

274000 AUDIO-VIDEO COMMUNICATIONS

TABLE OF CONTENTS	Page
PART 1 - GENERAL	2
1.01 Summary.....	2
1.02 References.....	2
PART 2 - AV CONTRACTOR RESPONSIBILITIES	5
2.01 Coordination and Communication.....	5
2.02 Submittals	5
2.03 System Commissioning.....	7
PART 3 - INFRASTRUCTURE STANDARDS.....	7
3.01 Electrical	7
3.02 Cable Path.....	8
3.03 Structural.....	9
3.04 Mechanical.....	10
PART 4 - DESIGN, INSTALLATION & TECHNICAL STANDARDS	10
4.01 Cables & Connectors	10
4.02 Lectern & Teaching Station.....	11
4.03 Equipment Rack.....	12
4.04 Control System	13
4.05 Projector.....	13
4.06 Projection Screen	14
4.07 Flat Panel Display.....	16
4.08 Switching and Signal Distribution.....	17
4.09 Bring-Your-Own-Device Connections.....	17
4.10 Audio & Acoustics	18
4.11 Assistive Listening System.....	19
4.12 Computer	20
4.13 Networking	20
4.14 Conferencing.....	21
4.15 Lecture Capture	21

PART 1 - GENERAL

1.01 Summary

A. Section Includes

1. This section defines the standards for the design and construction process surrounding audiovisual infrastructure and physical space on the Cornell University campus.
2. Audiovisual equipment included in these systems may consist of projectors, projection screens, flat panel displays, control systems, audio reinforcement/program systems, video/audio input devices, video/audio switching and processing equipment, capture/recording/streaming equipment, conferencing equipment, assistive listening systems, and AV furniture.
3. This Standard is for Architects, audiovisual Design Consultants, and Project Design Team members involved in the infrastructure design of audiovisual systems.
4. Design professionals shall use the Design and Construction Standards defined in this document when designing audiovisual systems and related project specifications. This document is not intended to act as a complete bid specification.
5. AV system design, procurement and integration is handled under Cornell’s Preferred AV Supplier program:
<https://www.dfa.cornell.edu/procurement/buyers/commodities/audiovisual>

1.02 References

A. Cornell University Audio Visual System Design References

1. Cornell University AV System Design Standards Documents
<https://it.cornell.edu/integrated-av/av-standards>

B. Reference other sections of CU Design & Construction Standards as appropriate:

1. [Section 12 56 39: Lecterns](#)
2. [Section 26 05 00: Basic Electrical Requirements](#)
3. [Section 26 05 26: Grounding](#)
4. [Section 26 05 33: Raceways](#)
5. [Section 27 00 00: Communications](#)
6. [Section 260923: Lighting Controls](#)
7. [Section 265100: Interior Lighting](#)

C. Industry Reference Standards

1. National Fire Protection Agency (NFPA) 70, “National Electrical Code”.
2. US Department of Justice, “2010 ADA Standards for Accessible Design”.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 2 of 21

3. Telecommunications Industry Association (TIA), “TIA Wiring Standards” (Includes the most recent versions of ANSI/TIA-568, ANSI/TIA-568-4, TIA-569, ANSI/TIA-570, TIA-598, ANSI/TIA-606, TIA-607, TIA-758, TIA-526-7 and TIA-526-14).
4. IEEE, “IEEE Standard 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems”.
5. InfoComm International, “ANSI/InfoComm 10:2013 Audiovisual Systems Performance Verification Standard”.
6. InfoComm International, “ANSI/InfoComm 1M-2009 Audio Coverage Uniformity in Enclosed Listener Areas Standard”.
7. InfoComm International, “ANSI/InfoComm 2M-2010 Standard Guide for Audiovisual Systems Design and Coordination Processes”.
8. InfoComm International, “ANSI/InfoComm 3M-2011 Projected Image System Contrast Ratio Standard”.
9. InfoComm International, “ANSI/InfoComm 4:2012 Audiovisual Systems Energy Management Standard”.
10. InfoComm International, “InfoComm F501.01:2015 Cable Labeling for Audiovisual Systems”.
11. InfoComm International, “ANSI/INFOCOMM V202.01:2016 Display Image Size for 2D Content in Audiovisual Systems”
12. InfoComm International, “Dashboard for Controls Design Guide”.
13. InfoComm International, “Basics of Audio and Visual Systems Design”, Revised Edition.
14. InfoComm International, “AV Installation Handbook”.
15. Building Industry Consulting Service International (BICSI), “Telecommunications Distribution Methods Manual”.

