manufacturer: Extron RG6, 22-098-02
 - 2. Manufacturer: Gepco VSD2001
 - 3. Manufacturer: Liberty RG6-CCTV-CM-BLK
 - 4. Or pre-approved equal
 - b. Plenum
 - 1. Manufacturer: Extron RG6P, 22-164-02

2. Manufacturer: Gepco VSD2001TS
 3. Manufacturer: Liberty RG6-CCTV-PL-BLK
 4. Or pre-approved equal
- (2) RGBH&V
- a. Mini-High resolution 5-Core Coaxial Cables, 25 or 26 AWG
 1. Non-Plenum
 - a. Manufacturer: Extron MHR-5, 22-020-02
 - b. Manufacturer: Gepco RGBSC250
 - c. Manufacturer: Liberty RGB5C-PVC
 - d. Or pre-approved equal
 2. Plenum
 - a. Manufacturer: Extron MHR-5P, 22-103-02
 - b. Manufacturer: Gepco RGBSC20CS
 - c. Manufacturer: Liberty RGB5C-PLN
 - d. Or pre-approved equal
 - b. High resolution 5-Core Coaxial Cables, 20 – 18 AWG
 1. Non-Plenum
 - a. Manufacturer: Extron RG6-5, 22-100-02
 - b. Manufacturer: Gepco VS-52000
 - c. Manufacturer: Liberty RGB5C-20-CMR
 - d. Or pre-approved equal
3. Radio Frequency
- a. Wireless Microphone (Receive) RG58 Coaxial Cable
 - (1) Non-Plenum
 - a. Manufacturer: Liberty RG58-CMR-BLK
 - b. Manufacturer: Belden 8240
 - c. Or pre-approved equal
 - (2) Plenum
 - a. Manufacturer: Liberty RG58-CMP-WHT
 - b. Manufacturer: Belden 88240
 - c. Or pre-approved equal
 - b. Assistive Listening System (Transmit) RG58 Coaxial Cable
 - (1) Non-Plenum
 - a. Manufacturer: Liberty RG58-CMR-BLK
 - b. Manufacturer: Belden 8240
 - c. Or pre-approved equal
 - (2) Plenum
 - a. Manufacturer: Liberty RG58-CMP-WHT

- b. Manufacturer: Belden 88240
- c. Or pre-approved equal

4. Control/Data

a. AMX

(1) Non-Plenum

- a. Manufacturer: Liberty AXLINK
- b. Manufacturer: Extron CTL, 22-148-02
- c. Or pre-approved equal

(2) Plenum

- a. Manufacturer: Liberty AXLINK-P
- b. Manufacturer: Extron CTLP, 22-119-03
- c. Or pre-approved equal

b. Crestron

(1) Non-Plenum

- a. Manufacturer: Crestron Crestnet-NP-TL

(2) Plenum

- a. Manufacturer: Crestron Crestnet-P-TL
- b. Or pre-approved equal

c. Network, 23 AWG Solid Bare Copper Conductors, Tested to 550 MHz with a Positive ACR spec to 550 MHz Third Party (UL, ETL) certified to Category 6 performance, NEC Rated CMR, CEC Rated CMR, CMG FT4, RoHS Compliant.

(1) Non-Plenum

- a. Manufacturer: Liberty 24-4P-L6
- b. Manufacturer: Mohawk M57206

(2) Plenum

- a. Manufacturer: Liberty 24-4P-P-L6
- b. Manufacturer: Mohawk M57197

B. Connectors

1. Audio

a. Balanced

(1) ¼" TRS male cable mount connector, solder on, Nickel/gold plated

- a. Manufacturer: Neutrik NJ3FC6 female
- b. Manufacturer: Neutrik NP3X male
- c. Manufacturer: Switchcraft 297 male
- d. Manufacturer: Switchcraft 131 female
- e. Or pre-approved equal

(2) ¼" TRS panel mount jack, solder on,

- a. Manufacturer: Neutrik "locking jacks series"
- b. Manufacturer: Switchcraft "enclosed jack"

