The George Washington University
AV Classroom Design Guidelines Document
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Technology Design Group

&

Academic Technologies

GW Academic Technologies

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1.0 DOCUMENT SCOPE

1.1 Background
The purpose of this document is to summarize the technology requirements for each set of classroom spaces described below and provide the necessary design parameters in order to implement them successfully. This document exists as a narrative summary and must be utilized in conjunction with the provided: Plans, Connectivity diagrams, Riser diagrams, and Equipment lists.

1.2 Room Types
The following room types are described:

Basic Classroom Categories:
1. Under 30 Person Class Room
2. 30 to 50 Person Class Room
3. 50 to 100 Person Lecture Hall
4. Over 100 Person Lecture Hall
5. VTC Classroom
6. Collaborative Teaching

Technology Additions:
1. Over 100 Student Tech Add.
2. Lecture Capture Classrooms
3. Web Conference
4. Lecture Capture – Basic
5. Lecture Capture – Enhanced

1.3 Outside Trade Coordination
The trade coordination requirements are provided in the section titled Trade Coordination. Additionally, each room type includes specifics or deviations relevant to that room type.

1.4 Standards
The latest version of the following standards shall be followed in the design of the classroom technology:
4. Pathways and rack accommodations shall meet the TIA-569-C Standard.

Pathway, infrastructure, and active systems are to be designed to support the day one requirements described herein, plus 20% for future expansion. Horizontal cabling is required to be plenum rated regardless of pathway conditions.

1 The LEED 2009 For Schools New Construction and Major Renovations rating system was developed for K-12 schools however the same principles can be applied to schools and per the guidelines, “…may also be used for postsecondary academic buildings…”.
2.0 DISPLAY SIZING AND ORIENTATION

2.1 Display Type Selection
Provide the proper screen type based on the room size and spacing required to accommodate the number of seats indicated. For seating distances to furthest viewer of less than 25', a large screen flat panel (LCD) display shall be provided with a native resolution of 1920x1080. For seating distances to the furthest viewer of 25' or greater, a 16:10 projector and projection screen shall be provided. Seating distances appropriate for various screen sizes are listed in charts 2.7 and 2.8.

If front projection, locate the projector to ensure that no obstructions protrude from the ceiling and obstruct the light path between the projector and the screen. The brightness of the projector shall be coordinated to provide a contrast ratio exceeding 10:1 between the projector light and the ambient light on the screen surface. This contrast ratio should be accomplished by a combination of controlling ambient light, screen surface selection and projector brightness.

The orientation of the display is critical for legibility; this includes the angle of view to the persons as well as the viewing distance.
2.2 Display Orientation

Layout Guidelines for Seating and Screen

1) Utilize multiple displays if seats are greater than 45 degrees off perpendicular from the side edges of the projection screen. (figure 2.3)

2) Plan display mounting heights for a maximum of 15 degrees eye rotation to the center of the screen and 30 degrees eye rotation to the top of the screen. (figure 2.4)

3) Plan the first row of seating at least one times the screen width from the screen (figure 2.5)
4) The furthest row of seating should not exceed six times the height of the screen, four times if feasible (figure 2.6)

![Diagram showing seating distance and viewing angles]

**Figure 2.6 - Maximum Seating Distance Flat Panels**

**Chart 2.7 – Seating Distance Chart, Flat Panels**

<table>
<thead>
<tr>
<th>Flat Panel Screen Diagonal</th>
<th>Closest Viewer</th>
<th>Ideal Viewer (14 pt. font)</th>
<th>Furthest Viewer (22 pt. font)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65”</td>
<td>4’-6”</td>
<td>10’-6”</td>
<td>16’</td>
</tr>
<tr>
<td>80”</td>
<td>6’</td>
<td>13’</td>
<td>19’-6”</td>
</tr>
<tr>
<td>90”</td>
<td>6’-6”</td>
<td>14’-6”</td>
<td>22’</td>
</tr>
</tbody>
</table>

**Chart 2.8 – Seating Distance Chart, Projection Screens**

<table>
<thead>
<tr>
<th>Screen (Height x Width)</th>
<th>Closest Viewer</th>
<th>Ideal Viewer (14 pt font)</th>
<th>Furthest Viewer (22 pt font)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50” x 80”</td>
<td>6’-8”</td>
<td>16’-6”</td>
<td>25’</td>
</tr>
<tr>
<td>57-1/2” x 92”</td>
<td>7’-8”</td>
<td>19’</td>
<td>28’-6”</td>
</tr>
<tr>
<td>65” x 104”</td>
<td>8’-8”</td>
<td>21’-6”</td>
<td>32’</td>
</tr>
<tr>
<td>72-1/2” x 116”</td>
<td>13’-10”</td>
<td>24’</td>
<td>36’</td>
</tr>
<tr>
<td>87-1/2” x 140</td>
<td>11’-6”</td>
<td>29’</td>
<td>43’-6”</td>
</tr>
<tr>
<td>100” x 160”</td>
<td>13’6”</td>
<td>33’</td>
<td>50’</td>
</tr>
</tbody>
</table>
3.0 UNDER 30 PERSON CLASSROOM

3.1 Room Description
The 30 person and under classroom shall be supported with a system capable of displaying a presentation using video and audio from multiple sources as detailed below.

3.2 Technology

3.2.1 Display
Based on the room size and spacing required to seat up to 30 persons, a large screen flat panel (LCD) display is appropriate for this size room. The screen native resolution shall be a minimum of 1920x1080.

Refer to the Section 2.0 Display Sizing and Orientation for further details on display selection and location.

Sources
Sources for presentation shall primarily be located within the lectern, connected directly to the display and include:
1) Networked PC
2) Laptop input supporting both VGA and HDMI (DisplayPort/mobile device via adapter)
3) Provide supplemental display input extension wall plate with VGA+1/8" stereo audio and HDMI connections hard wired to display inputs.

Figure 3.1 – Under 30 Student Typical Classroom Image
See the appendices for video functional/connectivity diagrams.
3.2.2 Audio

The classroom shall support stereo program audio playback via wall mounted stereo speakers.