D. Abbreviations, Acronyms, and Definitions

1. AC: Alternating Current
2. ADA: Americans with Disabilities Act
3. AFF: Above Finished Floor
4. ALS: Assistive Listening System
5. Aspect Ratio: The ratio of the width to the height of an image. Pertains to projection screens and flat panel displays.
6. AV Contractor: Contractor that specializes in the design, sale, installation, repair, and maintenance of audio-visual equipment and systems. May also be referred to as an “AV Integrator”.
7. AV Consultant: Consultant typically sub to Architect on Design Team.
8. BYOD: Bring Your Own Device. Portable devices owned by users, such as laptops, tablets, and phones.
9. CIT: Cornell Information Technologies
10. Contrast Ratio: The ratio of the brightest white to the darkest black that a display device can produce.
11. dB: Decibel

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 3 of 21

12. Design Team: Typically, the Architect lead team of specialties, including the audiovisual Design Consultant, and Electrical/Mechanical/Structural Engineer. Other consultants/specialists may include an Interior Designer, as well as Acoustical and Lighting Consultants.
13. DHCP: Dynamic Host Configuration Protocol
14. DNS: Domain Name System
15. DSP: Digital Signal Processor. Typically, referring to an audio processor that allows for control over audio input and output signals, including volume, compression/limiting, AEC, routing, and equalization.
16. EC: Electrical Contractor
17. EDID: Extended Display Identification Data is used by digital display to describe its capabilities to a video source.
18. Firestop: A material that prevents or slows the spread of fire. Typically, used in and around cable paths between floors and/or walls.
19. GC: General Contractor
20. HDBaseT: A connectivity standard for distribution of uncompressed ultra-high-definition video and audio content, as well as control signals, Ethernet, USB, and PoE over a single LAN cable.
21. HDCP: High-bandwidth Digital Content Protection is a digital copy protection preventing copying of digital audio and video content.
22. HDMI: High-Definition Multimedia Interface
23. High Voltage/Power: In the context of audio-visual systems discussed in this document, high voltage/power is defined as 110V and higher power. General intent is that work related to high voltage/power is to be performed by Electricians rather than by AV Installers.
24. IP: Internet Protocol
25. IR: Infrared
26. Keystoning: The trapezoidal shape of a projected image due to physical misalignment of the projector and screen.
27. Low Voltage: In the context of audio-visual systems discussed in this document, low voltage is defined as electrical circuits lower than 110V. General intent is that work related to low voltage may be performed by AV Installers rather than by Electricians.
28. Lumen and lux: Measurements of light intensity, may pertain to projectors or room lighting.
29. ME: Mechanical and Electrical services.
30. NEC: The National Electrical Code published by the National Fire Protection Association.
31. NPT: National Pipe Thread
32. OEM: Original Equipment Manufacturer
33. OFE: Owner Furnished Equipment
34. Phoenix connector: AKA a euroblock, this connector is a solderless connector using captive screws to secure wires.
35. Plenum cable: A cable constructed with fire retardant materials that meet the National Fire Protection Association's standards for cables run in plenum spaces.
36. Plenum space: Open spaces above ceilings or below floors that are used for air circulation without full ducting.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 4 of 21

- 37. PoE: Power over Ethernet
- 38. RS-232: Serial Communications Standard
- 39. SPL: Sound Pressure Level typically, weighted A
- 40. Sponsored NetID: Contractors or individuals who are not currently enrolled or employed by Cornell but have a business purpose for needing access to Cornell services or systems can be given a sponsored NetID. This NetID gives them secure access to non-public Cornell resources and information.
- 41. Preferred AV Integrator (Contractor): A vendor that has an existing relationship with Cornell University’s Procurement Services department to provide goods and services within agreed upon contractual terms.
- 42. TCO: Total Cost of Ownership

E. Document Terminology: The following words have specific definitions and intentions within this Standard.

- 1. Furnish: Supply and deliver to the project site, ready to install
- 2. Install: To place in position for service or use
- 3. Provide: Designed, engineered, furnished, installed, and tested by a party
- 4. Shall: Describes a mandatory task or item
- 5. Should: Used to advise, but not deem a task or item to be mandatory.

PART 2 - AV CONTRACTOR RESPONSIBILITIES

2.01 Coordination and Communication

- 1. The appointed Cornell University Project Manager (and/or designee) is the approving authority, in consultation with AV Designer/Design Team, for all contractual and design changes regarding the project’s audiovisual systems. They will act as the primary point of contact for the AV Contractor.
- 2. The AV Contractor shall appoint a primary point of contact for the Cornell University Project Manager to interface with for the duration of the project. This person shall be responsible for disseminating all project information to all members of their team. This individual will need Sponsored NetID credentials to execute various tasks before, during and after the project.

2.02 Submittals

A. AV Furniture Submittal

- 1. Cut sheets and finish samples for all AV furniture that is being provided by the AV Contractor. This may include, but not limited to: lecterns, teaching stations, equipment cabinets/credenzas, mobile carts, and equipment racks.