- c. Or pre-approved equal
- (3) XLR 3-pin cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik NC3MXX male
 - b. Manufacturer: Neutrik NC3FXX female
 - c. Manufacturer: Switchcraft A3F female
 - d. Manufacturer: Switchcraft A3M male
 - e. Or pre-approved equal
- (4) XLR 5-pin cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik N5CFX female
 - b. Manufacturer: Neutrik N5CMX male
 - c. Manufacturer: Switchcraft A5F female
 - d. Manufacturer: Switchcraft A5M male
 - e. Or pre-approved equal
- (5) XLR 3-pin panel mount connector, solder on,
 - a. Manufacturer: Neutrik NC3FD-LX female
 - b. Manufacturer: Neutrik NC3MD-LX male
 - c. Manufacturer: Switchcraft D3F female
 - d. Manufacturer: Switchcraft D3M male
 - e. Or pre-approved equal
- (6) XLR 5-pin panel mount connector, solder on,
 - a. Manufacturer: Neutrik NC5FD-LX female
 - b. Manufacturer: Neutrik NC5MD-LX male
 - c. Manufacturer: Switchcraft D5F female
 - d. Manufacturer: Switchcraft D3M male
 - e. Or pre-approved equal
- (7) XLR-1/4" Combination panel mount connector, solder on,
 - a. Manufacturer: Neutrik "Combo" series male
 - b. Manufacturer: Neutrik "Combo" series female
 - c. Or pre-approved equal
- b. Speaker Level
 - (1) Lockable loudspeaker cable mount connector, solder on
 - a. Manufacturer: Neutrik "speakON series" female
 - b. Manufacturer: Neutrik "speakON series" male
 - c. Manufacturer: Switchcraft "HPC series" female
 - d. Manufacturer: Switchcraft "HPC series" male
 - e. Or pre-approved equal
 - (2) Lockable loudspeaker panel mount connector, solder on
 - a. Manufacturer: Neutrik "speakON series" female

- b. Manufacturer: Neutrik “speakON series” male
 - c. Manufacturer: Switchcraft “HPC series” female
 - d. Manufacturer: Switchcraft “HPC series” male
 - e. Or pre-approved equal
- c. Unbalanced
- (1) ¼” mono cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Neutrik NYS224 male
 - b. Manufacturer: Neutrik NP2X female
 - c. Manufacturer: Switchcraft 280 male
 - d. Manufacturer: Switchcraft 121 female
 - e. Or pre-approved equal
 - (2) 3.5mm mini stereo cable mount connector, solder on, Nickel/gold plated
 - a. Manufacturer: Extron 3.5 mm Mini Stereo-HQ male, 100-331-01
 - b. Manufacturer: Switchcraft 35HDNN male
 - c. Or pre-approved equal
 - (3) RCA cable mount connector, solder on
 - a. Manufacturer: Extron RCA-HQ male, 100-334-01
 - b. Manufacturer: Neutrik NYS352G
 - c. Or pre-approved equal
 - (4) ¼” mono panel mount jack, solder on,
 - a. Manufacturer: Neutrik “locking jacks series”
 - b. Manufacturer: Switchcraft “enclosed jack”
 - c. Or pre-approved equal

2. Video

- a. BNC connector, 75ohm impedance, gold plated center pin, fully enclosed outer metal conductor and center pin cavity.
 - (1) Mini Hi-res
 - a. Manufacturer: BNC Male MHR Crimp, 100-250-01
 - b. Manufacturer: Liberty 112491-10
 - c. Or pre-approved equal
 - (2) RG6
 - a. Manufacturer: Extron BNC Male RG6 Crimp Connector, 100-260-01
 - b. Manufacturer: Kings 2065-10-9
 - c. Or pre-approved equal

3. Control/Data

- a. DB9, 9-pin solder on connector.
 - (1) Manufacturer: BTX Technologies CD-9709M, male
 - (2) Manufacturer: BTX Technologies CD-9709s, female

- (3) Or pre-approved equal
- 4. Category Cable
 - a. Cat 6 crimp plug
 - (1) Liberty 11108080034
 - (2) Comprehensive RJ45P-6
 - (3) Or pre-approved equal
 - b. Cat6a Crimp Plug
 - (1) Manufacturer: Liberty RJ45-STP-L6
 - (2) Or pre-approved equal
- C. Pre-manufactured Cables and Adapters
 - 1. All pre-manufactured cables should have the following minimum specifications:
 - a. High performance cables designed for transmission of video.
 - b. Terminated with high quality 75 ohm BNC connectors.
 - c. VGA shell grounded for ESD electrostatic discharge protection.
 - d. Injection mold with overall foil shield for improved EMI electromagnetic interference isolation.
 - e. Acceptable manufacturers
 - (1) Manufacturer: Extron
 - (2) Manufacturer: Liberty
 - (3) Manufacturer: Comprehensive
 - (4) Or pre-approved equal
- D. Rack Systems
 - 1. All Accessories will be from the same manufacturer as the rack enclosure.
 - 2. Horizontal lacing bars as required.
 - 3. Blank panels as necessary.
 - 4. Power distribution as required.
 - 5. Front and rear mounting rails.
 - 6. Front and rear doors as needed.
 - 7. Caster base as needed.
 - 8. Acceptable manufacturers
 - a. Middle Atlantic
 - b. Lowell
 - c. Or pre-approved equal
- E. Projection/Display Mounts
 - 1. A standard universal projector mounts compatible with nearly every projector up to 25 pounds will be used.
 - a. Manufacturer: Extron
 - b. Manufacturer: Chief
 - c. Manufacturer: Peerless