Loudspeakers
Program L/R loudspeakers shall be provided flanking the display.

Audio shall route w/ video directly to the display. Display source selection shall select audio. Source line level audio shall be routed from the display to an amplifier which will provide speaker level audio to the speakers at the display location. Amplification shall be configured to deliver minimum 100 dB(A) at front row of persons. Evaluate seating layout to verify back row of persons will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20 KHz.

Switching and Processing
The display will provide the video and audio switching via source selection; no external signal processing shall be required.

Sources
At a minimum, provide program audio inputs for all AV sources with audio out.

See the appendices for audio functional/connectivity diagrams.

3.2.3 Control

Control systems within the Classroom shall consist of a networked AV control processor, controlled by a user interface panel located at the lectern, and connected to controllable hardware via the most robust connection type available for each piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting, occupancy sensors, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O

The control system user interface consists of a touch panel located at the lectern.

In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources in a way that is consistent with the University’s standard GUI, but reflective of the available sources within the specific room.

Auto-detect features shall be designed for laptop inputs. This will automatically configure the presentation system to
a powered-on state with the laptop source routed. Selection of sources from the lectern touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, lighting or shades as appropriate.

Provide secondary control buttons for screens, lighting, and shades near lectern. Lighting, and shade control shall be ganged in together in a single 2-gang cover plate.

See the appendices for control functional/connectivity diagrams.

3.2.4 Lectern

Provide a custom lectern with rack rails for rack mounted equipment. Lectern shall be portable with all cabling dressed to a single disconnect point through a grommet within a cable sheath/snake with strain-relief.

The lectern is to be provided with accommodations for the laptop and auxiliary inputs, local PC with monitor, control processor, network switch and the control touch panel as well as mounting rails for the required drawers, power conditioning, and other equipment local to the lectern. No stand-alone rack is required for this classroom. Security at the lectern location shall follow the applicable GWU guidelines.

See the appendices for lectern elevations and details.

3.3 Outside Trade Coordination

See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

3.3.1 Pathway

Reference the appropriate riser diagram and provide cable pathway as required between the following locations

*Pathway Requirements Chart:*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectern</td>
<td>Display</td>
</tr>
<tr>
<td>Lectern</td>
<td>L/R Wall Speakers</td>
</tr>
</tbody>
</table>
4.0 30 TO 50 STUDENT CLASSROOM

4.1 Room Description
The over 30 TO 50 person lecture hall is supported with audio video presentation. The primary function of the room will be for an instructor to deliver a lesson from a lectern location utilizing the technology outlined below.

4.2 Technology

4.2.1 Display
Provide the proper screen type based on the room size and spacing required to seat up to 50 persons. For seating distances to furthest viewer of less than 25’, a large screen flat panel (LCD) display shall be provided with a native resolution of 1920x1080. For seating distances to the furthest viewer of 25’ or greater, a 16:10 projector and projection screen shall be provided.

If front projection, locate the projector to ensure that no obstructions protrude from the ceiling and obstruct the light path between the projector and the screen. The brightness of the projector shall be coordinated to provide a contrast ratio exceeding 10:1 between the projector light and the ambient light on the screen surface. This contrast ratio should be accomplished by a combination of controlling ambient light, screen surface selection and projector brightness.

Refer to the Section 2.0 Display Sizing and Orientation for further details on display selection and location.
Sources
Sources for presentation will primarily be located within the lectern and include:
1) Networked PC
2) Laptop input supporting both VGA and HDMI (DisplayPort/mobile device via adapter)
3) Ceiling mounted document camera above lectern
4) Blu-ray Player

Switching
Sources shall be routed to and switched by an HDCP compliant multi-format matrix video switcher as indicated in the equipment lists and connectivity diagrams. Output of the video switcher shall be routed to the display and touch panel locations. Support auto-detect on switcher inputs for automation of system configuration. See the appendices for video functional/connectivity diagrams.

4.2.2 Audio
The classroom shall support stereo program audio playback via wall mounted stereo speakers.

Loudspeakers
Program L/R speakers and amplification shall be configured to deliver a minimum of 100 dB(A) at front row of persons. Evaluate seating layout to verify back row of persons will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20KHz.

Inputs
At a minimum, provide:
1) Program audio inputs for all AV sources with audio out.

Switching and Processing
Audio switching shall be handled along with video at the video switcher as Audio-follows-Video. Volume control will be accomplished via the switcher using the control system. No external signal processing shall be required.

See the appendices for audio functional/connectivity diagrams.

4.2.3 Control
Control systems within the Classroom shall consist of a networked AV control processor, controlled by a user interface panel located at the lectern, and connected via network, serial (example; RS-232), or IR to controllable hardware, with the most robust connection type for each individual piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting and occupancy sensors, projection screens, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O

The control system user interface consists of, at a minimum, a touch panel located at the lectern.
In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources via automated scenes in a way that is consistent with the University’s standard GUI, but reflective of the available sources with the specific room.

Auto-detect features shall be designed for laptop inputs. This will automatically configure the presentation system to a powered-on state with the laptop source routed. Automatic or Manual selection of sources from the lectern touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, lighting or shades as appropriate.

Provide secondary control buttons for screens, lighting, and shades near lectern. Screen, lighting, and shade control shall be ganged in together in a single 3-gang cover plate.

See the appendices for control functional/connectivity diagrams.

4.2.4 Rack and Lectern

Provide a custom lectern plus a stand-alone 1/2 height rack for general rack mounted equipment. Lectern shall be portable with all cabling dressed to a single disconnect point through a grommet within a cable sheath/snake with strain-relief.

The lectern is to be provided with a flip-up shelf for document camera media. accommodations for the laptop and auxiliary inputs, the local PC and monitor, and the control touch panel as well as mounting rails for required drawers, power conditioner and other equipment local to the lectern.

The stand-alone rack will house the remaining AV control, switching, and amplification equipment required to support the classroom. This rack should be located in a space adjacent to the classroom but separated acoustically and should have the appropriate HVAC, power, and network connections required to support the AV equipment. See Trade Coordination section detailing power and network requirements.