B. Design Submittal

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 5 of 21

- 1. Equipment list
- 2. Shop Drawings, which may include but not limited to:
 - a. Floor and reflected ceiling plans showing AV equipment locations and ME infrastructure requirements
 - b. Wall elevations showing AV equipment
 - c. Audio, video, control, and data signal flow diagrams
 - d. Equipment rack elevation
 - e. Detail drawings:
 - (i) Custom and standard AV connector plates, showing engraving/labeling
 - (ii) Structural mounting details for: projector/flat panel display mounts, projection screens, and speaker/camera mounts.
 - (iii) Floor/table box connector layouts
 - (iv) Furniture and millwork modifications
 - (v) Custom fabricated items
 - f. Cable pull schedule
 - g. Cable labeling example
- 3. Samples, which may include but not limited to:
 - a. Cable labels
 - b. Custom AV connector plates
 - c. Custom fabricated items
 - d. Field connector terminations
 - e. All AV equipment that have multiple finish choices

C. Programming Submittal

- 1. Control system functional description (theory of operation)
- 2. User interface screen shots

D. Network Provisioning Submittal

- 1. Chart listing equipment make, model, device type, MAC address, serial number, PoE requirements, and planned location where equipment will be installed (building name and room number). Note that this submittal shall be received a minimum of two weeks prior to equipment installation in order to enable CIT or college IT to perform DNS registrations and assign IP addresses.

E. Closeout Submittal

- 1. Manufacturer equipment manuals and warranty statements
- 2. System operation manual
- 3. Equipment list showing finalized make, model, device type, location, MAC address, IP address, host name, VLAN assignment, serial number, manufacturer warranty period, username, and password
- 4. System warranty statement with support contact information
- 5. Maintenance contract
- 6. As-built record drawings showing:
 - a. Updated shop drawings

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 6 of 21

- b. Cable and wire ID numbers
 - c. Equipment settings and adjustment details
- 7. Programming software files: Compiled and un-compiled programming code for control system, audio DSP, custom and standard modules, and other equipment requiring programming. Any required passwords (including on sub-modules) must be included in closeout materials. Source code supplied must not be otherwise obfuscated which would in whole, or part, limit Cornell University’s use for future support.
- 8. Spare parts, materials, and tools included with equipment but not installed
- 9. Keys for AV furniture and equipment, with a list describing their purpose, and location (building name and room number)
- 10. System Commissioning/system verification report.

2.03 System Commissioning

- 1. Submittal required for completed system verification checklist (reference Cornell Preferred AV Supplier process/requirements).

PART 3 - INFRASTRUCTURE STANDARDS

3.01 Electrical

A. General

- 1. IT@Cornell AV System Design Guidelines & Basis of Design are addressed at (<https://it.cornell.edu/integrated-av/av-standards>), including sample Schematic Level Design documents.

B. Outlets

- 1. Ceiling outlets for projectors shall be downward facing on finished ceilings. No outlets shall be allowed above finished ceilings.
- 2. All power outlets servicing the AV system components shall be 120VAC 20A power, unless otherwise noted.

C. Circuits

- 1. All circuits powering AV equipment shall:
 - a. Be derived from the same electrical phase
 - b. Be dedicated strictly to AV devices
 - c. Have isolated grounds terminating at a single point in the associated subpanel
 - d. Be protected 20 AMP breakers per circuit
- 2. Circuits powering AV equipment shall not share circuits powering motorized equipment, lighting system dimmers, or any other inductive electrical loads.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 7 of 21

D. Electrical Cabling

1. Extension cords shall not be used between equipment and power outlets.
2. Power strips may be used, but shall contain a resettable circuit breaker. Power cables from power strips shall be run directly to the outlet, not daisy chained to another power strip.
3. Use of 3 to 2 prong AC plug adapters (or otherwise defeating safety ground) is prohibited.

3.02 Cable Path

A. Conduit

1. Standard AV signal cable conduit size shall be 1”, unless otherwise noted on design documentation.
2. Conduit material shall be rigid or EMT steel, not flexible, PVC, or aluminum.
3. The use of flexible conduit shall be used when no methods are practical. Flexible metal conduit lengths shall be minimized and secured per the NEC. Flex conduit size should be increased ½” beyond the size otherwise required by fill ratio.
4. Conduit ends shall be reamed and fitted with insulated bushings.
5. Pull strings shall be left in all conduits.
6. Conduit fill percentages shall be adhered to:
 - a. One cable: should not exceed 53% of the conduit’s internal diameter.
 - b. Two cables: should not exceed 31% of the conduit’s internal diameter.
 - c. Three or more cables: should not exceed 40% of the conduit’s internal diameter. Jam ratio should not fall between 2.8 and 3.2 (for three cables only).
7. Conduit and pull boxes containing analog AV cabling shall not contain power or data cabling.
8. AV signal conduit shall be separated from conduit containing single-phase high voltage power cabling by at least 12”, and separated from three-phase power by 36”.
9. Power conduit shall cross AV signal conduit at 90 degree angles.
10. Conduit pull boxes shall be placed after 180 degrees of bends and/or every 50 feet. Conduit pieces on opposite sides of pull boxes shall be aligned.
11. Bend radius for conduit sized 2” or less shall be no less than 6 times the internal diameter. Conduit sized larger than 2” shall have a bend radius of no less than 10 times the internal diameter.
12. Firestop used in vertical riser and horizontal conduit sleeves penetrating ceilings and floors shall be labeled. Provide and install labeling at each penetration including penetration type with UL listing used, material used, date of install, and name of installer.

