FLORIDA INTERNATIONAL UNIVERSITY

APPENDIX “C”

AV Standards
Classrooms

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AV Standards - Classroom

FIU
FLORIDA INTERNATIONAL UNIVERSITY
Miami's public research university

Contents

Programming and Planning Requirements

Primary Areas of Coordination

There are a few areas of construction coordination pertaining to audiovisual requirements for the typical FIU Course Capture Classroom. These are below:

- Teaching desk location
- Ceiling Mounted Projector(s)
- Ceiling Mounted Motorized Screen(s)
- Coordinated Ceiling AV Devices
    - Recessed Ceiling Speakers (6 typical)
    - Ceiling Mounted Microphones (5 typical)
    - Ceiling Mounted PTZ (pan/tilt/zoom) Camera
    - Recessed Ceiling Mounted Occupancy Sensor
    - Camera Location Tracking IR sensors

Infrastructure requirements for all the items above are listed in the Definition of Infrastructure Requirements section, along with engineering requirements that will dictate their placement within the space.

High Cost of Failure Items

The following items should be addressed early and monitoring often. They have demonstrated a potential to create undesirable situations that are costly or impossible to rectify when not properly addressed in design.

- Separation of adjacent raceways for EMI / RFI suppression
- Consideration of acoustics for RT60 and adjoining wall STC values
- Consideration of lighting locations/zoning/switching to achieve acceptable screen viewing
- Consideration of mechanical noise (specifically HVAC)

Acoustics

The design team should reference and build according to ANSI S12.60-2002, "Acoustical Performance Criteria, Design Requirements and Guidelines for Schools". A full breakdown of this standard is beyond the scope of this document, but a few key points are noted below:

Background Noise Levels

- Classrooms with internal volumes <20,000 cu/ft should have background noise levels of <35dBA (measured as 1 hr steady-state)
- Classrooms with internal volumes >20,000 cu/ft should have background noise levels of <40dBA (measured as 1 hr steady-state)

- Increase the limits by 5dB where the noisiest 1 hr period is dominated by transportation noise

Baseline recommendations

- Low noise light ballasts are recommended to meet the above requirements
- Mechanical noise should be isolated by teaching areas wherever possible, including:
- Distancing mechanical and electrical equipment rooms from learning spaces.
- Distance restrooms from learning spaces
- Do not run plumbing pipes above learning spaces
- Utilize cast iron waste water pipes where possible

Reverberation Time (RT60)

- Classrooms with internal volumes <10,000 cu/ft should not exceed 0.6s
- Classrooms with internal volumes of 10,000 -20,000 cu/ft should not exceed 0.7s
- Values above reflect one octave bands centered at 500 Hz, 1k, and 2k
- Classrooms with internal volumes <20,000 cu/ft should utilize an acoustical consultant as part of the design team.

STC Ratings

STC ratings are critical in learning spaces. Achieving the stated STC rating for a given construction methodology is highly dependent on controlling leakage through penetrations, joints, and structure borne vibration.

Significant time and cost is involved in the construction of walls, floors, and ceilings to meet contractually required STC construction details. However, these structures are chains that are only as strong as their weakest link. If significant attention is not paid to all discontinuities in these surfaces (doors, windows, junction boxes, penetrations, etc)

STC ratings are dependent upon the anticipated background noise level of the adjoining space and are noted in the table below:

Adjacent space			
Other enclosed or open plan core learning space, speech clinic, health care room and outdoors[c)]	Common use and public use toilet room and bathing room	Corridor,[a)] staircase, office or conference room[a,b)]	Music room, mechanical equipment room,[d)] cafeteria, gymnasium, and indoor swimming pool
50	53	45	60

a) For corridor, office, or conference room walls containing doors, the basic wall, exclusive of the door, shall have an STC rating as shown in the appropriate column in this table. The entrance door shall conform to the requirements of 4.5.5.

b) When the need for acoustical privacy is critical, the minimum STC rating of the partitions around an office or conference room shall be increased to 50.

c) An STC rating of 50 is the minimum for the exterior walls and roofs of a core learning space. However, this rating does not ensure conformance to the background noise limits in table 1 for noise from major outdoor noise sources. See D2.3 in annex D for further guidance on the selection of appropriate STC ratings.

d) When the adjacent space is a mechanical equipment room containing fans circulating 140 m3 /min. (5000 ft3 /min.) or more, the minimum STC rating shall be 60. When the fan circulation is less than this rate, the STC rating may be as low as 45 providing the maximum A-weighted steady background noise level in the adjacent core learning space does not exceed 35 dB. The minimum STC rating shall include the effect of entry door(s) into the mechanical equipment room.

The design team should review Annex B of ANSI S12.60-2002 and ensure compliance. The requirements of this section are frequently ignored in construction. The result is wasteful construction that fails to meet its objective through failure to adhere to the entire standard. Some frequent examples include:

- Utilization of single stud construction
- Leaking of sound through acoustical tiles where wall construction is not carried fully from wall to ceiling
- Providing junction boxes to both sides of adjoining spaces within a single stud cavity without additional treatment.
- Failure to treat all joints and penetrations with acoustical sealant.

Aside from STC ratings, IIC (Impact Insulation Class) ratings of floor-ceiling assemblies should comply with section 4.5.6 of ANSI S12.60-2002.

HVAC Noise

Careful design of HVAC systems is central to achieving the background noise levels indicated above.

The ASHRAE Handbooks, including “A Practical Guide to Noise and Vibration Control for HVAC Systems”, are especially helpful to assist in achieving an HVAC system design that will conform to the required minimum level of steady background noise. HVAC manufacturers should be able to provide useful design noise-rating information for their systems or components.

Acoustical Studies of HVAC Systems in Schools by Gary Seibein and Robert Lilkendey, is recommended reading and attached in the appendix. This article was published in ASHRAE Journal, May 2004.

Power and Grounding

Power conditioning is frequently utilized in commercial AV systems. These products are primarily sold based on misinformation or misunderstanding and do little to improve equipment performance or protection.

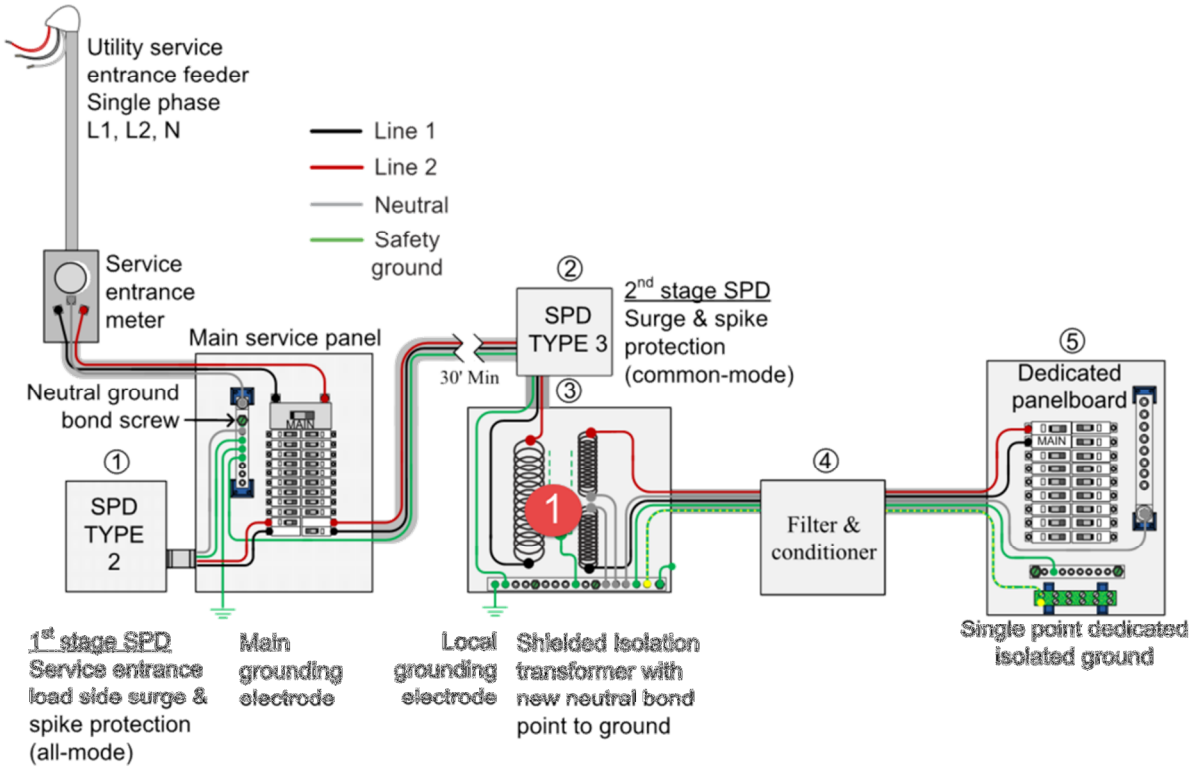
Most hum, buzz, and noise issues are resolved by proper design of power and grounding for AV systems. Much of this effort is related to interrupting low voltage ground loops and defeating EMI/RFI. Avoiding ground loops requires designing with a different objective than traditional building safety ground systems, while still accomplishing the same requirements, in compliance with NEC.

A simple 5 point design strategy for achieving these objectives is stated below:

1. Utilize a type 2 surge protection device outside the facility
2. Utilize a type 3 surge protection device inside the facility
3. Utilize a shielded isolation transformer with single ground reference point *
4. Utilize a 120/120 “same phase” secondary bonding **
5. Utilize a dedicated AV panelboard
6. Locate the isolation transformer as close to the panelboard as possible
7. Utilize a noise filter / conditioner prior to the dedicated AV panelboard
8. Bond all rack enclosures to either with either single point star grounding or daisy chained using paint piercing hardware.

*The neutral-ground bond must be at the AV transformer to prevent return current on the grounding conductor. Do NOT provide the neutral-ground bond point at the panel.

** In the 120/120V arrangement loads are on the same phase, minimizing cross-phase leakage currents. However, the neutral conducts ALL return current, so the panel must be specified with double the current rating, to provide a neutral bar of sufficient load rating and double sized neutral conductors between the panel and transformer.



NOTE: The diagram above reflects an isolated grounding scheme. We don't recommend the use of an isolated grounding system for learning spaces. Their integrity is easily compromised and we rarely see construction executed properly. For this reason, in our experience, this cost is not justified for classroom AV systems.