Closet housing rack to provide 3 feet clear space on each of 3 sides (front, back, and one side) for access, allowing a minimum of 50 sq. ft. assuming a single rack. Provide adequate airflow and/or supplemental cooling to accommodate heat load based on calculated thermal load, factoring in growth. Racks shall be accessible from the hallway. Security at the rack and lectern location shall follow the applicable GWU guidelines.
4.3 **Outside Trade Coordination**
See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

4.3.1 **Pathway**
Reference the appropriate riser diagram and provide cable pathway as required between the following locations

*Pathway Requirements Chart:*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
<td>Lectern</td>
</tr>
<tr>
<td>Rack</td>
<td>L/R Wall Speakers</td>
</tr>
<tr>
<td>Rack</td>
<td>Display</td>
</tr>
<tr>
<td>Rack</td>
<td>Ceiling¹</td>
</tr>
</tbody>
</table>

¹If ceiling is accessible, a single route may be provided, sized for all cabling that will go to the ceiling. For ceiling mounted devices that are not in accessible ceiling, provide dedicated pathway to each device location.

See the appendices for lectern elevations and details.
5.0 50 TO 100 STUDENT LECTURE HALL

5.1 Room Description
The 50 to 100 person lecture hall is supported with audio video presentation and instructor speech reinforcement capability. The primary function of the room will be for an instructor to deliver a lesson from a lectern location utilizing the technology outlined below.

5.2 Technology

5.2.1 Display
Based on the room size and spacing required to seat up to 100 persons, a projection based display is required. The projection screen aspect ratio shall be 16:10. The projection screen may be front projection or rear projection depending on space constraints.

If front projection, locate the projector to ensure that no obstructions protrude from the ceiling and obstruct the light path between the projector and the screen. The brightness of the projector should be coordinated to ensure a contrast ratio exceeding 10:1 between the projector light and the ambient light on the screen surface. This contrast ratio should be accomplished by a combination of controlling ambient light, screen surface selection and projector brightness.

Refer to the Section 2.0 Display Sizing and Orientation for further details on display selection and location.
Sources
Sources for presentation will primarily be located within the lectern and include:
1) Networked PC
2) Ceiling mounted document camera above lectern
3) Blu-ray player
4) Lectern laptop input supporting both VGA and HDMI (DisplayPort/mobile device via adapter)
5) Wall mounted aux input plate (matching lectern laptop connections)

Switching
Sources shall be routed to and switched by an HDCP compliant multi-format matrix video switcher as indicated in the equipment lists and connectivity diagrams. Support auto-detect on switcher inputs for automation of system configuration. Video output of the switcher shall be routed to the display and touch panel locations. Audio output of the switcher shall be routed to the audio DSP.

See the appendices for video functional/connectivity diagrams.

5.2.2 Audio
The classroom requires a complete sound reinforcement system comprised of inputs for microphones and program audio, digital signal processing, amplification, loudspeakers, and Assistive Listening System (ALS).

Loudspeakers
An overhead distributed loudspeaker system should be provided for speech reinforcement and general audio and a stereo L/R loudspeaker system should be provided for program audio playback.

The distributed system will allow for zoning to optimize gain before feedback, and contribute to uniform coverage. Loudspeaker spacing for uniform coverage at a seated height is determined by the coverage pattern of the selected loudspeaker. Plan sufficient overlap of loudspeaker coverage to provide no more than +/- 1.5dB variance within the listening area at a seated listener height. Select loudspeakers and design signal processing/amplification to ensure that the minimal loudspeaker level is at least 25 dB above the ambient noise level at the furthest listener from 200 Hz to 20KHz.

Program L/R speakers and amplification shall be configured to deliver minimum 100 dB(A) at front row of persons. Evaluate seating layout to verify back row of persons will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20KHz.

Zone overhead ceiling speakers to allow program L/R audio to be mixed in for additional reinforcement with delay to maintain directionality of signal.

Inputs
At a minimum, provide:
1) Program audio inputs for all AV sources with audio out.
2) Microphone level inputs for a hard wired gooseneck microphone at the lectern.
3) One channel of wireless microphone, handheld and lavaliere microphone to be used alternately.
4) (1) Aux XLR input routed from DSP
5) (1) Aux XLR output routed from DSP
Signal Processing
The AV control system will be coordinated with the DSP to switch audio sources and provide proper system configuration and levels dependent upon setup selected via the touch panel.

DSP setup shall supplement program L/R audio via the overhead speakers utilizing delay at the appropriate zones to maintain directionality of sound from the front of the room. At a minimum, provide DSP outputs for:

1) L/R speaker amplification
2) Two overhead/ceiling speaker zones
3) Lectern output plate
4) Assistive Listening System (ALS)

See the appendices for audio functional/connectivity diagrams.

5.2.3 Control
Control systems within the Classroom shall consist of a networked AV control processor, controlled by a user interface panels, and connected via network, serial (example: RS-232), or IR to controllable hardware, with the most robust connection type for each individual piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting and occupancy sensors, projection screens, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O

The control system user interface consists of a touch panel located at the lectern.

In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources via automated scenes in a way that is consistent with the University’s standard GUI, but reflective of the available sources with the specific room.

Auto-detect features shall be designed for laptop inputs. This will automatically configure the presentation system to a powered-on state with the laptop source routed. Manual selection of sources from the lectern touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, projection screens, lighting or shades as appropriate.

Provide backup direct control for screens, lighting, and shades near lectern. Screen, lighting, and shade control shall be ganged in together in a single 3-gang cover plate. See the appendices for control functional/connectivity diagrams.
5.2.4 Rack and Lectern

Provide a custom lectern plus a full height rack for general rack mounted equipment. Lectern shall be fixed with all cabling dressed to a floor poke-thru/core within a cable sheath/snake with strain relief. The lectern is to be provided with a flip-up shelf for document camera media, accommodations for the laptop and auxiliary inputs, the local PC and monitor, and the control touch panel as well as mounting rails for rack drawers and other equipment local to the lectern.