B. Cable Tray

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 8 of 21

1. Firestop used in vertical riser and horizontal cable tray/ladder runs penetrating ceilings and floors shall be labeled. Provide and install labeling at each penetration including penetration type with UL listing used, material used, date of install, and name of installer.

C. Raceway

1. It is not recommended to use surface mounted raceway that contains AV signal cables and also high voltage power cabling. If this has to be done, a metal divider shall exist inside the entire length of the raceway, separating AV and power cables. This divider shall be bonded to ground.
2. Raceway shall be secured to walls/ceilings with screws (and not just with adhesive tape).

D. Junction Boxes

1. All back box and outlet measurements on the project documentation shall refer to the vertical center of the object.
2. Many pieces of AV equipment require deeper than normal back boxes, per manufacturer specifications.

E. Free-air Cables in accessible ceilings

1. Shall be placed in J-hooks or bridle rings secured to the hard deck ceiling, and never resting on the ceiling tiles.
2. The AV Contractor is responsible for checking with the project manager regarding plenum rated cable requirements for each project.

3.03 Structural

1. All AV equipment (speakers, cameras, projectors, flat panel displays, etc.) installed on walls or ceilings shall be secured to structural blocking or hard deck ceiling with safety tethers, as specified by the project’s architect or structural engineer.
2. Structural mounting surface (wall, ceiling, and floor) shall be able to bear a load no less than five times the weight of the installed AV equipment.
3. At a minimum, SEA grade 5 hardware shall be used.
4. The Architect/Structural Engineer shall specify structural mounting of all AV equipment.
5. Structural wall blocking for flat panel display, camera, and speaker mounts shall be specified by the architect/structural engineer and furnished by the GC.
6. Single stud wall mounts shall never be used on flat panel displays larger than 32”.
7. The AV designer is responsible for coordinating with the project manager regarding any asbestos abatement taking place on-site, and shall convey this information to the AV contractor.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 9 of 21

3.04 Mechanical

1. Rooms containing AV equipment shall have temperatures within 65-75 degrees Fahrenheit, and humidity levels within 30-55 percent.
2. Heat load shall be calculated for all AV systems and the AV Contractor shall address all equipment cooling concerns with the Project Manager.
3. When possible, the building’s HVAC system shall be used to properly cool locations containing AV equipment.
4. HVAC ducts and vents should be placed away from audiovisual equipment to prevent noticeable vibration on projected images, projection screen movement due to airflow, and lack of accessible ceiling space for AV equipment mounting.

PART 4 - DESIGN, INSTALLATION & TECHNICAL STANDARDS

4.01 Cables & Connectors

A. General

1. Selected cables, connectors, and termination techniques shall meet or exceed manufacturer recommended specifications for each piece of AV equipment.
2. The AV Designer is responsible for determining the need for plenum rated cabling, and conveying this information to the AV Contractor.
3. All abandoned and unused cables shall be removed by the AV Contractor from conduit, raceway, accessible ceiling space, walls, and equipment racks.
4. All cables shall be labeled per InfoComm’ s Standard “F501.01:2015 Cable Labeling for Audiovisual Systems”. These labels shall match the labeling on the system as-built drawings.
5. All AV connection plate jacks shall be labeled with engraving or printed labels.
6. Cable bend radius should be no less than four times the cable’s diameter.
7. Microphone and speaker cabling shall be separated and not be run inside the same conduit/raceway or pull box as other AV signal or control cables.
8. No in-line splices or couplers on cables shall be allowed.
9. Cable manufacturer approved pull lubricants and pull tension shall be used.
10. Cables pulled for future use shall be labeled as such.
11. Wires contained in phoenix type connectors shall not have tinned ends.
12. Connector strain relief and heat shrink shall be used to avoid cable/connector damage.

B. Cable Management

1. Exposed cable looms (ex: between equipment rack/lectern and wall) shall be covered in flexible braided cable mesh. Cable mesh shall be solid, with no split running the length of the mesh.
2. Power and AV signal cables shall be routed on separate sides of the equipment rack.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 10 of 21

- 3. Rack cabling shall include service loops for equipment removal, servicing, and re-termination of connectors.
- 4. Velcro strips shall be used in all cable management situations. Plastic zip ties shall not be used.
- 5. Loomed cables shall be combed straight and neatly dressed.

C. HDMI Cables

- 1. Shall meet or exceed resolution, refresh rate, and color bit rate bandwidth requirements for the entire system.
- 2. Ultra-thin and/or ribbon HDMI cables shall not be used.
- 3. HDMI cables exceeding 30’ shall not be used. HDMI extenders over Category cable or fiber shall be used.
- 4. Active HDMI cables shall not be used. HDMI extenders over Category cable or fiber shall be used.
- 5. Female-to-female HDMI couplers shall not be used.

D. Speaker Cables

- 1. Speaker cable gauge shall be selected based on specific system design considering length of run and whether speaker loads are 4/8 ohm or 70v constant voltage.