Raceway Separation

The values in the table below reflect recommended raceway separation for cables in EMT. For conduit not enclosed in EMT, utilize cable hooks and double the distances noted below, wherever possible:

	Group A	Group B	Group C	Group D
Group A (Microphone)	Adjacent	6"	12"	Adjacent
Group B (Line/Data/Video)	6"	Adjacent	6"	Adjacent
Group C (Speaker/MATV)	12"	6"	Adjacent	Adjacent
Group D (Fiber Optic Cable)	Adjacent	Adjacent	Adjacent	Adjacent
120/208V AC	24"	24"	12"	Adjacent
277/480V AC	36"	24"	24"	Adjacent

Microphone cables are particularly susceptible to EMI / RFI. Close attention must be paid to the path of these cables, particularly for longer parallel runs of cabling. For shorter parallel runs, where it is impossible to meet the criteria above, maintain the greatest possible separation. This can have significant impact, when cables are extremely close to each other, as noted by Jim Brown in "Cables, Transmission Lines, and Shielding for Audio and Video Systems":

In the very near field, field strength of the dominant field falls off as the cube of the distance from a point source, and as the square of the distance for the other field. For example, doubling the distance between the noise source and victim circuit would divide the dominant field strength by 8. Since the induced voltage or current is proportional to the field strength, that's 20 log 8 = 18 dB for the dominant field, and 12 dB/doubling for the other field! In the far field, it's 6 dB per doubling. 6 dB/doubling also applies to coupling between parallel cables.

To put this in perspective, consider a power cable tie-wrapped to a video cable. Separating these two cables by just ½" would reduce the current induced into the video cable by 12-18 dB. Whether or not this makes any noticeable impact depends on a huge number of other factors, but when these other factors come into play, good design will provide the necessary isolation.

Cable shields are very effective at attenuating electrical fields, but ineffective at attenuating magnetic fields. The only strategies for reducing AC magnetic field induction are physical separation, tightly twisting the conductors, , or encasing them in ferrous tubing (steel conduit).

Tight twisting of conductors is far more effective, **thus we recommend steel clad "MC" type or "AC-HCF" type flexible cable for use in proximity to low voltage cabling.** Refer to the chart below for specific examples:

Wire Type	Test Subject	Current Draw, using a Resistive Load @120V	Milligauss		
			1/2" Away	2" Away	
Single #12	Conductor only (loose, not in conduit)	7.5A (900 watts) not in proximity to return conductor	180	135	↑
12-2	Romex	7.5A (900 watts)	12.0	7.2	
12-2	1" EMT	7.5A (900 watts)	6.9	4.6	
12-2	1/2" EMT	7.5A (900 watts)	2.7	1.7	Worst
12-2	1/2" Rigid	7.5A (900 watts)	1.5	0.9	Best
14-3	Rubber cord, approx. 2" twist	7.5A (900 watts)	1.2	0.4	
12-2	1/2" steel-clad MC	7.5A (900 watts)	0.6	0.1	
12-3	SignalSafe™ Cord*	7.5A (900 watts)	0.2	0.0	↓

*SignalSafe™ is a trademark of Middle Atlantic Products, Inc.

Lighting Coordination for Screen Viewing

Students require sufficient task lighting to read and write at their desks. Lighting that impacts a projection screen will reduce its contrast and make it harder to read, degrading the learning experience. These two requirements are frequently in direct conflict. Best practices require a minimum of three zones, as dictated on page 57 of the InfoComm AV/IT Infrastructure Guidelines for Higher Education :

1. Front lights that spill directly on the screen (including board lights)
2. Directional task/spot lighting to illuminate the presenter at the lectern or presentation position without spill on the screen
3. Audience area room lights

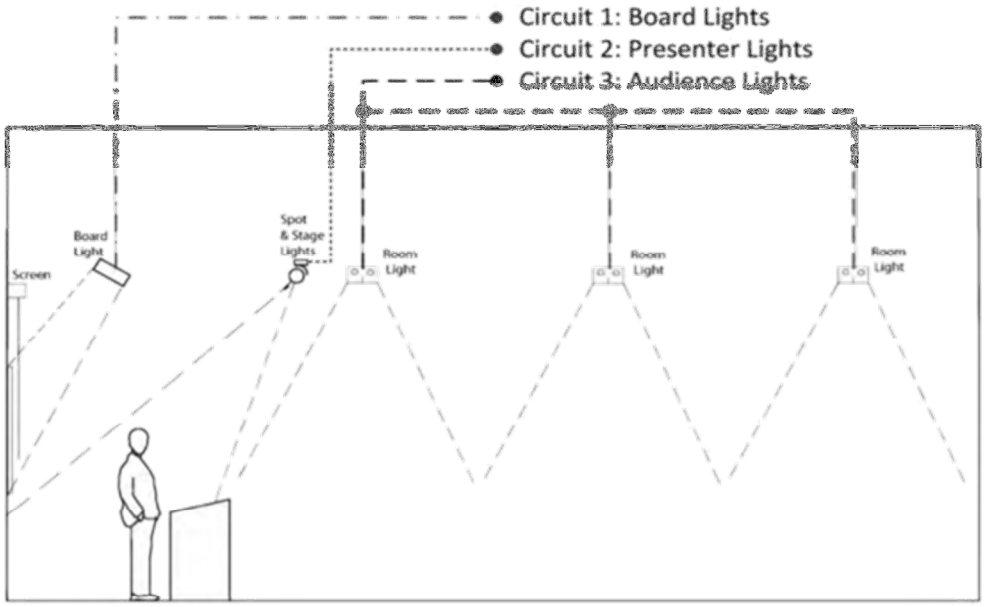


Figure 3.4 Typical three-circuit lighting scheme consisting of separate lighting instruments and control circuits for board lights, presenter illumination, and audience (note taking) lights

Overhead light is not suitable (particularly if non-directional) and light that illuminates the face needs to come at an angle. Presenter lighting should be angled in a way to avoid blinding the presenter and to enable them to maintain eye contact with the audience. Note that in small rooms, even if specific board lights are not used, it may be necessary to isolate the lighting nearest the screen surface so that it may be switched off during projection without affecting the note-taking lights over the general audience area.

During commissioning, the AV team should work with the lighting programmer to establish three lighting presets for non-projection, optimal note taking, and optimal image quality. The second two presets should be measured to obtain a 7:1 and 15:1 contrast ratio, respectively. This process is

described in great detail in ANSI/INFOCOMM 3M-2011 and described briefly in the commissioning section of this document. Typical contrast categories are shown in the adapted table below:

3M -2011 Viewing Category	Minimum contrast ratio	Viewer's Requirements	Examples
Passive Viewing	7:1	Images and text distinguishable from background; informal viewing of video and data	General-purpose classrooms that may have little control of ambient light and where task lighting may not be ideal
Basic Decision Making	15:1	Bullet point text, documents, spread sheets, charts and graphs	Classrooms, boardrooms, multipurpose rooms with improved light control
Analytical Decision Making	50:1	Assimilation, retention and analysis of Images and text that contain finest detail	Specialist seminar rooms and lecture halls with highly controlled ambient light and focused task lighting
Full Motion Video	80:1	High level of engagement with film, video or television programs	Lecture hall or other environment with precisely controlled ambient light

Architectural Coordination of Projection Screens

While natural light is desirable in learning environments, external light must be controlled so that direct light does not affect projection screens or monitors. Depending on finish colors, even indirect light can wash out important details.

In order to properly support pedagogy, projection screens must be properly sized and placed to:

1. Be large enough to be visible to the furthest viewers
2. Provide clear sightlines to all viewers with consideration to instructor position
3. Provide acceptable horizontal and vertical angles of view for comprehension.

Screen Size

Screen Height

1. Measure from the center of the screen location to the furthest viewer
2. Divide this distance by 6
3. The result is the minimum required screen height for comprehension (does not include frame)

Screen Width

1. Start with the screen height as determined by the instructions above
2. Multiply by 1.78
3. The result is the width of the screen, not including frame.

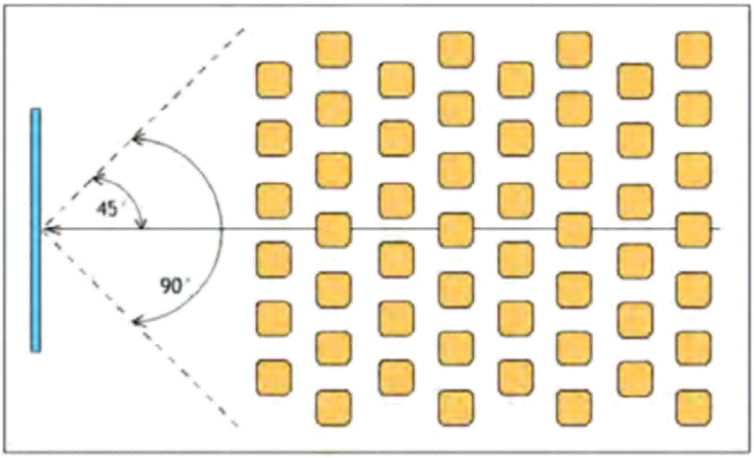
The chart below displays approximate maximum viewing distances for different screen sizes at a 16:10 aspect ratio:

Screen Diagonal in (mm)	Screen Width in (mm)	Screen Height in (mm)	Detailed Viewing H x 6 ft (m)	Inspection Viewing H x 4 ft (m)
84 (2130)	72 (1810)	45 (1130)	22.5 (6.8)	15 (4.5)
96 (2440)	82 (2070)	51 (1294)	25.5 (7.8)	17 (5.2)
100 (2540)	85 (2155)	53 (1347)	26.5 (8.1)	17.5 (5.4)
120 (3050)	102 (2585)	64 (1616)	32 (9.7)	21.3 (6.5)
130 (3300)	113 (2880)	71 (1800)	35.5 (10.8)	23.5 (7.2)
150 (3810)	127 (3230)	79 (2019)	39.3 (12.1)	26.5 (8.1)
200 (5000)	170 (4300)	106 (2700)	53 (16.2)	35.5 (10.8)
300 (7600)	254 (6450)	157 (4000)	78.5 (24.0)	52.5 (16.0)