2. Projectors over 25 pounds should be mounted using custom hardware manufactured for the application.
 - a. Manufacturer: Chief Mfg
 - b. Manufacturer: Peerless
 - c. Or pre-approved equal

F. Hardware

1. Wall/floor plates and rack panels
 - a. NEMA gang plates shall be standard or jumbo sized as required at each location.
 - b. Plates shall be sized to fit rough opening or fit box opening.
 - c. Text and graphics shall be engraved.
 - d. Finish should be approved by CITES Classroom and Conference Room Media Engineering.
 - e. Connectors shall be fitted to plates using nuts, screws, or by the method designated by connector. No rivets.
 - f. Acceptable manufacturers
 - (1) Manufacturer: Panel Crafters
 - (2) Manufacturer: Whirlwind
 - (3) Or pre-approved equal

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before starting installation, verify proper installation of the following work by others -
 1. Inspect site. *[Note to AE: Insert appropriate project-specific information in this paragraph. See the general guideline entitled Audio-Video Communications and Instructional Media for additional information.]*
 2. Document and submit a single report for each space with AV to the Owner before any work is started on-site.
 3. Carry out this requirement for each phase of work on-site (field wiring, and system/equipment installation) for each space with AV.
- B. Frequency Coordination - Prior to ordering equipment, the Installing Contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms.
 1. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
 2. Frequency coordination shall take place with the use of a spectrum analyzer and frequency allocation/analysis software.
 3. Documentation of this frequency coordination shall be provided to the Owner for review.

3.2 QUALITY CONTROL/COMMISSIONING: *[Note to AE: Include project-specific information in this paragraph. See the "Audio-Video Communications and Instructional Media" general guideline in these Standards for additional information.]*

- A. Required testing and testing procedures listed at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, exhibit 27 40 00-11 & 27 40 00-12.

1. See related Performance Standards and Testing Procedures paragraphs in Part 3 of this technical section.
- B. The main AV milestones that testing will be required:
 1. Prototype verifications (off-site and on-site)
 2. Staging Testing
 3. Final System Commissioning
 4. Final Checkout

3.3 INSTALLATION PRACTICES

A. General

1. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations described in the Contract Documents, referenced material, and the *U of I Facilities Standards*.
2. Installation shall include the delivery to the installation site, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and all other work whether or not expressly required herein which is necessary to result in complete and fully operational systems.

B. Physical Installation

1. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors
2. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used
3. Trim and Escutcheon Components
 - a. To insure a proper finished appearance, the AV Installing Contractor shall furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This would include but not be limited to video projector supports, television monitor/receiver supports and any other component which is not specifically supplied with integral flanges/trim components; i.e. speaker mounts, assistance listening devices, etc
 - b. The visible component of any trim should be minimal in size, preferably no wider than 1/2". All trim components at the ceiling plane shall be finished to match the approved ACT ceiling grid system components.
 - c. All trim components shall be submitted for review and approval prior to fabrication

4. Mounting

- a. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
- b. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five (5). All boxes, equipment, etc., shall be secured plumb and square.
- c. All displays and video projectors must have security cables attached to the building structure or other approved methods to assist in the prevention of loss.
- d. Other equipment, not designated as 'Portable' shall be provided with security fasteners, secured to furniture, or otherwise secured, using approved methods or materials as described in the Contract Documents

C. Cable Installation

1. Cable General Installation

- a. All wire bundles are to be neat and combed free of cable crossovers.
- b. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
 - Power cables
 - Control cables
 - Video cables
 - Audio cables carrying signals less than – 20 dBm
 - Audio cables carrying signals between – 20 dBm and +20 dBm
 - Audio cables carrying signals above +20 dBm
- c. All cables shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes.
- d. Cables running in plenum areas without conduit shall be plenum rated cable, and match the specified cable above.
 - (a) It is the responsibility of the Installing Contractor to inspect the Contract Documents, and verify in what spaces plenum cable shall be used.
 - (b) No claims for additional monies, based on the use of plenum cable, will be allowed