E. Category Cables for AV equipment

- 1. Shall be solid core Cat 6A STP (or higher) cable.
- 2. Shall be shielded and meet or exceed bandwidth requirements per equipment manufacturer specifications.
- 3. HDBaseT cabling shall be purple in color to easy differentiate between AV and network data cabling.

F. RJ-45 Connectors for AV equipment

- 1. Shall be standard RJ-45 connectors, not “pass-through” (aka EZ-RJ45) connectors.
- 2. Shall be terminated using the T568B Wiring Standard.
- 3. Shall meet or exceed manufacturer specifications based on the cable type.
- 4. High use, floorbox and/or connections requiring end user connect/disconnect shall use Ethercon connectors.

4.02 Lectern & Teaching Station

A. Design Standards

- 1. AV equipment integrated with furniture shall conform to the standards outlined in the most recent version of ADA Standards for Accessible Design.
- 2. Provide AV infrastructure for lecterns & teaching stations as outlined in existing AV Basis of Design documentation (<https://it.cornell.edu/integrated-av/av-standards>).

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 11 of 21

4.03 Equipment Rack

A. General

1. Equipment rack design is addressed in the existing AV design guidelines. (<https://it.cornell.edu/integrated-av/av-standards>), including the Equipment Basis of Design and sample Schematic Level Design documents. These existing AV Standards documents shall be used as the basis of design for all AV design projects.

B. Design Standards

1. Passive and active cooling solutions shall be considered for proper rack cooling.
2. Equipment racks shall be properly cooled with the building’s HVAC system and rack cooling accessories.
3. Internal rack temperature shall not exceed 85 degrees.
4. Equipment installed in non-standard equipment racks or enclosed cabinets should have proper top and rear ventilation.
5. Equipment racks built into furniture shall have a preferred usable depth of 24”, and no less than 21”.
6. Equipment racks built into furniture shall have a locking front and rear door for equipment access and security.
7. Equipment racks built into cabinets or with inaccessible backs should pull out and rotate for rear equipment access.
8. Equipment remotes shall be left inside the lectern/equipment rack on an internal shelf, not accessible by users from the front.
9. Equipment racks containing a CIT owned and maintained managed switch shall be in a secure location, have locking front/rear rack doors, or have a locking security cover over the patch panel and switch.

C. Technical/Installation Standards

1. Rack rails shall be threaded for 10-32 rack screws. No cage or clip nuts.
2. Rack rail location shall be adjusted to allow the front and rear doors to close properly, and allow air space between door and front/rear venting equipment.
3. Rear rack rails shall be installed in all AV equipment racks.
4. Equipment racks shall have a locking front and rear door, as well as side panels.
5. Equipment rack accessories shall be used for proper equipment/cable management, air flow, cooling, and security. This may include, rack shelves, horizontal/vertical lacing bars, vent panels, blank panels, security covers, power strips, cooling fans, temperature sensors, etc.
6. Cables and small equipment within equipment rack shall be neatly dressed so as to not impede proper airflow within the rack.
7. Equipment power transformers and power supplies shall be secured to internal rack shelves rather than hang from rack rails.
8. Small equipment shall be rack mounted or secured to rack shelves.
9. Security covers shall be placed over any controls not intended to be accessed by general users.
10. Blank rack space panels shall be installed in all rack openings.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 12 of 21

- 11. Audio amplifiers and other heavy objects shall be installed in the bottom rack spaces.
- 12. When multiple audio amplifiers are installed in a rack and have front intake cooling fans, they should be installed on top of each other, with no vented rack panels between them.
- 13. Equipment rack locations in close proximity to electrical panels shall not obstruct required space around that electrical equipment.

4.04 Control System

A. General

- 1. Control system design is addressed in the existing AV design guidelines (<https://it.cornell.edu/integrated-av/av-standards>), including the Equipment Basis of Design and sample Schematic Level Design documents, as well as existing, standardized control system code and user interface programming.

B. Technical/installation Standards

- 1. All display devices and switchers shall be controlled via serial RS-232 or IP, input devices (DVD/Blu-ray) should be controlled via RS-232 or IR, and motorized screens controlled by relay. RS-232 serial and IP control is preferred over IR.
- 2. Power saving features shall be incorporated into control system programming, like using occupancy sensors to provide system shutdown command when the room isn't occupied.
- 3. Individual device remote controls shall not be used or accessible when a control system exists.

4.05 Projector

A. General

- 1. Cornell University has established a supplier contract for standard projector models, which are listed on existing AV Standards documentation (<https://it.cornell.edu/integrated-av/av-standards>), as the Equipment Basis of Design. Cornell Procurement shall be involved in purchase process for projectors to ensure contractual benefits are applied to project purchases.