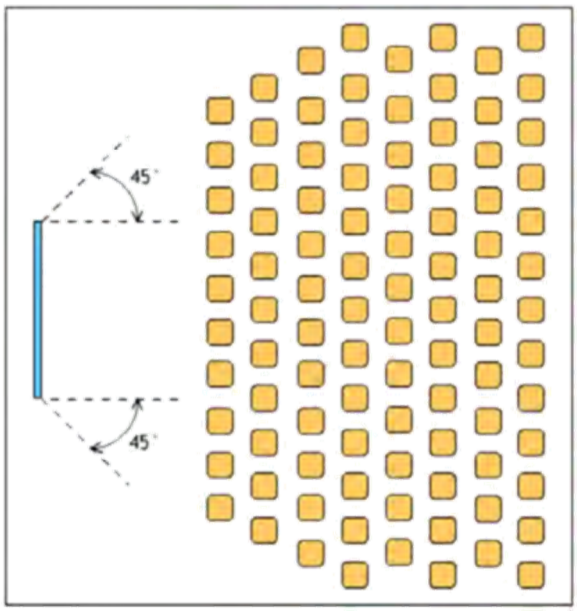
H = the height of the projection screen

Horizontal Viewing Angle

Best practice is to provide horizontal viewing angles where the first seat is at a maximum 45 degree angle from the centerline of the screen. See below :



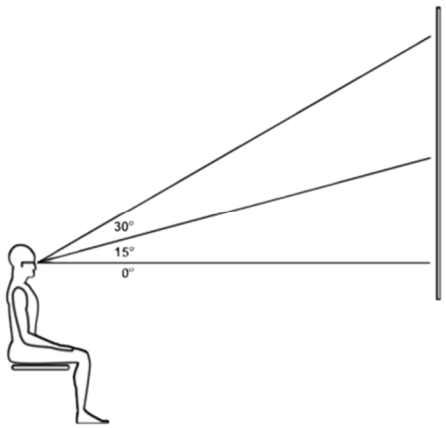
Where this is not possible, a compromise can be achieved by providing a horizontal viewing angle of 45 degrees from the outer edges of the screen. This will provide acceptable **(but not good)** sightlines to the students at the outer edges of the seating area. See below:



If there are a large number of student seats towards the outer edges of the room, it is far preferable to add a second screen and projector. Use the first example above (45 degree angle from the **centerline** of the screen). Mirror the screens around the room centerline and align them so that the 45 degree angles meet at the first seating row.

Vertical Viewing Angle

The maximum viewing angle in the vertical plane should not exceed 15 degrees to image center, when seated. This is the ideal. For difficult rooms, this can be increased to a maximum of 25 degrees to the **top of the screen**, though this is not ideal.



When considering placement of the first row of seating, the distance from the screen to the first row should not be less than the width of the screen. This ensures that students will be able to see the entire screen within their natural field of vision.

Definition of AV Infrastructure Requirements

Teaching desk location

Location Criteria

At front of room. Offset from projection screens for sightlines.

AC Power Requirements

(1) 20A / 120V duplex outlets inside floorbox (see Raceways below)

Raceways

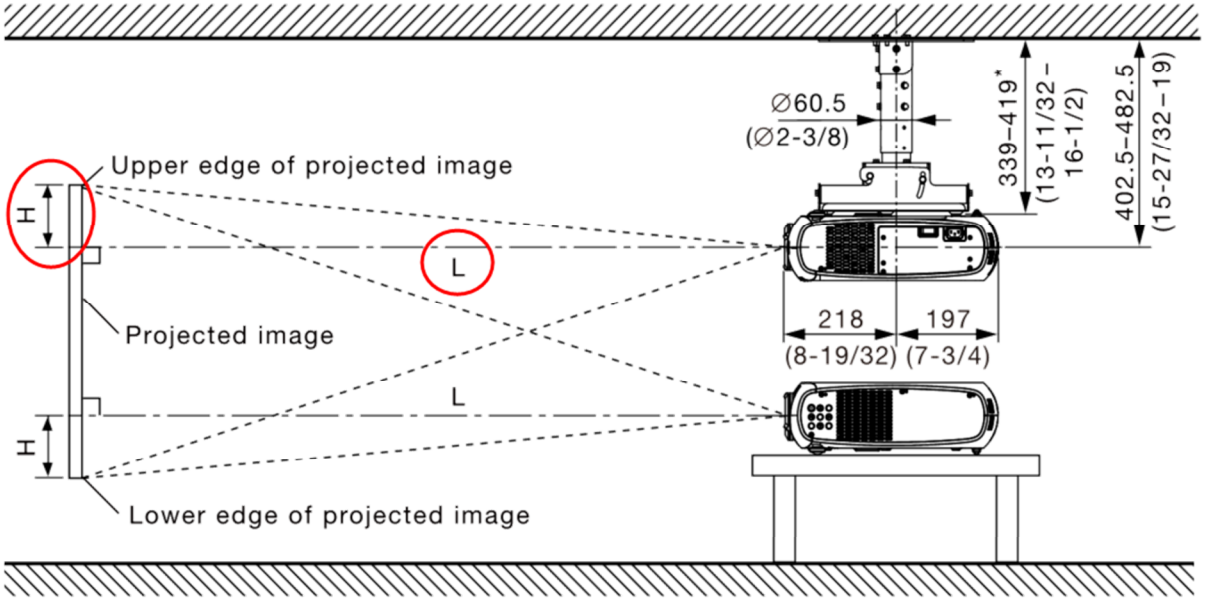
Provide (1) FSR FL500P-6 recessed floorbox at lectern location, with the following:

- Provide (2) 1.5" EMT stub ups for AV cabling
- Provide (1) 1.25" EMT stub up for Data cabling
- Provide (1) 20A / 120V circuits on one quad outlet
- Adhere to conduit separation schedule noted in this document.

Ceiling Mounted Projector(s)

Location Criteria

Mount @ CL of screen (horizontal). Lens aligned near top of screen. AV team to confirm exact mounting height. Distance from screen will vary, based on screen size. See references "H" and "L" below for throw distance and mounting height, based on screen size. AV team to mount at center of lens throw.



Projection distance for 16:9 aspect ratio screen

unit: meters (feet)

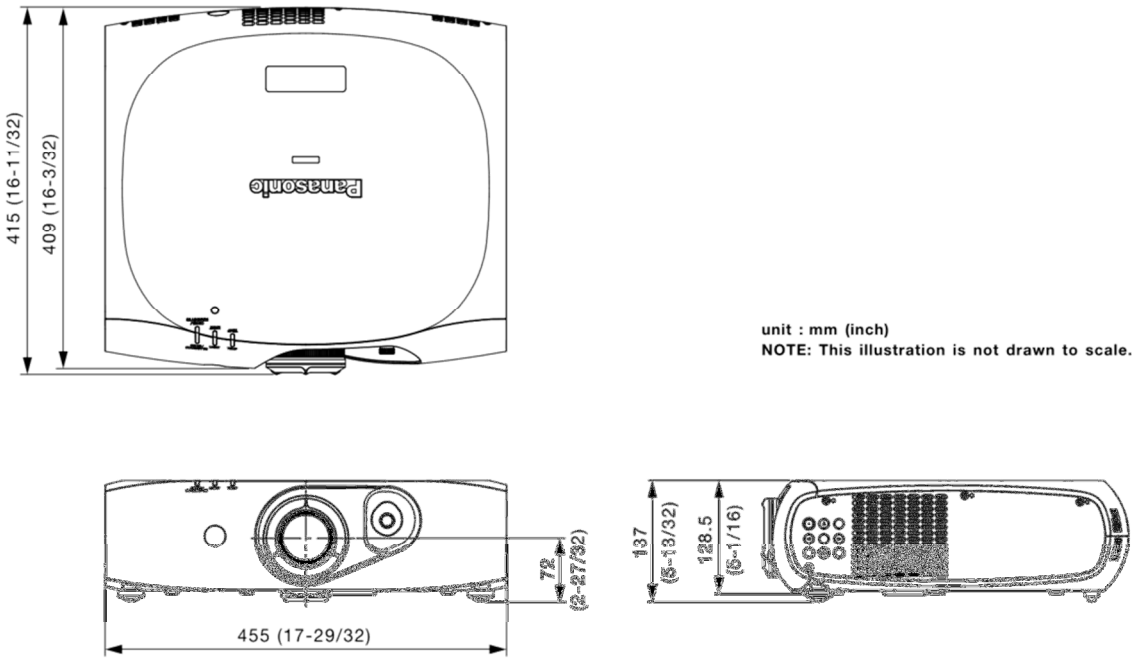
Projection size [diagonal] [m]	[in]	Projection distance [L] Min [wide]		Max [telephoto]		Height from the edge of screen to center of lens [H]	
1.02 /	40	1.3	(4.1)	2.6	(8.5)	-0.12 – 0.49	(-0.4 – 1.6)
1.27 /	50	1.6	(5.2)	3.2	(10.6)	-0.14 – 0.61	(-0.5 – 2.0)
1.52 /	60	1.9	(6.3)	3.9	(12.8)	-0.17 – 0.73	(-0.6 – 2.4)
1.78 /	70	2.2	(7.4)	4.6	(14.9)	-0.20 – 0.85	(-0.7 – 2.8)
2.03 /	80	2.6	(8.5)	5.2	(17.1)	-0.23 – 0.98	(-0.8 – 3.2)
2.29 /	90	2.9	(9.5)	5.9	(19.2)	-0.26 – 1.10	(-0.8 – 3.6)
2.54 /	100	3.2	(10.6)	6.5	(21.4)	-0.29 – 1.22	(-0.9 – 4.0)
3.05 /	120	3.9	(12.8)	7.8	(25.7)	-0.34 – 1.46	(-1.1 – 4.8)
3.81 /	150	4.9	(16.0)	9.8	(32.1)	-0.43 – 1.83	(-1.4 – 6.0)
5.08 /	200	6.5	(21.4)	13.1	(42.9)	-0.57 – 2.44	(-1.9 – 8.0)
6.35 /	250	8.2	(26.8)	16.4	(53.7)	-0.72 – 3.05	(-2.3 – 10.0)
7.62 /	300	9.8	(32.2)	19.6	(64.4)	-0.86 – 3.66	(-2.8 – 12.0)

Dimensions and Weight (Approx)

18”W x 5 ½”H x 16 ½”D, 35 lbs

AC Power Requirements

(1) Duplex oulet – (500W max, 8W standby)



Ceiling Mounted Motorized Screen(s)

Location Criteria

See Architectural Coordination of Projection Screens section of this document for specific criteria.