The stand-alone rack will house the remaining AV control, switching, DSP, and amplification equipment required to support the classroom. This rack should be located in a space adjacent to the classroom but separated acoustically and should have the appropriate HVAC, power, and network connections required to support the AV equipment.

Closet housing rack to provide 3 feet clear space on each of 3 sides for access, allowing a minimum of 50 sq. ft. assuming a single rack. Provide adequate airflow and or supplemental cooling to accommodate heat lode based on calculated thermal load, factoring in growth. Racks shall be accessible from the hallway. Security at the rack and lectern location shall follow the applicable GWU guidelines.

See the appendices for lectern elevations and details.

5.3 Outside Trade Coordination

See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

5.3.1 Pathway

Reference the appropriate riser diagram and provide cable pathway as required between the following locations

*Pathway Requirements Chart:*

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
<td>Lectern</td>
</tr>
<tr>
<td>Rack</td>
<td>L/R Wall Speakers</td>
</tr>
<tr>
<td>Rack</td>
<td>VTC Camera Locations²</td>
</tr>
<tr>
<td>Rack</td>
<td>Ceiling¹</td>
</tr>
<tr>
<td>Rack</td>
<td>Seating Rows²</td>
</tr>
</tbody>
</table>

¹If ceiling is accessible, a single route may be provided, sized for all cabling that will go to the ceiling. For ceiling mounted devices that are not in accessible ceiling, provide dedicated pathway to each device location.

²Provide pathway and cabling to desk locations for future use.
6.0 OVER 100 STUDENT LECTURE HALL

6.1 Room Description
The over 100 person lecture hall is supported with audio video presentation, and speech reinforcement. The primary function of the room will be for an instructor to deliver a lesson from a lectern location utilizing the technology outlined below. Secondary functions shall include accommodating basic special events.

6.2 Technology

6.2.1 Display
Based on the room size and spacing required to seat more than 100 persons, a projection based display is required. The projection screen aspect ratio shall be 16:10. The projection screen may be front projection or rear projection depending on space constraints.

If front projection, locate the projector to ensure that no obstructions protrude from the ceiling and obstruct the light path between the projector and the screen. The brightness of the projector should be coordinated to ensure a contrast ratio exceeding 10:1 between the projector light and the ambient light on the screen surface. This contract ratio should be accomplished by a combination of controlling ambient light, screen surface selection and projector brightness.

Refer to the Section 2.0 Display Sizing and Orientation for further details on display selection and location.
Sources
Sources for presentation will primarily be located within the lectern and include:
1) Networked PC
2) Optical disc player (DVD/Blu-ray)
3) Auxiliary inputs supporting both VGA and HDMI (DisplayPort/mobile device via adapter) at lectern and wall plates
4) Ceiling mounted document camera above lectern
5) Additional auxiliary input, matching lectern laptop connectivity, located at front of room for facilitating panel discussions.

Other required sources include ceiling recessed document camera and optional technology packages as defined below. The document camera shall be located immediately over the lectern and be controlled by the AV control system.

Video Switching
Video switching in this space shall offer spare capacity for growth. This room type shall utilize a card based system, with room for expansion via additional cards in un-used slots. A minimum of 20% room for growth shall be accounted for in the number of inputs and outputs, with a minimum of 2 open card slots (video sources) on the input and output side of the chassis.

Provide confidence monitoring of the room system at the equipment rack location.

See the appendices for video functional/connectivity diagrams.

6.2.2 Audio
The classroom requires a complete sound reinforcement system comprised of inputs for microphones and program audio, digital signal processing, amplification, loudspeakers, and Assistive Listening System (ALS)

Loudspeakers
An overhead distributed loudspeaker system shall be provided for speech reinforcement and general audio and a stereo L/R loudspeaker system should be provided for program audio playback. Depending on use case of the specific room, an LCR arrangement shall be evaluated.

The distributed system will allow for zoning where applicable and contribute to uniform coverage. Loudspeaker spacing for uniform coverage at a seated height is determined by the coverage pattern of the selected loudspeaker. Plan sufficient overlap of loudspeaker coverage to provide no more than +/- 1.5dB variance within the listening area at a seated listener height. Select loudspeakers and design signal processing/amplification to ensure that the minimal loudspeaker level is at least 25 dB above the ambient noise level at the furthest listener from 200 Hz to 20KHz.

Program L/R speakers and amplification shall be configured to deliver minimum 100 dB(A) at front row of persons. Evaluate seating layout to verify back row of persons will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20KHz.
Zone overhead ceiling speakers to allow program L/R audio to be mixed in for additional reinforcement with delay to maintain directionality of signal.

Provide Assistive Listening System.

**Inputs**
At a minimum, provide DSP inputs for:
1) Switched (audio-follows-video) stereo program audio inputs
2) Microphone level input for a hard wired gooseneck microphone at the lectern
3) Four total channels of wireless microphones: two handheld and two lavaliere microphones
4) Additional microphone inputs at the front of the room for facilitating panel discussions. Number to be determined based on room usage scenarios

**Auxiliary/Recording outputs**
At a minimum, provide routable outputs at the following locations:
1) Equipment Rack (1 line level recording output)
2) Lectern (2 separate line level recording outputs)
3) Rear of Room (2 separate line level recording outputs)
4) Provide Audio monitoring at the rack location
5) Assistive Listening System (ALS)

**Signal Processing**
The AV control system will be coordinated with the DSP to switch audio sources and provide proper system settings and levels dependent upon settings selected via the touch panel or keypads.

DSP setup shall supplement program L/R audio via the overhead speakers utilizing delay at the appropriate zones to maintain directionality of sound from the front of the room.

Audio processing in this space shall offer spare capacity for growth. This spare capacity shall be provided via a DSP frame with spare inputs. A minimum of 20% room for growth shall be accounted for in the number of inputs and outputs, with a minimum of 2 additional line level and 2 additional microphone level input and outputs on the frame plus additional expansion via bus or networked inputs.

See the appendices for audio functional/connectivity diagrams.