2. Cable – Rack/Termination Points

- a. Cable separation/routing:
 - (a) All power cables, control cables, and high level cables shall be run on the left side of an equipment rack as viewed from the rear.
 - (b) All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
- b. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
- c. Cables shall not protrude from the back of racks.
- d. Cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles, two inches for horizontal bundles.
- e. All vertical cable bundles shall be attached to the rack frame.
- f. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length
- g. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
- h. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.
- i. Except where noted otherwise in the specifications, NO BARE WIRE TERMINATIONS WILL BE ACCEPTED.
- j. Heat-shrink tubing shall be used to insulate the ground or drain wire.
- k. Unused wires at the end of a cable shall remain unstripped and shall be laid back and held in place with wire ties.

- l. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations.
 - (a) Care shall be taken to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be resoldered by the Installing Contractor before acceptance of the system.
- m. Mechanical connections using insulated, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.
- n. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4 inch of insulation from the stranded conductor. Then the un-tinned wire shall be inserted into the terminal and the screw tightened using a secure fitting precision screwdriver
- o. Terminal blocks, boards, strips, or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules.
- p. All cables shall have proper connector housing.

3. Cable – Labeling

- a. All cables, regardless of length, shall be marked with a permanent, self-laminating wrap-around number or letter cable marker at both ends, similar to the Brady and Panduit products for laser/ink-jet printers, and handheld thermal printers.
 - (a) A000x for audio
 - (b) V000x for analog video
 - (c) D000x for digital video
 - (d) N000x for network
 - (e) C000x for control
 - (f) P000x for power
 - (g) Or other pre-approved schemes
- b. Labels must be computer-generated for legibility.
- c. Wire labels done by hand in the field must be replaced with computer generated labels.
- d. There shall be no unmarked cables at any place in the system.
- e. Marking codes used on cables shall correspond to codes shown on drawings and or run sheets.
- f. All wire markers shall face a common direction.

D. Connector Plate Receptacles

- 1. Audio (microphone or line level) – XLR, locking type.
- 2. Audio (line level—Mono or Stereo) – 1/4" jack, locking type Jack shall be insulated from panel type
- 3. Audio (loudspeaker level) – lockable loudspeaker panel mount connector Type.
- 4. Audio (multipin analog mic/line level) – 61 pin circular bayonet type – Jack shall be insulated from panel type.
- 5. Intercom Panels – XLR type.
- 6. Video – BNC type.
- 7. VGA – DB-15HD jack, isolated from panel type, with hex nuts.
- 8. RF (CCTV/CATV) – "F" type. Receptacles shall be insulated from panel type.

9. RF (Wireless Antennae) – BNC type, 75 or 50 Ohm, as required. Receptacles shall be insulated from panel type.
 10. Digital Audio Snake/UTP transmission – RJ-45 type.
 11. Note: All connectors on wall plates, or in other exposed locations, are to be recessed.
- E. Grounding – In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:
1. System Grounds:
 - a. A single primary “system ground” shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground.
 - b. The system ground shall be provided in the audio equipment rack for the area, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors.
 - c. A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground bar to the nearest approved electrical ground.
 - d. Secondary system grounding conductors shall be provided from all racks, audio consoles, and grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.
 - e. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground
 2. No metallic conduit will terminate into the rack cabinet.
 3. Audio Cable Shields
 - a. All audio cable shields shall be grounded at one point only. There are no exceptions.
 - b. For inter and intra-rack wiring, this requires that the shield be connected at one end only.
 - c. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
 4. Video Receptacles
 - a. All video receptacles that are provided and installed by the Installing Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
 5. Audio Receptacles
 - a. All audio receptacles that are provided and installed by the Installing Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
 6. Caution
 - a. Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Installing Contractor to follow good engineering practices.

3.4 PERFORMANCE STANDARDS

[Note to AE: This section will need to be customized to reflect the needs of the actual project. Full functional operation will be required of all equipment. To be provided by the AE. Refer to <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, 27 40 00-01]

[Note to AE: Insert appropriate project-specific information in this paragraph. See the general guideline entitled Audio-Video Communications and Instructional Media for additional information.]