B. Design Standards

- 1. Installation Location
 - a. To prevent vibrations from affecting the projected image, projector mount shall not be installed on or near HVAC ducts, vents, or other mechanical devices.
 - b. Projector shall not be installed in a cubby, wall cutout, box, or any other enclosed area that would prevent proper projector ventilation.
- 2. Projector mount should be installed at a throw distance at the middle point of the lens' zoom range.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 13 of 21

3. Ceiling mounted projector lens should be the same height as the top of the screen’s viewing area to eliminate need for digital keystone correction.
4. Mounting:
 - a. In an attempt to allow for forward/back and side movement, as well as vibration control, projector mounts shall be secured to the hard deck ceiling on a 2’x2’ grid of 1 5/8” slotted channel, as specified per the architect/structural engineer.
 - b. Drop ceiling tile tray mounts shall not be used.
 - c. Projector mounts attached to 1 1/2” NPT threaded pipe.
 - d. Anti-vibration mounts shall be used in areas with high potential of ceiling vibration.
5. Reflected screen contrast ratio should be no less than:
 - a. General viewing (general presentations, spreadsheets and webpages): 15:1
 - b. Critical viewing (close inspection of detailed images): 50:1
 - c. Video/film viewing: 80:1
6. Projector case, mount, and pipe color shall be white.
7. AV equipment located at the projector (amplifier, HDBaseT scaler-receiver, etc.) shall be housed inside a UL approved enclosure or ceiling tile box, and not on top of the projector.
8. Projectors installed inside projection booths require a port window to be installed that consists of optical grade glass, made specifically to not alter the projected light.

C. Technical/installation Standards

1. Projector shall have four direction lens shift.
2. Projector shall be compliant with the latest HDCP revision.
3. Projector shall contain security hardware securing the projector to the building structure, or emitting an audible indication that the projector has been disconnected.
4. Mounting pipe shall be solid, not an adjustable extension pipe.
5. No electronic keystone adjustment shall be used. Physical projector mount tilt and lens shift should be adjusted to correct projected image geometry.
6. Included security screws should be used on the projector mount, replacing one screw at each point of mount separation.
7. All AV signal cables shall be pulled through the projector mount’s pipe for a clean appearance.
8. Escutcheon ring shall be installed at ceiling tile pipe hole.
9. All projector mount pipe connection points should be locked with a set screw or a through bolt.
10. Projector mount installation shall not obstruct access for lamp and air filter removal.

4.06 Projection Screen

A. General

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 14 of 21

1. Projector screen models are listed at the following location(<https://it.cornell.edu/integrated-av/av-standards>), as the Equipment Basis of Design.
2. Screens shall be coordinated with AV but furnished and installed by the general contractor, when possible.
3. Projection screens shall be stored horizontally prior to installation.

B. Design Standards

1. Bottom of the projected image shall be at least 48” above the floor in a standard classroom/meeting room, and 42” above the floor in tiered rooms.
2. Installation Location
 - a. Projection screens shall not be installed blocking fire strobes, alarms, or other life safety equipment.
 - b. Projection screens shall not block thermostats, clocks, light switches or power outlets.
 - c. Projection screens shall not be installed next to active air vents that will cause screen movement.
 - d. Projection screen location shall take into account clearances needed for wall mounted objects, like chalkboard trays and chair rails.
 - e. Projection screens shall be installed a location that maximizes continuous blackboard/whiteboard access when the screen is dropped, coordinated with the design team.
 - f. Projection screens should not be installed in an area with excessive natural light from windows without blinds or close to lighting fixtures that can't be controlled by the user.
3. Screen Sizing
 - a. Critical viewing distance (close inspection of detailed images): The screen height should be no less than 1/4 the distance from the screen to the farthest viewer.
 - b. General viewing distance (general presentations, spreadsheets and webpages): The screen height should be no less than 1/6 the distance from the screen to the farthest viewer.
 - c. Video/film viewing distance: The screen height should be no less than 1/8 the distance from the screen to the farthest viewer.
 - d. The screen width should not be greater than the distance from the closest viewer to the screen.
4. Viewing Angles
 - a. Horizontal viewing angle should be less than 45 degrees from every viewer to the center of the screen.
 - b. Vertical viewing angle should be less than 30 degrees from every viewer to the top of the screen.
 - c. Downward vertical viewing angle (from tiered seating) should be less than 15 degrees from every viewer to the bottom of the screen.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 15 of 21

- 5. Mounting
 - a. Screens shall never be mounted to ceiling tile grid T-bar clips.

C. Technical/installation Standards

- 1. Screen aspect ratio shall be 16:10.
- 2. Screen surface shall be matte white.
- 3. Screen case color shall be coordinated with Project Manager.
- 4. Motorized tab tensioned screens preferred.
- 5. Screens hanging from wall “L” brackets shall have their S-hooks crimped closed.
- 6. Motorized screens shall include a low voltage controller for control system integration.
- 7. Motorized screens shall always have a wall mounted switch installed, in addition to any control system integration. Wall mounted switch(s) for the electric projection screens should be located on the wall (46” AFF) close to the lectern location/teaching position, and clearly labeled "SCREEN CONTROL".
- 8. High voltage/power for motorized screens shall be a direct connection, no Edison plugs.