Dimensions and Weight (Approx)

Dimensions vary (see section above), Weight is < 150 lbs

AC Power Requirements

Direct connection to pigtail in screen housing – 1.5A / 120V

Recessed Ceiling Speakers (6 typical)

Location Criteria

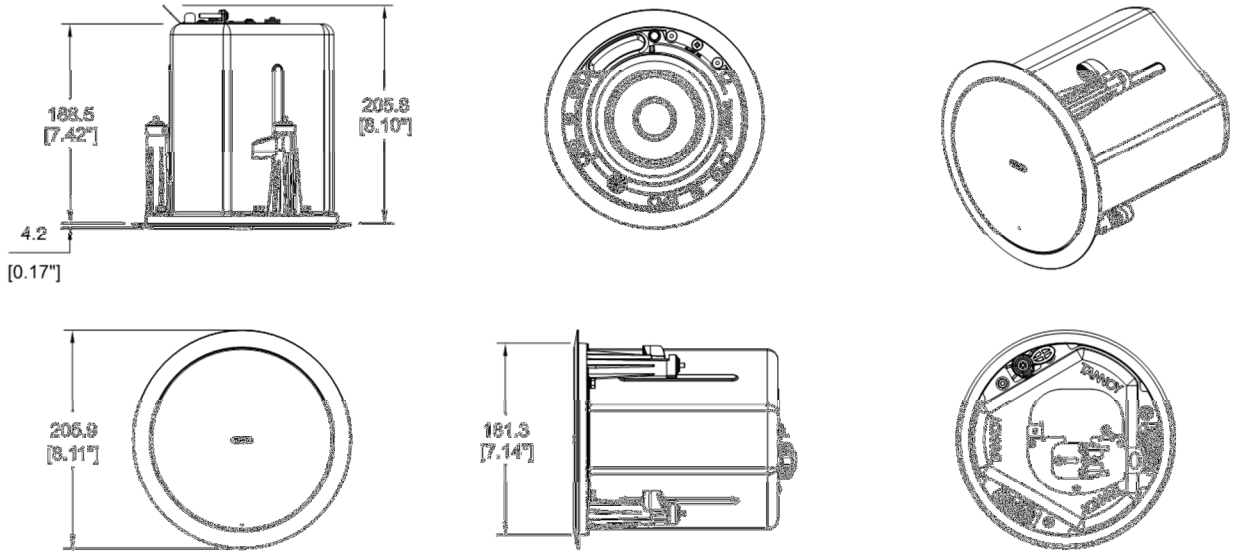
Evenly spaced over student seating. No speakers near instructor area. Increase spacing by 1.5x between speakers and perimeter walls. Set transformer tap to OFF position.

Dimensions and Weight (Approx)

*8.*11” Bezel diameter, 12 lbs

AC Power Requirements

NONE



Ceiling Mounted Microphones (5 typical)

Location Criteria

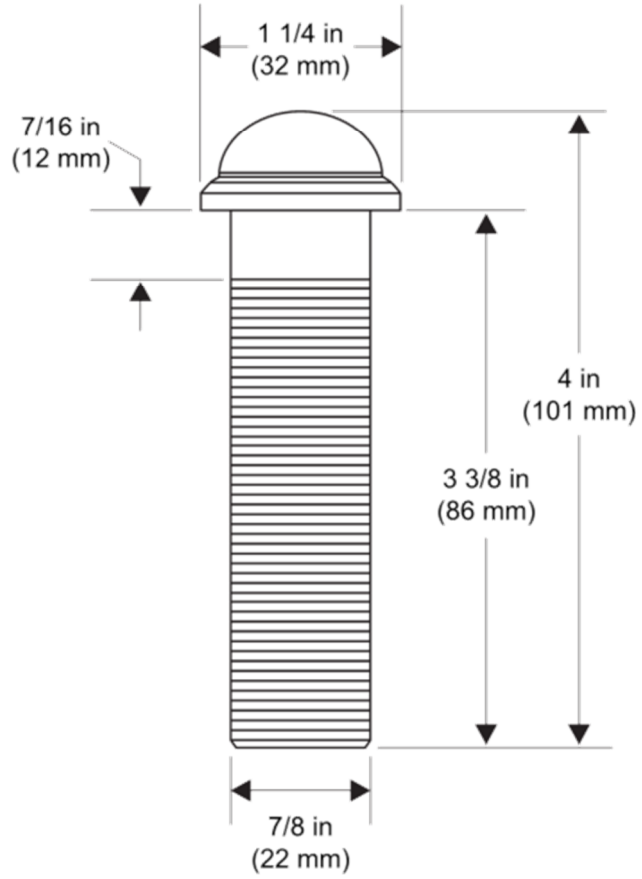
Plan for a row of microphones with centerline between front wall and first desk. Microphones must be equally spaced along this line. Skip the area directly above the instructor lectern / desk. The purpose of these microphones is to consistently reproduce the instructor’s voice when he/she is not sitting at the desk (there is a microphone installed in the desk surface). After installation, the microphone grille only protrudes 5/8” through the finished ceiling.

Dimensions and Weight (Approx)

Diameter – 1 ¼”, Depth – 4”, Weight – <1 lb

AC Power Requirements

NONE



Ceiling Mounted PTZ (pan/tilt/zoom) Camera

Location Criteria

Mount on rear wall at horizontal centerline of room. Ideal vertical position is +/- 15 deg of instructor eye level. Mount at 120" AFF.

Dimensions and Weight (Approx)

6 ½" W x 7 ½"H x 6 ½"D

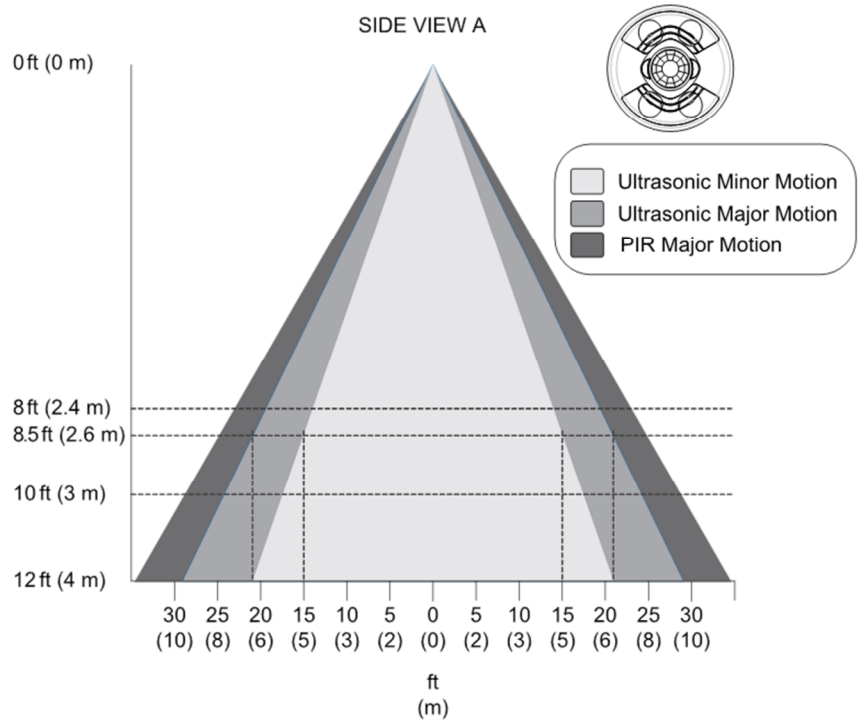
AC Power Requirements

(1) Duplex outlet – 1.2A / 120V

Recessed Ceiling Mounted Occupancy Sensor

Location Criteria

Ceiling mount centered between primary room entries. See diagram below:

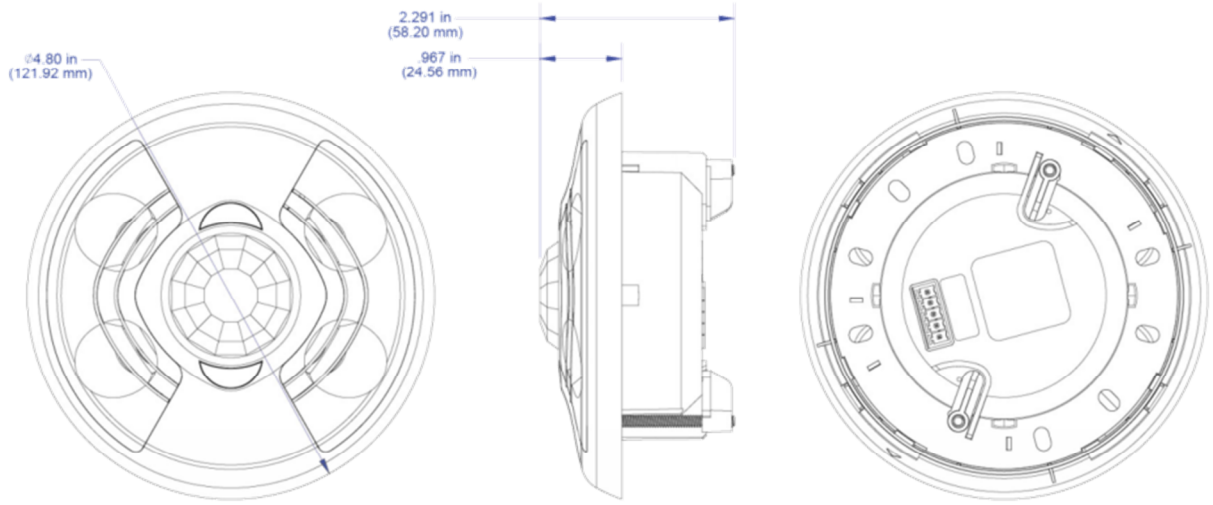


Dimensions and Weight (Approx)

*4.*80” diameter, 5.1 oz

AC Power Requirements

NONE



Camera Location Tracking IR sensors

Location Criteria

Coordinate with AV department.