- A. Testing shall be done at several stages during the project to assure there are no problems, prove the functionality of the control system and to confirm all wiring is in accordance with industry practice.
- B. Using the proper test equipment the following shall be checked:
 - 1. DC resistance between the rack and equipment.
 - 2. Audio systems functionality.
 - 3. Audio equipment operation.
 - 4. Video systems functionality.
 - 5. Video equipment operation.
 - 6. Control system functionality.
 - 7. Control system operation.
 - 8. User interface functionality.
- C. The Testing Process will continue throughout the Warranty Period of the AV system.

3.5 TEST PROCEDURES

[Note to AE: This section will need to be customized to reflect the needs of the actual project. Test Procedures will utilize latest in test equipment that has been recently calibrated and able to test all capabilities. Reports will need to be documented in spreadsheet form. See Exhibits 27 40 00-1 through 12 for proper forms]

- A. Calibrated Test Instruments required (minimum)
 - 1. Sensitive AC voltmeter, -80dBu sensitivity or more, 20Hz -30KHz response, able to measure signal to noise ratio, THD, electrical levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.
 - 2. Sound Pressure Level Meter, ANSI Type II, with A and C weighting filters, fast or time averaged.
 - 3. Audio Signal Generator, 20Hz-30kHz, sine wave, pink noise, and continuous sine wave sweep.
 - 4. Amplified Loudspeaker 100 mm producing 60 dBa at one meter, and 70 dBa at one meter, pink noise, sine wave, and speech files.
 - 5. 200Mhz Oscilloscope, with TV sync (analog video only).
 - 6. Analog Signal Generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include Pluge pattern. (analog video only)
 - 7. Digital Signal Video Generator for computer patterns for all resolutions and refresh rates required for the systems under test, HDMI/DVI/HD-SDI with and without HDCP.
 - 8. The ability to measure STI-PA (source analyzer).
 - 9. Colorimeter/luminance meter, 10% accuracy.
 - 10. Infrared thermometer.
 - 11. Test media with known levels (audio, video, etc): Cd's, VS, DVD's etc.
 - 12. AD/DC multimeter.
 - 13. Light meter, lux/foot-candles.

- 14. Outlet tester (to test power outlet wiring).
- 15. The ability to measure electrical power (watt meter, clamp meter, etc).
- 16. Cable sets, cable assemblies, adapters as required to sample and measure in-or-out of circuit as req'd.

3.6 STAGING CHECKOUT (PROTOTYPE SHOP CHECKOUT)

- A. Staging of systems and equipment at the Installing Contractors shop will be done to expedite the on-site installation by allowing the assembly and checkout where the resources are, and prior to the project site being ready.
 - 1. See <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, 27 40 00-11 & 27 40 00-14.
 - 2. Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- B. Installing Contractor will successfully perform, document, and then submit all the test results to the Owner
- C. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Staging Checkout verification
 - 1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
 - 2. See related paragraphs entitled *Performance Standards* and *Test Procedures* for more details on Testing procedures can be found at <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, exhibit 27 40 00-11 & 27 40 00-14.
 - 3. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner.
 - 4. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Consultant, or Owner, required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor.
- D. Checkout will include:
 - 1. Appropriate Testing with as many of the various inputs and outputs that can be used to emulate the full system operation
 - a. Insure there are no equipment problems
 - b. Test as much of the control system operation as possible and to make sure the user interface is intuitive
 - 2. Inspection
 - a. Workmanship
 - b. Safety related issues
 - c. Serviceability of the system
- E. Once successful completion of the Staging Checkout has been acknowledged the Installing Contractor can:
 - 1. for "One-Off" Type of System – Prepare or proceed to the next phase of the installation

2. for Prototypical – continue the assembly of the other like rooms while testing, documenting and submitting results for each system.

3.7 ON-SITE PROTOTYPE CHECKOUT

- A. Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- B. Installing Contractor will successfully perform, document, and then submit all the test results to the Owner (<http://www.fs.illinois.edu/resources/facilities-standards/exhibits> 27 40 00-14). Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do On-Site Prototype Checkout verification
 1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
 2. See Section 3.4 Testing and 3.5 Testing Procedures for more details on testing and testing procedures
 3. AV Consultant will be responsible to note any minor infractions on a "punch list" and Installing Contractor will be responsible for fixing these items before next checkout phase.
 4. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Consultant required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor
- C. Checkout will include:
 1. Appropriate Testing with all field cables and connections made, and all equipment operational.
 - a. Insure there are no equipment and field wire problems
 - b. Test the complete control system operation and to make sure the user interface is intuitive
 2. Inspection
 - a. Workmanship
 - b. Safety related issues
 - c. Serviceability of the system
- D. Once successful completion of the On-Site Prototype Checkout has been acknowledged the Installing Contractor can continue the build-out of the other like rooms.