4.07 Flat Panel Display

A. General

- 1. Flat Panel models are listed on existing AV Standards documentation (<https://it.cornell.edu/integrated-av/av-standards>), as the Equipment Basis of Design

B. Design Standards

- 1. Installation Location
 - a. Flat panel displays shall not be installed in an area with excessive natural light from windows without blinds or light from lighting fixtures that can't be controlled by the user.
- 2. Screen Sizing
 - a. Critical viewing distance (close inspection of detailed images): The screen height should be no less than 1/4 the distance from the screen to the farthest viewer.
 - b. General viewing distance (general presentations, spreadsheets and webpages): The screen height should be no less than 1/6 the distance from the screen to the farthest viewer.
 - c. Video/film viewing distance: The screen height should be no less than 1/8 the distance from the screen to the farthest viewer.
 - d. The screen width should not be greater than the distance from the closest viewer to the screen.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 16 of 21

- 3. Viewing Angles
 - a. Horizontal viewing angle should be less than 45 degrees from every viewer to the center of the screen.
 - b. Vertical viewing angle should be less than 30 degrees from every viewer to the top of the screen.
 - c. Downward vertical viewing angle (from tiered seating) should be less than 15 degrees from every viewer to the bottom of the screen.
- 4. Mounting
 - a. Structural wall blocking for flat panel display mounts shall be specified by the architect/structural engineer and furnished by the GC.
 - b. Single stud wall mounts shall never be used on displays larger than 32”.

C. Technical/installation Standards

- 1. Digital signage displays should be installed using a mount that hides and protects the media player.
- 2. Cables should be dressed to allow full motion on articulating mounts.
- 3. Flat panel display shall be compliant with HDCP (latest revision).

4.08 Switching and Signal Distribution

A. General

- 1. Cornell University has established a supplier contract for standard switching and signal distribution equipment models. Reference:
https://downloads.cornell.edu/AV/Equipment_Basis_of_Design.pdf

B. Design Standards

- 1. All switchers and signal distribution equipment shall be compliant with the latest HDCP revision.
- 2. Switchers shall store and manage EDID information between sources and displays.
- 3. HDBaseT compatible signal extenders preferred over other proprietary signal transport methods.
- 4. Excessive scaling and processing of video signals shall be avoided to not degrade the quality of the video signal.

4.09 Bring-Your-Own-Device Connections

A. General

- 1. BYOD design is addressed in the existing AV Standards documentation (<https://it.cornell.edu/integrated-av/av-standards>), including the Schematic Level Design documents. These existing AV Standards documents shall be used as the basis of design for all AV design projects.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 17 of 21

B. Design Standards

1. BYOD connections shall exist in all rooms, primarily located on the lectern or teaching station.
2. BYOD connections provided shall be current to standard design drawings, as well as a wired network connection.
3. BYOD cables shall originate from a cable cubby table box cut into the lectern/teaching station. Cables shall pass through the cable cubby to the HDBaseT transmitter in a location not accessible to general users. The BYOD cables shall not terminate at connectors inside the cable cubby that can be disconnected by users.
4. BYOD cables shall be long enough to reach anywhere on the teaching station, keeping in mind that device connectors may be on the far-side of the device in relation to the cable cubby.

4.10 Audio & Acoustics

A. General

1. Audio system design is addressed in the existing AV design guidelines (<https://it.cornell.edu/integrated-av/av-standards>), including the Schematic Level Design documents. These existing AV Standards documents shall be used as the basis of design for all AV design projects.

B. Design Standards

1. Acoustical consultants should be contracted to analyze large and complex spaces before commencing audio system design.
2. Speaker placement shall be coordinated with the Design Team to maximize quality audio reinforcement, feedback prevention, uniformity of coverage, and intelligibility.
3. Typical installation locations:
 - a. Program audio reinforcement speakers shall be wall mounted on the front wall or mounted on the ceiling.
 - b. Speech audio reinforcement speakers shall be mounted on the ceiling, centralized over the seating area to prevent feedback issues.
4. Ceiling speaker reinforcement systems should be designed using a 30% overlap technique.
5. The distance of installed microphones from the presenter should be no more than 50% of the room's measured critical distance.
6. Acoustic reverberation time in small/medium classrooms and meeting rooms shall not exceed 0.5 seconds, and in large rooms/lecture halls shall not exceed 0.7 seconds.
7. Unoccupied room background noise should be no more than 35dBA. Measurement will be taken at six different locations within the listener area in a standard classroom and 20 locations in a lecture hall, at typical head level, with HVAC system running, using an A weighting on a sound pressure meter.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 18 of 21

8. Sound system signal to room ambient/background noise ratio shall be no less than +20dBA in all octave bands.
9. There should be a maximum of 6dB difference in amplified sound system signal coverage when measured in various locations in the listener area.
10. Speakers installed in a fire resistance rated wall or ceiling shall be listed for that purpose, or be installed in an enclosure that maintains the fire resistance rating.
11. Audience/student microphone design strategy needs to consider performance and functional needs supporting the audio visual use case. For example, table microphone may be preferred over ceiling microphones, due to their close proximity to the subjects and higher degree of end user control.
12. Ceiling plenum rating should be taken into account when selecting ceiling speakers.