6.2.3 **Control**
Control systems within the Classroom shall consist of a networked AV control processor, controlled by one or more user interface panels, and connected via network, serial (example; RS-232), or IR to controllable hardware, with the most robust connection type for each individual piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting and occupancy sensors, projection screens, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O
The control system user interface consists of, at a minimum, a touch panel located at the lectern. In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources via automated scenes in a way that is consistent with the University’s standard GUI, but reflective of the available sources with the specific room.

Auto-detect features shall be designed for laptop inputs. This will automatically configure the presentation system to a powered-on state with the laptop source routed. Manual selection of sources from the lectern touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, projection screens, lighting or shades as appropriate.

Provide backup direct control for screens, lighting, and shades near lectern.

See the appendices for control functional/connectivity diagrams.

6.2.4 Rack and Lectern

Provide a custom lectern plus a full height rack for general rack mounted equipment. Lectern shall be fixed with all cabling dressed to a floor poke-thru/core within a cable sheath/snake with strain relief. The lectern is to be provided with a flip-up shelf for document camera media, accommodations for the microphone, laptop and auxiliary inputs, the local PC and monitor, and the control touch panel as well as mounting rails for any rack mounted shelves or equipment local to the lectern.

The stand-alone rack will house the remaining AV control, switching, DSP, and amplification equipment required to support the classroom. This rack should be located in a space adjacent to the classroom but separated acoustically and should have the appropriate HVAC, power, and network connections required to support the AV equipment. Access to this rack space shall be from the hallway.

Closet housing rack to provide 3 feet clear space on each of 3 sides for access, allowing a minimum of 50 sq. ft. assuming a single rack. Provide adequate airflow and or supplemental cooling to accommodate heat load based on calculated thermal load, factoring in growth. Racks shall be accessible from the hallway. Security at the rack and lectern location shall follow the applicable GWU guidelines.

See the appendices for lectern elevations and details.
6.2.5 **Spare Cabling**

Provide Cat6 terminated to patch panels or work area outlet faceplates for routing signals as required at the following locations:
1) (4) Cat6 lines from rack to rear of room
2) (4) Cat6 lines from rack to lectern

6.3 **Outside Trade Coordination**

See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

6.3.1 **Pathway**

Reference the appropriate riser diagram and provide cable pathway as required between the following locations

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
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<td>Rack</td>
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</tr>
<tr>
<td>Rack</td>
<td>VTC Camera Locations²</td>
</tr>
<tr>
<td>Rack</td>
<td>Ceiling¹</td>
</tr>
<tr>
<td>Rack</td>
<td>Seating Rows²</td>
</tr>
</tbody>
</table>
| Rack            | Rear Room Expansion Plates

¹If ceiling is accessible, a single route may be provided, sized for all cabling that will go to the ceiling. For ceiling mounted devices that are not in accessible ceiling, provide dedicated pathway to each device location.

²Provide pathway and cabling to desk locations for future use, or with VTC package.
7.0 COLLABORATIVE TEACHING

7.1 Room Description
The collaborative teaching classroom is a round table collaborative environment supported with audio video presentation capabilities and speech reinforcement. The primary function of the room will be to promote collaboration between participants at the table and the moderator or presenter running the session.

7.2 Technology

7.2.1 Display
In addition to display sizing and orientation, screen design in collaborative teaching spaces shall allow participants to always be able to see a screen, regardless of where they are looking, either at a fellow participant, or the presenter who may be at any location in the room. A combination of projection screens and flat panels may be required to achieve desired visibility.

For the flat panel displays the screen native resolution shall be a minimum of 1920x1080. For the projectors and projection screens a 16:10 screen and projector aspect ratio shall be used.

Refer to the Section 2.0 Display Sizing and Orientation for further details on display selection and location.

Figure 7.1 - Collaborative Teaching Typical Classroom Image
**Sources**
Sources for presentation will primarily be located within the lectern and include:
1. Networked PC
2. Centralized laptop input supporting both VGA and HDMI (DisplayPort/mobile device via adapter)
3. Ceiling mounted document camera above “presenter location” or “lectern”
4. Blu-ray Player
5. Minimum of two ceiling mounted PTZ cameras on opposite ends of the room, appropriate quantity and location to provide unobstructed views of all participants in given room layout and size.
6. Collaboration laptop inputs at each table supporting both VGA and HDMI (DisplayPort/mobile device via adapter)

**Video Switching**
Video switching in this space shall offer spare capacity for growth. This room type shall utilize a card based system, with room for expansion via additional cards in un-used slots. A minimum of 20% room for growth shall be accounted for in the number of inputs and outputs, with a minimum of 2 additional card slots (video sources) on the input and output side of the chassis.

See the appendices for video functional/connectivity diagrams.

**7.2.2 Audio**

**Inputs**
At a minimum, provide:
1. Program audio inputs for all AV sources with audio out.
2. Microphone level inputs for a hard wired gooseneck microphone at the lectern.
3. (2) channels of wireless microphones
4. Push-to-Talk microphones at the collaboration tables.

**Loudspeakers**
Ceiling mounted loudspeakers shall be centered above each table. Verify each seat will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20KHz.

**Signal Processing**
Digital signal processing is to be provided for room equalization, volume control and zoned to allow for a mix-minus system to optimize gain before feedback while the participant Push-to-Talk microphones are in use. Push-to-talk shall be controlled by the DSP, such that input signal from microphones is never cut to the DSP in order to optimize performance of the AEC. The AV control system will be coordinated with the DSP to switch audio sources and provide proper system settings and levels dependent upon settings selected via the touch panel or keypads.

Audio processing in this space shall offer spare capacity for growth. A minimum of 20% room for growth shall be accounted for in the number of inputs and outputs, with a minimum of 2 additional line level and 2 additional microphone level input and outputs on the frame plus additional expansion via bus or networked inputs.
See the appendices for audio functional/connectivity diagrams.

7.2.3 Control
Control systems within the Classroom shall consist of a networked AV control processor, controlled by a user interface panel wall mounted near the central presenter location, and connected via network, serial (example; RS-232), or IR to controllable hardware, with the most robust connection type for each individual piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting and occupancy sensors, projection screens, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O

The control system user interface consists of wall-mounted a touch panel.