3.8 FULL SYSTEM COMMISSIONING

- A. Installing Contractor's Full System Checkout
 1. Installing Contractor will accomplish a complete system(s) inventory of all equipment, and inspection of all workmanship quality relating to installation details.
 2. Installing Contractor will complete all testing for system operational compliance, and test to ensure all equipment is working fully to published specifications. See <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, exhibit 27 40 00-12
 3. Results will be recorded and submitted to the Owner. Installing Contractor's commissioning submittal will serve to allow 7-days for the Owner to perform an Owners System commissioning.

4. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
5. The operation of all system equipment shall be demonstrated by the Installing Contractor.
6. Both subjective and objective tests will be required to determine compliance with the specifications. See <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, exhibit 27 40 00-12.
 - a. The Installing Contractor shall be responsible for providing test equipment for these tests.
 - b. The Installing Contractor shall be responsible for providing qualified personnel to run the tests, make adjustments, and answer system questions for as long as required to accomplish the tests and setup satisfactorily.
7. The Installing Contractor shall be responsible for providing the personnel that accomplished all programming for the system; this includes the control system and any DSP software. This person will be available to run requested demonstration, make adjustments, and answer system programming questions for as long as required to accomplish the demonstration satisfactorily.
8. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Owner will advise if training can commence while any further cleanup is being done before Final System Checkout.

3.9 TRAINING

- A. The Installing Contractor shall provide on-the-job training by a qualified instructor, to personnel designated by the Owner, to instruct them in the operation and routine maintenance of the systems.
 1. All training shall take place after the systems are operational, but before the acceptance tests.
 2. Operational Training:
 - a. There shall be a minimum of _____ (XX) hours of end-user training included in this specification for this activity. *[Note to AE: Include the specific number of hours of training required for the Project.]*
 - b. In the event the Installing Contractor does not have qualified instructors on staff for certain sophisticated equipment, the Installing Contractor, at no additional cost to Owner, will provide a manufacturer's representative for such instruction to the Owner.
 - c. Training Materials Supplied:
 - (a) System operational manual (not equipment operation manuals) that explains how to fully operate the system; from start-up to shut-down, and all operational steps in-between, in a step by step description, with pictures and other visuals to help convey information.
 - (b) The Installing Contractor shall video record training session(s) for Owners reference (to help limit minor follow up phone calls in the future).
 3. Maintenance Training:
 - a. A session with Owner's designated technical personnel for routine and preventive maintenance will be given.
 - (a) This training is for scheduled preventative maintenance for such items as filter and lens cleaning, minor equipment checks and "user" adjustments.

- (i) This training is not meant to teach Owner's representatives how to use commercial test equipment and/or do sophisticated equipment/system alignment.
- b. There shall be a minimum of _____ (XX) hours of end-user training included in this specification for this activity. *[Note to AE: Include the specific number of hours of training required for the Project.]*
- c. Training Materials Supplied:
 - (a) Utilizing the equipment manuals and flow diagrams of the required in contract closeout submittals supply a listing with suggested preventative maintenance schedule of the system equipment.
- d. Follow-up training within sixty (60) days shall also be provided.
 - (a) There shall be a minimum of _____ (XX) hours of end-user training included in this specification for this activity. *[Note to AE: Include the specific number of hours of training required for the Project.]*

3.10 FINAL CHECKOUT

- A. Final Checkout will not be performed until the Installing Contractor's Full System Commissioning has been successfully completed (including all "punch-list" items) and the test results have been reviewed by the Owner.
 - 1. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Final Checkout
- B. The Final Checkout with the Owner will consist of the following:
 - 1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
 - 2. The operation of all system equipment shall be demonstrated by the Installing Contractor.
 - 3. Both subjective and objective tests will be required to determine compliance with the specifications. The Installing Contractor shall be responsible for providing test equipment and qualified personnel for these tests. See <http://www.fs.illinois.edu/resources/facilities-standards/exhibits>, exhibit 27 40 00-12
 - 4. All final, "as-built" drawings, run sheets, manuals, and other required documents shall be on hand.
 - a. Two complete sets of these documents shall be delivered to the Owner at this time.
 - b. <http://www.fs.illinois.edu/resources/facilities-standards/exhibits> 27 40 00-15.

END OF SECTION 27 40 00

This section of the *U of I Facilities Standards* establishes minimum requirements only. It should not be used as a complete specification.