Dimensions and Weight (Approx)

6 1/8" diameter, < 1lb

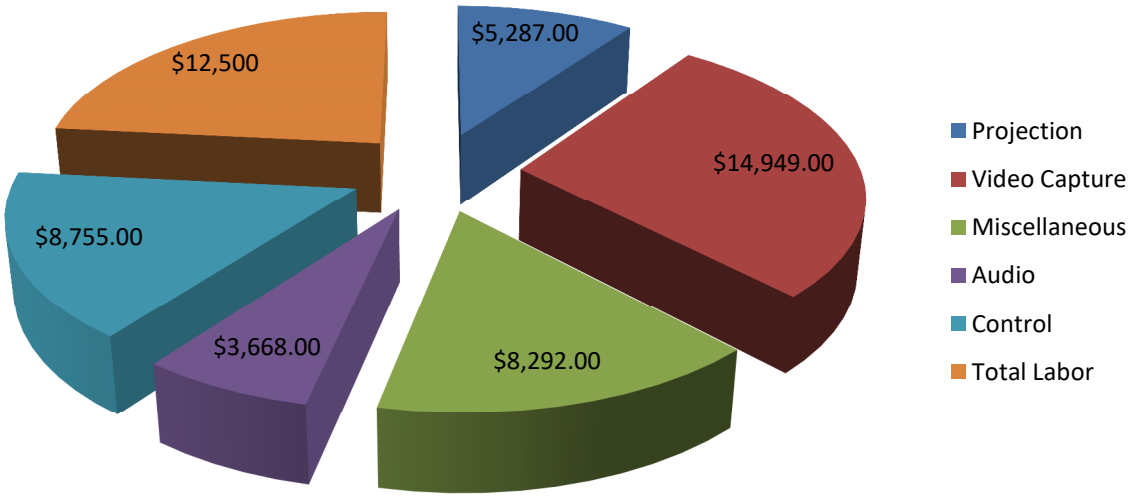
AC Power Requirements

NONE

Division of Scope / Responsibility Matrix

Item	Furnished By				Installed By				Notes
	GC	EC	AV	IT	GC	EC	AV	IT	
Raceways, conduit, junction boxes, and wireways		x				x			
All related rough-in for above									Provide 2 weeks notice after completion for AV inspection
Specialty backboxes and floorboxes			x			x			
Speaker backcans			x				x		
All wall, floor, and ceiling mounted AC power receptacles		x				x			EC to abide by AV raceway seperation guidelines
Power distribution within racks and teaching consoles			x				x		
Dedicated AV Isolation Transformer and Panel		x				x			See requirements in AV documents
All low voltage AV cabling			x				x		
All low voltage AV terminations			x				x		
Wall blocking and structural hang points for AV devices	x				x				See detail drawings in AV documents
Projection Screens			x				x		
Provision of OFE PCs			?				x		
Millwork cutouts for teaching furniture			x				x		

Typical Cost Distribution



TOTAL COST - $53,000

The cost distribution shown above is typical for a capture classroom with a single projector and screen.

AV System Functional Narrative

Overview

The FIU Standard Course Capture Classroom allows an instructor to choose between (5) video sources (Desktop PC, Document Camera, BluRay, Wireless laptop presentation, Wired laptop connections (either HDMI or VGA). When selected, the source will be displayed on the motorized projection screen.

The audio feed from these video sources is mixed with a microphone at the instructor's desk within an audio DSP and sent to (6) recessed ceiling speakers. This signal is combined with a mix of (5) additional ceiling hung microphones and sent to two different course capture systems.

Both course capture systems receive the content from the video sources, as well as a PTZ camera feed of the instructor. The PTZ camera is automatically triggered to preset positions, based on IR probes that sense the instructor's position.

Capture feeds are ingested to MediaSite server, then into Blackboard. Vidiu is recorded to Wowza.

The FIU Standard Course Capture Classroom consists of the following primary subsystems:

- Source Devices
- Switcher / Control Processor
- Course Capture
- Audio System
- Projector / Screen / Confidence Monitor

The function of these systems is described below:

Source Devices

Source Devices include:

- Document Camera
- Instructor fixed PC
- BluRay
- Wireless PC Presentation System (AirMedia)
- Aux Connections
    - HDMI
    - VGA
    - Audio (VGA)

All of the source devices are installed within the instructor desk and connect directly to the Video Matrix / Control Processor. All devices utilize HDMI connections, with the exception of the AirMedia and the Aux VGA connection.

Switcher / Control Processor

The current FIU standard is the Crestron DMPS3-300C. This device provides all audio and video routing, control processing, and amplification in a single package. A touchscreen control sits on top of the teaching console and is connected to the control processor via the network.

Device control is provided for the BluRay, Projector, and PTZ Camera via RS232. An occupancy sensor connects via Cresnet. Additionally, (3) IR sensors are utilized to trigger PTZ camera presets, based on the instructor's position.

Course Capture

The primary course capture feed is scaled and sent directly to a MediaSite RL120 unit. This unit feeds the course capture system over network connection. The output of the RL120 is fed back to the main video matrix via Crestron DM. All cabling remains local. The DM transmission hardware simply provides access to the only remaining input on the matrix for confidence monitoring.

The secondary course capture signal feeds a Teradek VIDIU unit via a Crestron Capture HD Encoder. This unit provides a feed for monitoring on the command center video wall.

Both primary and secondary capture units are fed by three inputs:

- Content (Source fed from Video Matrix)
- Camera (Direct feed from PTZ camera)
- Audio (Analog Audio Mix from DSP)

Audio System

The core of the audio system is an audio DSP (digital signal processor). Currently this device is a Biamp Tesira Forte CI. There are 8 audio inputs:

- Teaching Desk Microphone
- (5) Ceiling Microphones
- Stereo source feed from Video matrix

There is a discrete output from the DSP to each of the two course capture systems.

There are also (6) recessed ceiling speakers. These are wired directly to an internal amplifier in the DMPS processor. Speakers must be wired for a minimum load of 4 ohms (preferably not less than 8 ohms). The DMPS amplifier outputs 20W RMS per channel at 8 ohms.

Projector / Screen / Confidence Monitor

Course Capture Classrooms utilize motorized screens. These are triggered by Crestron contact closure. Projectors and solid state and controlled by RS232 via DM-RMC. A confidence monitor is mounted to a moveable arm atop the teaching desk (along with the all-in-one PC on the other arm). The confidence monitor is fed by DM. This is a local connection, again using DM not for extension but to utilize the DMPS DM output.

Typical Oneline Flow Diagrams, Rack Elevations

Approved Cabling

Wire Types

ID	Useage	Riser	Plenum	Cable Description

		Belden	West Penn	Belden	West Penn	
A	Line Level Audio	9451	454	9451P	D25454	1 Shielded PR #22 AWG Twisted Shielded
B	Data - CAT5e	1583A	4245	1585A	254245	Cat5e U/UTP 24 AWG Solid Copper
C	HDVideo - Field	1694A	6350	1695A	256350	75 Ohm, Precision Video Cable, #16 AWG
D	HDVideo - Rack	1505A	819	1506A	25819	RG-59U, 20awg, solid, foil/braid shield
E	8 ohm speaker	5000UE	227	6000UE	25227B	1 PR #12 AWG, Stranded, Twisted
F	70V speaker	5200UE	225	6200UE	25225B	1 PR #16 AWG, Stranded, Twisted
G	Control	1502R	77350	1502P	D25350	2PR, #22 AWG Shielded, #18 AWG
H	HDBase-T (DM)	AV6SHR	4246F	AV6SHP	254246F	Cat6 F/UTP 23AWG bare solid copper*

*Cables used for HD BaseT must be certified as HDBaseT Recommended Cable by the HDBaseT Alliance.

**Crestron DM Cabling (Creston DM-CBL-8G-NP / DM-CBL-8G-P) to achieve Crestron DM Certification

***Comparable product by Canare, Gepco, Liberty, or Comm/Scope acceptable if submitted for approval prior to purchasing.

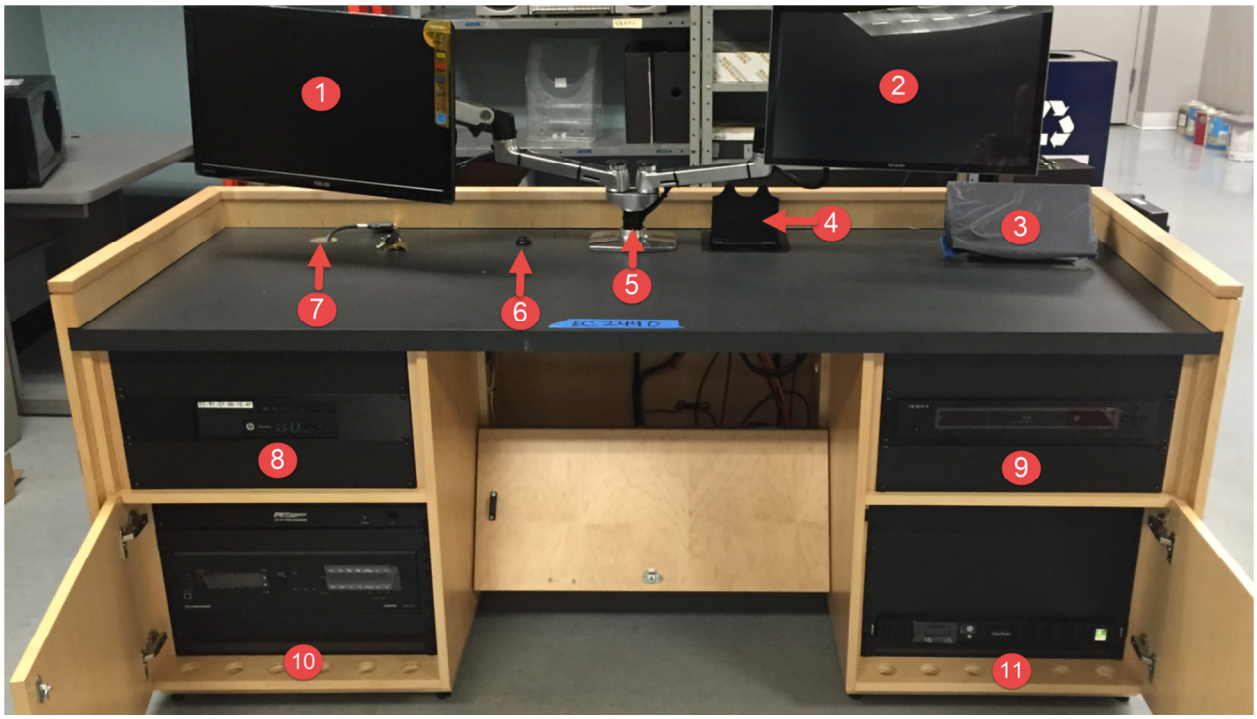
Connector Types

1. 1/4 Inch Cable Connectors: Non long frame type.
    a. Neutrik “NP” Series
    b. Comparable product by Switchcraft.
2. Loudspeaker Cable Connectors: 4 or 8 pole.
    a. Neutrik Speakon NL4FC or NL8FC
    b. Comparable product by Switchcraft.
3. IHF (RCA) Audio Cable Connectors: For all IHF (RCA) audio jacks, gold center pin, spring type strain relief.
    a. Canare F 09
    b. Comparable product by Switchcraft.
4. 1/4 Inch Panel Connectors: All conductors shall be insulated from panel.
    a. Neutrik “NJ” series
    b. Comparable product by Switchcraft
5. Loudspeaker Panel Connectors: 4 or 8 pole.