In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources via automated scenes in a way that is consistent with the University’s standard GUI, but reflective of the available sources with the specific room.

Manual selection of sources from the touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, lighting or shades as appropriate.

See the appendices for control functional/connectivity diagrams.

7.2.4 Rack and Lectern
Provide a custom “lectern” or “presentation station” plus a stand-alone full height rack for general rack mounted equipment. The optional “lectern” or “presentation station” shall be provided with accommodations for the laptop and auxiliary inputs and the local PC and monitor. If a “lectern” is provided, it shall be portable with all cabling dressed to a single disconnect point through a grommet within a cable sheath/snake with strain-relief. If lectern is not provided, provide a presentation station that the same connectivity and functionality described for the lectern.

The stand-alone rack will house the remaining AV control, switching, DSP, and amplification equipment required to support the classroom. This rack should be located in a space adjacent to the classroom but separated acoustically and should have the appropriate HVAC, power, and
network connections required to support the AV equipment. Racks shall be accessible from the hallway.

Closet housing rack to provide 3 feet clear space on each of 3 sides for access, allowing a minimum of 50 sq. ft. assuming a single rack. Provide adequate airflow and or supplemental cooling to accommodate heat load based on calculated thermal load, factoring in growth. Security at the rack and "lectern" or "presentation station" shall follow the applicable GWU guidelines.

See the appendices for “lectern” elevations or “presentation station” details.

7.3 Outside Trade Coordination
See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

7.3.1 Pathway
Reference the appropriate riser diagram and provide cable pathway as required between the following locations

Pathway Requirements Chart:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack</td>
<td>Central Presenting Location</td>
</tr>
<tr>
<td>Rack</td>
<td>Projector Locations</td>
</tr>
<tr>
<td>Rack</td>
<td>Display</td>
</tr>
<tr>
<td>Rack</td>
<td>Ceiling&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rack</td>
<td>Table Locations</td>
</tr>
</tbody>
</table>

<sup>1</sup>If ceiling is accessible, a single route may be provided, sized for all cabling that will go to the ceiling. For ceiling mounted devices that are not in accessible ceiling, provide dedicated pathway to each device location.
8.0 VTC CLASSROOM

8.1 Room Description
The VTC classroom is a medium sized classroom intended to seat 40-60 students while enabling video teleconference with remote sites.

8.2 Technology

8.2.1 Display
Based on the programming requirements of the space the primary room displays shall be either dual large format flat panel displays or a dual rear projection setup, as required by visibility of the furthest seat. Rear projection shall be planned instead of front projection to maximize performance in ambient lighting conditions associated with VTC. Projectors and projection screens shall be 16:10. The projector shall utilize a short throw lens and not require a cradle mirror system for light folding. The screen shall have a gain less than 1 to prevent hot-spotting and be combined with a projector with sufficient brightness to provide the contrast ratio, discussed in section 2.0 Display Sizing and Orientation given specified room lighting constraints discussed in section 13.0 Trade Coordination.

In addition to the primary presentation/VTC displays, a confidence monitor shall be provided next to the rear camera locations to ensure the presenter is always looking in the direction of the camera. The confidence monitor shall be a flat panel display, sized for the presenter as the furthest viewer using the information in the display sizing and orientation section.
Sources
Sources for presentation (local and remote) will primarily be located within the equipment cabinet and include:
1) Video Codec: (2) Video outputs for Local/Content and Far end on separate screens
2) Networked PC
3) Lectern Laptop input supporting both VGA and HDMI (DisplayPort/mobile device via adapter)
4) Document Camera – Ceiling Mounted above lectern
5) Blu-ray Player
6) Front and Rear PTZ cameras for capturing presenter and audience

Switching
Sources shall be routed to and switched by an HDCP compliant multi-format matrix video switcher as indicated in the equipment lists and connectivity diagrams. Video output of the switcher shall be routed to the display, VTC codec and touch panel locations. Audio output of the switcher shall be routed to the audio DSP.

See the appendices for video functional/connectivity diagrams.

8.2.2 Audio

Inputs
At a minimum, provide:
1) Program audio inputs for all AV sources with audio out.
2) Microphone level inputs for a hard wired gooseneck microphone at the lectern.
3) One Push-to-Talk microphone per pair of seated participants at seating rows (no ceiling microphones).
4) One Channel of wireless lavaliere microphone for presenter

Loudspeakers
Program L/R speakers and amplification shall be configured to deliver minimum 100 dB(A) at front row of persons. Evaluate seating layout to verify back row of persons will receive a minimum of 15 dB above the ambient noise level from 64 Hz to 20KHz.

Signal Processing
DSP is to be provided for room equalization, volume control and AEC on all microphone inputs. Push-to-talk shall be controlled by the DSP, such that input signal from microphones is never cut to the DSP in order to optimize performance of the AEC. The AV control system will be coordinated with the DSP to switch audio sources and provide proper system settings and levels dependent upon settings selected via the touch panel.

Audio processing in this space shall offer spare capacity for growth. A minimum of 20% room for growth shall be accounted for in the number of inputs and outputs, with a minimum of 2 additional line level and 2 additional microphone level input and outputs on the frame plus additional expansion via bus or networked inputs.

See the appendices for audio functional/connectivity diagrams.

8.2.3 Control

Control systems within the classroom shall consist of a networked AV control processor, controlled by a user
interface panel located at the lectern, and connected via network, serial (example; RS-232), or IR to controllable hardware, with the most robust connection type for each individual piece of hardware. The scope of the control system includes all AV equipment, as well as connections to room lighting and occupancy sensors, projection screens, and room shades where appropriate.

Controls are to be used from Most to Least Robust:
1) Network Control
2) Serial (RS-232/422)
3) IR
4) Relay or I/O

The control system user interface consists of, at a minimum, a touch panel located at the lectern. In addition to the user controls, utilize occupancy sensors to ensure the system is turned off when not in use. Utilizing occupancy sensors for lighting and AV automation extends equipment life and lowers energy usage consistent with LEED guidelines. Either dedicated Infrared/Ultrasound occupancy sensors should be utilized to control both lighting and AV systems, or if CO2 sensors are being utilized for HVAC controls, the AV and lighting system could tie into these sensors.