C. Technical/Installation Standards

1. Proper unity gain structure shall be set on all systems, paying attention to dynamics and equalization, resulting in uniform and clean audio signals.
2. Wireless microphones shall operate in FCC approved spectrum bands, with the AV designer also ruling out spectrum bands deemed not-approved by the FCC for future use.
3. Mic level cables should not be bundled with line level or speaker level cables, or power cables.
4. If the equipment rack is remotely located, the wireless microphone antennas shall be remotely mounted inside the main room with necessary antenna signal amplification.
5. Ceiling tile speakers shall be installed using grid bridges to support the weight of the speaker, as well as secured to the hard deck ceiling with a safety tether.
6. Ceiling and in-wall speakers shall have rear enclosures to reduce sound transmission through wall and ceiling spaces into other rooms.

4.11 Assistive Listening System

A. General

1. ALS models are listed on existing AV Standards documentation (<https://it.cornell.edu/integrated-av/av-standards>), as the Equipment Basis of Design

B. Design Standards

1. All classrooms or public gathering spaces containing an AV system shall also contain an assistive listening system adhering to the most recent version of ADA Standards for Accessible Design.
2. All speech and program audio sources shall be routed to the ALS.
3. An 2.3 MHz carrier infrared emitter, and/or loop system is required vs. FM transmission, to prevent crossover between ALS systems in adjacent rooms. Inductive loop systems shall be considered in large assembly areas or other public gathering areas.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 19 of 21

4.12 Computer

A. General

1. Cornell University has established a supplier contract for standard computer technology models:
https://www.dfa.cornell.edu/procurement/supplierlistview?field_po_cost_source_desc_value=All&field_contract_desc_value=Computers+-+Desktops+and+Laptops&title=&=Apply

B. Design Standards

1. Resident computers shall have video outputs that are HDCP compliant, for playback of copyright protected content.
2. Wired network connections shall be used for resident computers. No wireless cards.
3. Annotation monitors require mounts that allow the monitor to swing to a low, flat position, comfortable for writing.

4.13 Networking

A. General

1. Networking Standards defined in [Cornell University’s Design and Construction Standards Section 27 00 00 \(Communications\)](#) apply to audiovisual network design.

B. Design Standards

1. All equipment related to the AV system with networking capabilities shall be connected to the network for control, and remote access/monitoring.
2. All audiovisual systems shall have a managed network switch installed in the equipment rack, rather than multiple network jacks servicing the AV system.
3. The AV Contractor shall coordinate with Cornell University CIT for the managed network switch.
4. All AV equipment, the resident computer, BYOD connections, and wireless access points shall be connected to this managed switch.
5. Subnet assignments for each port shall be determined based on established AV design guidelines (<https://it.cornell.edu/integrated-av/av-standards>).

C. Technical/installation Standards

1. A fiber connection will be pulled from the building’s CIT telecommunications room to the AV managed switch for uplink. This fiber connection shall be provided by Cornell University CIT.
2. AV equipment shall be set to DHCP to obtain IP addresses, with host names and IP addresses configured on the DHCP/DNS servers. The AV contractor shall coordinate IP address assignment with Cornell CIT.

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 20 of 21

- 3. AV equipment shall be updated to the latest firmware version available at the time of installation.
- 4. All AV equipment network connections shall be wired connections. No wireless connection.

4.14 Conferencing

A. General

- 1. Conferencing technology design is addressed in the existing AV design guidelines (<https://it.cornell.edu/integrated-av/av-standards>), including the Equipment Basis of Design and Schematic Level Design documents. These existing AV Standards documents shall be used as the basis of design for all AV design projects.

B. Design Standards

- 1. Cornell University has an established video conferencing solution that should be used. Coordinate with Cornell CIT for details.
- 2. Video conferencing CODEC's obtain address book information from a centralized managed source. The AV contractor shall coordinate with Cornell CIT for address book access.
- 3. Conferencing involving cameras shall require the installation of a confidence monitor visible from the teaching station.

C. Technical/installation Standards

- 1. Acoustic echo cancellation processing shall be incorporated into AV systems involving conferencing technology.

4.15 Lecture Capture

A. General

- 1. Cornell University has established supplier contracts for standard lecture capture hardware and software. Reference the existing AV Standards documentation (<https://it.cornell.edu/integrated-av/av-standards>), including the Equipment Basis of Design and Schematic Level Design documents.

B. Design Standards

- 1. Cornell University has established lecture capture hardware and methods, depending on the functionality needed. Coordinate with Cornell CIT for details.
- 2. Lecture capture involving cameras shall require the installation of a confidence monitor visible from the teaching station.

END OF SECTION

REVIEWED BY:JAS	REVISED BY:JAS	AUDIO-VIDEO COMMUNICATIONS	27 40 00
DATE: 12/8/17	DATE: 12/8/17		Page 21 of 21