a. Neutrik Speakon NL4MP or NL8MP
b. Comparable product by Switchcraft

6. XLR Panel Connectors: Black shell, gold pins.
    a. Neutrik “D” Series
    b. Comparable product by Switchcraft.
7. 3.5mm (1/8”) Cable Connectors: Mini TRS for balanced mono audio or unbalanced 2 channel audio.
    a. Canare F-12
    b. Comparable product by Switchcraft.
8. Electrical/Electronic Hardware: Telco 66 type punch blocks are not acceptable. All materials located in plenum spaces must be plenum rated.
    a. Terminal barrier strips - provide marker strips
        i. Phoenix UK
        ii. Comparable product by Cinch, Beau.
    b. Split ring punch block - provide marker strips
    c. ADC ICON series 4.
    d. Comparable product by AVP, Switchcraft.

Instructor Desk Details



1. **Confidence Monitor** – For instructor to monitor streaming video feed
2. **All-in-one PC** – Conceal USB hub and all connections within furniture
3. **Touchpane**l – Mount directly on top of desk surface at this location
4. **Cable Cubby** – Mount at this location for laptop Aux connections, network and power
5. **Dual arm mount** – Install swivel arm mount directly in center of desk
6. **Boundard Microphone** – Flush mount at this location.
7. **Document Camera** – Use grommet for cable pass at this location
8. **Accessible Rackspace** – Previously used for desktop PC
9. **Accessible Rackspace** – BluRay player mounted accessible for instructor
10. **Locked Rackspace** – DMPS processor with 8 port network switch mounted in rear
11. **Locked Rackspace** – Dual UPS units

Approved Equipment Manufacturers / Models

Manufacturer	Model	Description
Projection System		
FIU		Custom Projection Screen
Panasonic	PT-RZ370U	3500 lumen LED/laser projector
Chief	CMA440	Above tile suspended ceiling kit
Chief	RPMAUW	Project mount
Chief	CMSZ006	Fixed Pipe fully threaded 6"
Capture System		
Sonic	Foundry Mediasite RL120	Dual DVI Input Recorder
Crestron	Capture HD PRO	HD Recorders
Panasonic	AW-HE40S	HD-SDI PTZ camera w/30x zoom
Crestron	HD-Scaler-HD-E	HD Scaler
Teradek	VidiU	Web streaming applicance
Vaddio		AutoView IR Triggers
Vaddio	535-2000-230	Thin profile wall PTZ mount
Blackmagic Design	Mini Converter SDI-HDMI	HDSDI to HDMI Converter
B&B Electronics	4WSD9TB rs422-to-rs232	RS-422 to RS-232 Converter
Miscellaneous		
Camilo	Podium Model E	Teaching Podium
Extron Electronics	Cable Cubby 600 black	Cable cubby
Oppo	UDP-203	4k Bluray Player
Middle Atlantic	RSH4A2M OPPO UDP203	Custom Rack Shelf for Oppo UDP-203
WolfVision	VZ3	Document Camera
TrendNet	TPE-TG44g	8-Port Gigabit PoE+Switch
Ergotron	LX Dual Side	Dual Arm Mounting Kit
CyberPower	OR1000LCDRM1U	1000VA line interactive UPS - 1RU

ASUS	VS228H	Desktop confidence monitor
D-Link	DUB-H7	USB Hub 7 Port
Dell		All-in-one PC for instructor desk
Furman	D10-PFP	1RU 15A power distribtor w/10 outlets
Middle Atlantic	UTR1	1SP Universal Half-Rack T
Audio System		
Tannoy	CMS-503DC-BM	5" recessed ceiling speaker (blind mount)
Biamp	Tesira Forte CI	12x8 DSP with 8ch of USB audio
Shure	MX395B/C	Low profile boundary microphone
Control System		
Crestron	DMPS3-300-C	DMPS Video Matrix and Control Processor
Crestron	AM-101	Airmedia Wireless Presentation Gateway
Crestron	C2N-1O	Cresnet Control Port Expansion Module
Crestron	DM-RMC-4K-SCALER-C	DM 4k Scaler
Crestron	DM-TX-201-C	DigitalMedia 8G+ Transmitter 201
Crestron	GLS-ODT-C-CN	Cresnet Occupancy Sensor , 2000 Sq Ft
Crestron	DM-RX1-4K-C-1G-B-T	Wall Plate 4K DigitalMedia 8G+Receiver
Crestron	TSW-1060-B-S	10.1" Touch Screen, Black Smooth
Crestron	TSW-1060-TTK-B-S	Tabletop Kit for TSW-1060, Black Smooth
Crestron	TSW-560/760/1060-SMK	Swivel Mount Kit for TSW-1060-TTK

Control System Narrative with Screenshots and Callouts

Quick Start Guide

Button Functions:

(1) **Date and Time** - The top left of the touchpanel always displays the date and time

(2) **Video Source Selection** - The left side of the touchpanel shows the available video sources when these are available to be routed. Pressing to select a source routes it to the screen. In cases where there are additional controls available on the touchscreen for that source (BluRay and Air Media), these controls will be displayed at the area to the right (#12)

(3) **Volume Meter** – This bargraph shows the volume level of the speakers in the classroom. This meter will respond to changes made with Buttons 4,5,6.

(4) **Audio Mute** – Silences the sound to the ceiling speakers in the classroom

(5) **Audio Volume Down** – Lowers the volume of the ceiling speakers in the classroom

(6) **Audio Volume Up** – Raises the volume of the ceiling speakers in the classroom

(7) **Blank Projector** – This button mutes the projector image (makes it go black)

(8) **Home** – This button returns the user to the main page shown above from any other page

(9) **Projectors** – Displays a page to turn the projector(s) on/off and raise/lower the screen(s). These functions are normally handled through the power button.
(10) **Help** – Displays the phone number for support
(11) **Power** – Turns the entire system on/off and raises/lowers the projection screen(s).
(12) **Additional control functions** – Buttons and text in this area will change based on the source selected at the left or the functions triggered at the bottom of the touchpanel.

Detailed Touchpanel Narrative

After a few minutes of inactivity, the system will automatically log the user out and the screen below will be displayed:

After pressing the screen, the touchpanel will update to the page below:

The page above includes the majority of the necessary user controls. Individual functions for all of these controls will be noted individually later in this section. The system is turned on with the button at the bottom right, then a video source can selected from the list on the left side. Volume can be turned up, down, or muted at the bottom left. When the BluRay or AirMedia is selected, additional controls for these devices will appear at the right, as shown below:

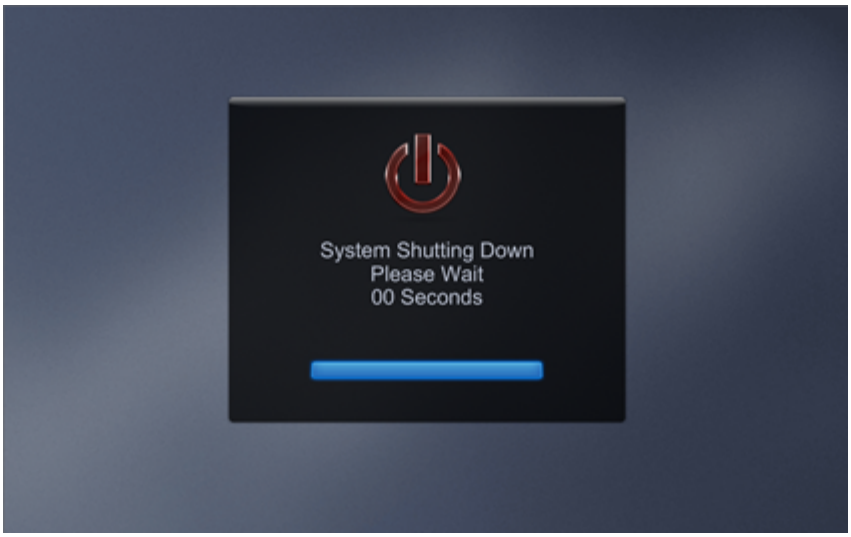
Although the power button is typically used to turn the entire system on and off, there are also discrete controls for turning the projector on/off and to raise/lower the projection screen. Pressing the "Projectors" button on the bottom of the screen brings up the screen shown below for these functions:

From this screen, the main functions are still available along the bottom of the screen (volume control, power, blank projector (Screen mute). To get back to the main menu to select a source again, the user simply presses the "Home" button at the bottom of the screen. For rooms with dual projectors and screens, this page will include discrete controls for each, labeled left / right (looking directly at the screens).

Error Trapping and User Information

An important aspect of the FIU programming standard is error trapping. This means giving the user additional information about what is happening and at time explain why the system is not performing as they expect. This reduces help desk calls and allows instructors to solve the problem more quickly. Examples are shown below:

The screen above allows the user to cancel out of their action, if they pressed the power button by mistake.



The screen above lets the user know that the projector is powering down. When a projector is turned off, the fan must remain running and a cooldown cycle must complete to avoid damage to the projection lamp. During this time, the projector cannot be turned back on. This popup window avoids confusion by letting instructors know that something is still happening.

This screen lets the user know that something is happening, so they have confidence that they have pressed the correct button. There is a similar screen letting them know when the projector is powering off.