The control system shall provide access to the available presentation sources via automated scenes in a way that is consistent with the University’s standard GUI, but reflective of the available sources with the specific room.

Auto-detect features shall be designed for laptop inputs. This will automatically configure the presentation system to a powered-on state with the laptop source routed. Manual selection of sources from the lectern touch panel shall automatically adjust the video and audio routing, as well as any hardware control of displays, lighting or shades as appropriate.

See the appendices for control functional/connectivity diagrams.

8.2.4 Rack and Lectern

Provide a custom lectern plus a stand-alone rack for general rack mounted equipment. Lectern shall be fixed with all cabling dressed to a grommet plate within a cable sheath/snake with strain relief. The lectern is to be provided with a flip-up shelf for document camera media, accommodations for the laptop and auxiliary inputs, the local PC and monitor, and the control touch panel as well as mounting rails for rack drawers and other equipment local to the lectern.

The stand-alone rack will house the remaining AV control, switching, DSP, and amplification equipment required to support the classroom. This rack should be located in a space adjacent to the classroom but separated acoustically and should have the appropriate HVAC, power, and network connections required to support the AV equipment.

Closet housing rack to provide 3 feet clear space on each of 3 sides for access, allowing a minimum of 50 sq. ft. assuming a single rack. Provide adequate airflow and or supplemental cooling to accommodate heat load based on calculated thermal load, factoring in growth. Racks shall be
accessible from the hallway. Security at the rack and lectern location shall follow the applicable GWU guidelines.

See the appendices for lectern elevations and details.

8.3 Outside Trade Coordination
See section 13.0 Trade Coordination for typical details on required coordination. Specifics or deviations relevant to this room are below.

8.3.1 Pathway
Reference the appropriate riser diagram and provide cable pathway as required between the following locations:

Pathway Requirements Chart:

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<tr>
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<td>Projector Locations</td>
</tr>
<tr>
<td>Rack</td>
<td>Camera Locations</td>
</tr>
<tr>
<td>Rack</td>
<td>Confidence Monitor</td>
</tr>
<tr>
<td>Rack</td>
<td>Ceiling Speakers&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rack</td>
<td>Seating Rows for Mic.</td>
</tr>
</tbody>
</table>

<sup>1</sup>If ceiling is accessible, a single route may be provided, sized for all cabling that will go to the ceiling. For ceiling mounted devices that are not in accessible ceiling, provide dedicated pathway to each device location.

8.3.2 Lighting
To accommodate video teleconference optimally the room lighting shall meet the following requirements:
1) Lighting shall be uniform within the field of view of the cameras to minimize contrast and minimize camera auto-iris adjustments.
2) Key lighting shall be positioned to fall on the participant's faces at an angle of 45 degrees or more to minimize harsh shadows.
3) Ambient lighting shall be provided to further minimize shadows.
4) Background light shall be planned for vertical surfaces within the camera shoot including walls.
5) The contrast ratio between the foreground and background lighting shall be between 3:1 and 1:1 and shall be controlled by a dimming system.
6) The lighting falling on the display screen shall be minimized (see below) and shall not exceed 15 fc in any case.
7) Lighting system shall be tied to the AV control system for automatic selection of lighting scenes dependent on room usage.

As LEED guidelines illustrate, day lighting provides, “…building occupants with a connection between indoor spaces and the outdoors…” and is to be encouraged. However daylight, like artificial light must be controlled and taken into account when locating projection screens and sizing projectors. The ambient light level on the screen is based on the total combination of daylight and artificial light. Dimmable lights will facilitate using a projector with a lower energy requirement and provide greater flexibility in the classroom. Motorized shades are required to automate
prevent outside/ambient lighting from disturbing camera auto-iris functions and exceeding camera dynamic range.

Using a combination of shades, dimmable lighting and projector/lamp selection, ensure a minimum contrast ratio of 10:1 between the light level (foot candles) from the projector and ambient light level measured at the screen.

For VTC room, displays may not be placed in front of exterior windows.

Any shade control or light dimming is to be controlled by the AV control system. This will ensure that the proper room environment is automatically set based on the type of presentation selected from the touch panel. Also provide a basic lighting control wall station near the lectern for direct local control of the lighting that will maintain synchronization with the overall lighting control system.

8.3.3 IT Accommodations

The following addition shall be required beyond the standard IT accommodations outlined in the Trade Coordination section.

1. VTC rooms shall be provisioned for high bandwidth and QOS to ensure high quality, consistent video signals.
9.0 WEB CONFERENCE

9.1 Technology Description
The web conference add-on is a package intended to be added to an existing classroom or design for 30 student and over class room sizes. The purpose of this add-on is to enable basic web based conferencing utilizing the existing presentation system and minimal new technology.

9.2 Technology
Implementation of this add-on will require the following changes.
1) Provide an HD video and audio to USB converter in the equipment rack.
2) If absent provide an audio DSP with AEC in the equipment rack.
3) If absent, provide wired and wireless lectern/presenter microphones for use in web conferencing.
4) If absent provide an HD PTZ camera in the ceiling, tied to the AV control system for control.
5) Ceiling or Push-to-Talk microphones or multiple wireless microphones must be added for participant pickup.
6) Route the video signal from the HD PTZ camera to the video switcher inputs in the equipment rack.
7) Connect the video input of the HD AV-USB converter to the video output of the existing video switcher.
8) Connect the audio input of the HD AV-USB converter to the audio output of the DSP.
9) Connect the USB side of the HD AV-USB converter via USB 2.0 compliant extenders to the local PC in the lectern.
10) Add touch panel GUI elements to initiate Web conference.
10.0 LECTURE CAPTURE BASIC

10.1 Technology Description
The basic lecture capture add-on is a package intended to be added to an existing classroom or design for any classrooms of 30 students and above. The purpose of this add-on is to provide digital recording of the presentation, including presentation video and audio from presenter and students.