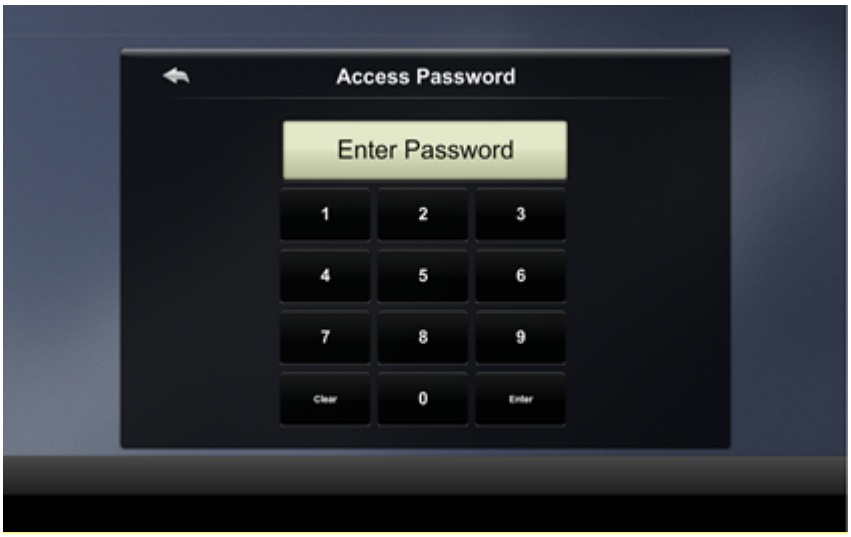
Source Selection Tips

When a source is selected from the menu at the left, there is a tip provided at the blank area on the right. This lets the user know what to check if they are not seeing an image on the screen. Examples are below:

- **Desktop** – Please make sure desktop computer is powered on if no image is present on the screen
- **DocCam** – Please use controls on the document camera
- **BluRay** – (Displays BluRay controls)
- **AirMedia** – (Displays connection status, IP address, and Passcode)
- **Aux HDMI** – Please make sure the HDMI device is powered on if no image is present on the screen
- **Aux VGA** - Please make sure the VGA device is powered on if no image is present on the screen

Advanced Screens

How to access advanced control screens – Press and hold the help button for more than 5 seconds

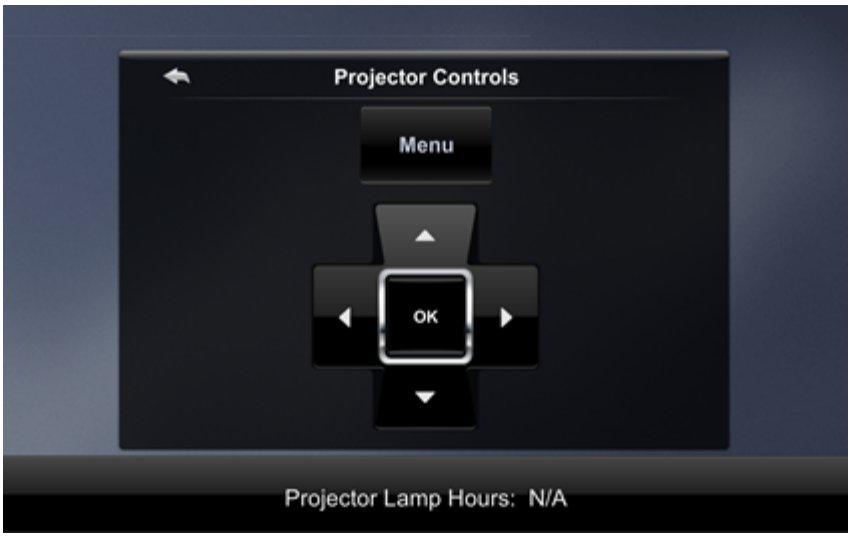


The page above is displayed, requiring users to enter a passcode to proceed. When the correct code is entered, the page below is displayed:

Reboot Processor – Reboots the Crestron control processor

Enter Setup – Enters the Crestron touchpanel setup menu for accessing Cresnet ID, etc.

Projector Menu – Allows a technician to view lamp hours, enter and navigate through the projector menu, using the controls below:



Integrator Standards for Quality, Labeling, and Documentation

General

A. Contractor shall provide all necessary cables, connectors, adaptors, converters, EDID locks, and similar elements required to achieve fully functional design intent, without claim for additional payment.

B. Mount equipment and enclosures plumb and square. Permanently installed equipment to be firmly and safely held in place.

C. All AV equipment that requires an IP address shall be coordinated with FIU. AV Integrator to provide FIU with a list of all required IP addresses two months prior to start of device configuration. Any changes required due to un-approved addresses shall be at the integrator's expense.

D. Cover edges of cable pass-through holes in chassis, racks, boxes, etc., with rubber grommets or Brady GRNY nylon grommets.

E. Neatly harness wires together within racks by power level classification using horizontal and vertical wiring supports as required. Rigidly support all wires within 6" of fixed connection points. Leave service loops of sufficient lengths to allow rack hinges or slides to fully extend to facilitate access to rear panel connectors from the front of each rack. Do not use self-adhesive anchor pads for support of cables.

F. Where exposed wiring exits from walls to desks, lecterns, credenzas, or other furniture, cable harnesses shall be neatly bundled and covered with TechFlex. Any wiring harness intended for connection to a floorbox or wallbox must have label

designations matching the connectors that they are intended to mate with at the floorbox / wallbox. Every cable in the system must have a matching cable number identifier at both ends. Cable labels must be printed and laminated for protection.

G. Provide “bullnose” plates at any wallbox location where cabling passes through the box and terminates at the equipment, rather than the wallbox.

Equipment Racks / Teaching Consoles

A. Install rack mounted equipment with black 10-32 button head machine screws with Phillips drive, using plastic cup washers to protect equipment faces.

B. Provide security covers on non-user operated equipment having front panel controls. Install covers at the conclusion of Acceptance Testing.

C. Provide engraved lamacoid labels at the front and rear of signal processing equipment mounted in racks. Mount labels on the equipment and attach in a neat, plumb, and permanent manner. Provide engraved labels at the rear only of equipment mounted in furniture consoles. Equipment labels to include the schematic reference of the device, i.e., VC-01 or AMP-01.

D. Custom rack panels shall be 1/8 inch thick aluminum, standard EIA sizes, brushed black anodized finish unless otherwise noted. (Brush in direction of aluminum grain only.) Custom connector plates (speaker, microphone, etc.) are typically stainless steel; however, verify plate finish with the Owner. Plastic plates will not be accepted.

E. Engraving shall be 1/8 inch block sans serif characters unless noted otherwise. On dark panels or pushbuttons, letters shall be white; on stainless steel or brushed natural aluminum plates, or light-colored pushbuttons, letters shall be black.

F. Install 3-conductor, 120 VAC outlets in each rack or console, as required. Provide a minimum of two spare outlets in each rack. Label each outlet as to which AC circuit is feeding it and provide the same information in the circuit breaker panel.

G. Provide blank panels to cover any unused rack spaces in the front of all AV racks.

H. Provide rackmount kits for any product where this is available from the manufacturer, regardless of whether the product skew is specifically referenced in the bid documents. Provide rackmount shelves as necessary to mount all required equipment that does not have a rackmount kit available from the manufacturer

I. Provide ventilation adequate to keep temperature within the rack below 100 degrees Fahrenheit. Provide whisper type ventilation fan in each rack if temperature in rack rises above 100 degrees with power on for five continuous hours. This ventilation system must be temperature actuated.

J. Looking at the rack from the rear, locate AC power, digital control, DC control, and

speaker wiring on the left; microphone, line level audio, and video wiring on the right. Panels or equipment mounted on the rear rack rails shall not block access to any front mounted components.

Cabling and Connectors

A. Use only Neutrik or Switchcraft Connectors unless otherwise noted.

B. Use only WAGO or Weidmuller tension clamp / DIN rail mount type for all terminal block connection. Utilize ferrules for all connections to terminal blocks.

C. For all fiber optic cabling only utilize connectors and tools specifically approved by cable manufacturer for the specified model.

D. Do not use pass-thru type RJ45 crimpers for any Vaddio category cable terminations.

E. Use shielded keystone jacks for all HDBaseT video connections

F. Take precautions to prevent and guard against electromagnetic and electrostatic hum. For line level audio signals, float cable shields at the output of source device. Shields not connected to be folded back over cable jacket and covered with heat-shrink tubing. Do not cut off unused shields.

G. Exercise care in wiring; damaged cables or equipment will not be accepted. Isolate cables of different signals or different levels; and separate, organize, and route to restrict channel crosstalk or feedback oscillation in any amplifier section. Keep wiring separated into groups per project documentation.

H. Make joints and connections with rosin-core solder or with mechanical connectors approved by the Owner; where spade lugs are used, crimp properly with ratchet type tool. Spade lugs mounted on 22 gauge or smaller cable to be soldered after crimping. All solder for signal terminations to be lead-free and RoHS compliant.

I. Route unbroken microphone, audio line, and control wiring from source to destination. NO SPLICES WILL BE ALLOWED. Remove spliced cables and replace without additional charge to the Owner.

J. Connect cable to active components through screw terminal connections and spade lugs whenever available. Make connections to speaker transformers with properly sized closed end connectors crimped with factory approved ratchet type tool. Wire nut or "Scotchlock" connectors are not acceptable. Do not wrap audio cable splices or connections with adhesive backed tape.

K. Neatly bundle excess AC power cable from rack mounted equipment with plastic cable ties. Rack wiring to be bundled with plastic cable ties or lacing twine. Electrical tape and adhesive backed cable tie anchors are not acceptable.

L. Connect loudspeakers electrically in phase, using the same wire color code for speaker wiring throughout the project.

M. All cables within the system shall be labeled with a unique identifying number at each end of the cable. Use only pre-printed labels. Cover labels with clear heat shrink tubing. Self-adhesive labels will not be allowed without prior approval of Consultant.

N. Secure all cables in equipment cabinets and terminal cabinets to provide strain relief at all raceway exits in accordance with NFPA 70 including all supplements. All

O. Neatly tie all cabling within equipment cabinets, housings, and terminal cabinets with nylon cable ties at not more than 8" intervals. Install in accordance with the latest EIA installation standards.

Execute wiring in strict adherence to "standard broadcast practices," as excerpted from:

1. "Recommended Wiring Practices," Broadcast Audio Equipment for AM, FM, Television (5th Edition), Radio Corporation of America (RCA), Camden, N.J. 1962

2. Appendix II, "Recommended Wiring Practices", Sound System Engineering, (2nd Edition), D. Davis.

Standard Requirements for Testing and Commissioning

A. Final Inspection Report. Prepare a final checkout report submitted one week prior to system commissioning that the system is ready for acceptance testing. This report should include verification that all tests outlined below have been performed, and include the results of those tests. Include the name of the person who performed each individual line item. If not specified below, indicate how the tests were performed. A representative of the contractor must be responsible to oversee all testing and sign the Final Inspection Report to confirm completion and validity of all items.

1. General

   a. Confirm the newest version of firmware has been installed on all devices in the project. Submit a spreadsheet one week prior to acceptance testing listing the firmware version of all devices in the installation.

   b. Confirm all rack rooms, control booths, and other technical areas are clean, dust free, and finished.

   c. Clean all air filters on any device with an operable fan assembly

   d. Confirm no stray AC voltages on any equipment accessible to a user relative to ground.

   e. Have no sharp or jagged surfaces accessible to a user.

f. Thermal gradient inspected; all equipment operating within manufacturers' guidelines.

g. Cable inspection: labeling, cable dress, signal separation, cable stress, serviceability, tie wraps too tight (none on Category cable, only Velcro ties). Cable labeling is positioned and oriented in a consistent manner, are legible and unambiguous.

h. Confirm the full inventory to be all new equipment, in full compliance with the specification, or as modified by approved submission. Record test results as pass/fail, and list exceptions. Record all equipment not present, and why.

i. Confirm rack elevation and flow drawings, cable and other labels and engravings are an accurate paper model of the furnished system, and in compliance with latest revised specifications. Record test results as pass/fail.

j. All equipment in the rack is labeled, and the labels match those on the drawings (equipment symbols and/or description), control system, field plates, patch panels, and any labels associated with the system.

k. RJ terminations are solid in their connectors.

l. Be serviceable. This includes accessibility to equipment to be easily pulled for repair by one person, neatly dressed cables, bundled in forms (refer to Giddings, Davis and Davis), having no excessive pressure on cables at termination points and connectors, utilize service loops, and have each cable number in agreement with the as-built drawings. This includes the equipment rack itself. All switches and receptacles shall be logically and permanently labeled.

m. Confirm all nomenclature for consistency: drawings, touch screen, wall plates, floor boxes, patch panels, equipment, etc.

n. Patch cables have cable numbers.

o. Coax cables respect a bend radius of at least 5x the cable's radii, or as recommended by the manufacturer.

2. Sound Systems

a. Record ambient noise, A-weighted, slow.

b. No power amplifier shall have its rated load exceeded. Record the impedance of each loudspeaker homerun at 1k and test each lead for shorts to ground. Record Results on a separate form and attach

c. Classroom audio distribution systems shall have uniform coverage within ±2.5 dB for octave-band sound pressure levels with midband frequencies of

500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz (ANSI/ASA, 2010)

d. Be capable of producing an additional (15) dB above this level, with less than 0.5% THD (Total Harmonic Distortion) plus noise. Measure THD plus noise at three seating locations in the room under these conditions and record results.

e. Confirm that noise level is electrically (55) dB below the normal operating level for all audio sources. “Noise” refers to hum, electrostatic noise, RF interference, etc. Measure and record Signal to Noise (“signal” measured electrically at nominal operating level at each destination, for all sources selected.)

f. Test polarity for all microphones and speakers. Include details of testing method and results on a separate sheet and attach.

g. There shall be no audible vibration caused by improper mechanical installation. Use continuous sweep signal at headroom level (from generator or test CD) pass/ fail result or which device at what frequencies. (“Buzzes and Rattles Test”).

h. Test system under typical operating conditions and confirm that system is stable with a minimum of 6dB headroom before feedback.

i. Confirm RF immunity at areas where users are expected to operate cell phones and messaging PDA's, smartphones, etc.

3. Video Systems

a. Displays are focused, centered, and evenly illuminated. Confirm using the calibrated light meter that the brightest measurement locations shall be no more than +10% above average, and the dimmest locations no less than –5% below average measurement.

b. Display stable images, with no scaling-related visual artifacts when switching between, at a minimum, (1024 x 768), (1280 x 1024), (1920 x 1080) and (1280 x 720) sources, and/or all those specified in the performance criteria for this system. Record test results.

c. The display is able to switch between different color spaces and resolutions. Switch between all video sources in the system. The source should always display properly.

d. All sources can be routed to all expected destinations. Disregard any routes that are not permitted by design, as described in the narrative, such as HDCP sources routed to a codec.

e. All HDCP sources can be routed to all expected destinations at the same time. There are some devices with a limited capability to display on multiple displays. The system requires that each source can display on the required

number of displays in the system.

f. For HDMI signals, test using the entire cabling to be installed in the field, to the extent it is possible. Using an HDMI generator, display pixel on/pixel off, with HDCP enabled, for the following resolutions: 1920x1200@60, 1920x1080@60, 1600x1200@60, 1280x720@60, 1280x768@60, 1280x800@60, 1024x768@60, 800x600@60, 640x480@60 (base default, in case the PC has issues and boots up in default mode). Inspect each, leaving the signal on for several seconds (no "sparklies"). HDMI Generator required

g. Perform all "Source Tests" with HDMI tester on each source, especially Format Analyzer, Video Display, Audio Analyzer, and HDCP Tests immediately before all the sinks (displays) in the system. Test will verify source integrity and EDID information. QD 780 Analyzer required.

h. Perform "Sink Test" with HDMI tester on each display. Test will verify display can handle various resolutions, and spot check EDID to make sure they work with all sources. QD 780 Analyzer required.

i. If the switcher makes available a system status report with information regarding each source and destination signal integrity, EDID and CEC status information, etc., then obtain a report. If a printed or ‘pdf’ report is not included, take a screen print showing the status of the system (including source and destination communications with the switcher) and include it in the Report.

j. Inspect camera image quality.

k. Confirm typical instructor laptop has been successfully used with the system, inclusive of default resolution (works with switcher EDID), any adapters, etc. Client laptop required.

l. Confirm there are no lost or stuck “on” pixels when Full White Test signal is displayed (follow manufacturer’s specification). Note number and location of lost pixels, if any.

m. Check for excessive vibration on VC camera(s) at full telephoto position.

n. For laptops with digital outputs: if the audio is not embedded in an HDMI connection, or if the user connects to his audio out, is the analog audio satisfactorily distributed? Instructor laptop required.

4. Control Systems

a. The Control System performs all the functions as indicated on the function list (“control system specification”) provided, with stability, and in sync with the equipment being controlled without the need to reset any item of equipment.

b. When system is powered down, system “up” sequence presents the system in a desirable state with no objectionable anomalies.

c. IP information provided by client and loaded into system, including IP address, network ID’s, subnet masks, default gateway, timeserver, Gatekeeper, alias, hostnames, etc. All network functions specified by the customer are shown to function properly on customer's LAN. These settings are listed in a report that will remain with the system.

d. Any web-based system control or monitoring features, and other IP functionality of system (time servers, system-generated e-mail, etc.) thoroughly tested.

e. Displays have On-Screen Displays/Menus Are Disabled, or as specified by the user.

f. Does the system under test satisfy ALL of the system requirements as laid out by the client-approved narrative/signed proposal?

g. Prepare document report, certifying the product, performance, and practices are in compliance, and noting any exceptions. Distribute accordingly.

B. All tests above are adapted from the ISO9000/AV9000 standard facilitated by the Association for Quality in Audio Visual Technology, Inc. (AQAV). Companies with a certified AV9000 Quality Management System may implement their own system, assuming requirements above are all met.

C. Required Test Equipment

1. Digital Multimeter - -80 dBu sensitivity, 20-30 kHz response

2. Impedance Meter - Capable of testing audio lines at individual frequencies, between 250 Hz and 4k Hz. Measurement Range: 1 ohm to 100k ohms.

3. Audio Generator – Sine Wave, Pink Noise, Sweep, Chirp, and Sawtooth.

4. Digital and Analog Video Signal Generator(s) for all resolutions and refresh rates utilized by devices under test.

5. Colorimeter/luminance meter with 10% accuracy

6. Light meter reading in lux/footcandles

7. Sound Level Meter – ANSI Type 2 with A & C weighting filters.

8. Quantum Data 780 Video Generator / Analyzer with ACA Passive Monitoring, and Network Analyzer options installed.

Lighting and Projection Presets

During commissioning, the AV team should coordinate with the lighting programmer to configure lighting presets based on the ANSI/INFOCOMM 3M- 2011 standard. This is noted briefly in the InfoComm AV/IT Infrastructure Guidelines for Higher Education:

The clarity of projected images relies on a sufficient contrast ratio between the light from the projector and the ambient or spilled light falling on the projection screen. The relevant international standard regarding contrast ratios in projected images is ANSI/INFOCOMM 3M- 2011. As this standard applies to the academic environment, we can identify three situations where it can be brought to bear on lighting design:

- Non-projection preset with full task lighting and board lights on
- Projection of text and graphics (e.g., PowerPoint slides or document camera), where it is expected that reasonable ambient light levels are provided for note taking
- Projection of detailed photographic images (including medical images and x-rays), where note-taking is secondary to a full-contrast-ratio projected image that allows for the reproduction of detail in the darkest areas of the picture

The three scenarios above should be programmed as lighting presets in the control system. The second and third presets should be measured to achieve a contrast ratio of 7:1 and 15:1, respectively.

Project Punchlist and Closeout Checklist

The following procedures will be performed:

1. The audio fidelity test shall consist of driving the system with pink noise and measuring the response from 40 Hz to 16k Hz. Digital Signal Processing will be used to adjust the response of the system (s) to fit the requirements of the space.
2. Control functions shall be checked for proper operation, from controlling devices to controlled devices.
3. Adjust, balance, and align equipment for optimum quality and to meet the manufacturer's published specifications. Establish and mark normal settings for each level control, and record these settings, in the "System Operation and Maintenance Manual".
4. Confirm color matching of all displays. Switch between all video sources in system to confirm proper operation under typical usage scenarios.
5. Installed and loose equipment will be inventoried for correct quantity.
6. Any other test on any piece of equipment or system deemed appropriate.