10.2 Technology
Implementation of this add-on will require the following changes.
1) Provide and integrate an HD capture appliance to the outputs of the existing video switcher.
2) Tie the HD capture appliance into the AV control system and incorporate control of capture into touch panel GUI.
3) If absent, provide wired and wireless lectern/presenter microphones for audio capture.
4) If absent, provide sufficient ceiling microphones above student seating for uniform audio capture.
5) An audio mixer, or DSP must be present or added for this add-on package.
11.0 LECTURE CAPTURE ENHANCED

11.1 Technology Description
The enhanced lecture capture add-on is a package intended to be added to an existing classroom or design for any classrooms of 50 students and above. The purpose of this add-on is to provide digital recording of the presentation, including presentation video, automated cameras and audio from presenter and students.

11.2 Technology
Implementation of this add-on will require the following changes.
1) Provide and integrate an HD capture appliance to the outputs of the existing video switcher.
2) Tie the HD capture appliance into the AV control system and incorporate control of capture into touch panel GUI.
3) In over 100 student classrooms verify that video switcher has sufficient outputs for HD capture appliance and provide additional switcher output cards as required.
4) Provide 1-2 HD PTZ cameras with HDMI connectivity to capture audience.
5) Provide an active camera tracking system or IR camera positional preset/camera selection trigger system for automation of camera shots during recording.
6) If absent, provide wired and wireless lectern/presenter microphones for audio capture.
7) If absent, provide sufficient table or ceiling microphones above student seating for uniform audio capture.
8) Where table infrastructure already exists, or in new construction, preference is to be given for table microphones.
9) For rooms without a DSP, provide a DSP for routing of processing and microphone audio.
12.0 AV EQUIPMENT CENTRALIZATION

12.1 AV Control Description
Centralization of AV equipment is to be considered when appropriate in order to minimize floor space, and Mechanical and Electrical services, as well as simplifying support.

Centralization shall be considered the default preference when renovating multiple adjacent classrooms, or when undergoing new construction.

12.2 Rack Space
For a centralized equipment room, rack floor space requirements shall be calculated as indicated in the relevant classroom standards section. The number and type of classrooms served out of the centralized equipment room will be determined by the scope of construction or renovation. If nearby classrooms are not being renovated, consideration shall be made for additional space in the centralized equipment room to relocate the equipment for these classrooms to the centralized room when they are renovated.

Within the centralized equipment rooms, all equipment racks shall be 7'-0" or 8'-0" tall four post cabinets, as ceiling height and infrastructure allow. Where the AV equipment for a classroom requires less than half of a full height rack, multiple classrooms may be installed in a single full height rack.

12.3 Architecture
Room layout requirements for a centralized equipment room shall follow the same guidelines as those given in the relevant classroom standard section. Specifically, once the quantity of racks is identified, adequate space shall be provided around the racks for movement and access/service.

12.4 Infrastructure
The one element of equipment centralization that may be more onerous is infrastructure. In addition to the infrastructure outlined in the relevant classroom standard section, the additional pathway distances may require additional pull boxes to facilitate cable pulls over longer distances.

Pullboxes and conduit pathway shall be designed to meet the NEC and TIA/EIA-569-C. This includes, but is not limited to, placing pull boxes at the beginnings and endings of runs, when the length is over 30 meters, when there are more than two 90 degree bends, or equivalent; or when there is a reverse (U-shaped) bend in the run.

Where approved, cable tray may be considered in lieu of conduit pathway.

Cable pathways shall be designed to accommodate all present day cabling plus a future capacity of an additional 20% fill. The day one cabling plus future cabling cross sectional area shall be no more than 40% of the pathway cross sectional area.
12.5 Power
Dedicated circuits shall be provided for each rack location based on the electrical load calculations as discussed in the relevant classroom standards section.

12.6 IT/Network
The following accommodations shall be provided to support the equipment in and servicing of the centralized equipment room:

1) Provide a trunk port at the equipment rack location for a managed switch. The capacity of that switch shall be determined by the number and type of classrooms being centralized.

2) If the centralized equipment room is supporting VTC rooms the trunk port shall be provisioned for high bandwidth and QoS to ensure high quality, consistent video signals.
13.0 TRADE COORDINATION

Information within this section is typical for all AV spaces. See individual rooms sections for any special conditions or deviations from this section.

13.1 AV Control

The AV control system shall be based upon GUI and modules developed by and provided by GWU. These modules and GUI files shall be provided to the contractor. Contractor is responsible for each room’s final code, implementation of code and validation of system programming in field.

13.2 Architectural Acoustics

The acoustics of the classroom are crucial to ensuring persons can clearly hear the presenter without straining. Any focus on acoustics requires evaluating the finishes in the space.

Reverberation Time

Minimizing the reverberation time, a general measurement of the “liveliness” of a room, is key to ensuring that persons can hear the presenter and each other clearly. The USGBC through the credits outlined in the LEED 2009 For Schools offers additional incentive to, “…provide classrooms that are quiet so that teachers can speak to the class without straining their voices and persons can effectively communicate…”

Selecting more absorptive finishes will lower the reverberation time of the room. Refer to the LEED 2009 For Schools guidelines and note that for:

1) Classrooms less than 20,000 cubic feet there is an option for a rule-of-thumb approach or an RT60 calculation.
2) Classrooms larger than 20,000 cubic feet, the RT60 calculation is to be done per ANSI Standard S12.60-2002 to show that the reverberation time is 1.5 seconds or less,

To meet these requirements sound absorbing materials should be used on an area greater than the total ceiling area. Sound absorbing material could range from standard materials like acoustical ceiling tile; carpet, or fabric wrapped acoustical wall panels to wood, metal or acrylic with sufficient perforations over an acoustical core, provided the NRC value is greater than 0.70. The precise minimum required area is dictated by the volume of the room and the level of absorption the materials provide. Commonly, this may be accomplished by utilizing a sound absorbing ceiling, and incorporating absorptive materials into walls or other vertical faces.

In addition to materials, room geometry is crucial to acoustics for large lecture hall spaces. To facilitate speech intelligibility in minimally amplified situations, the following should be viewed as a minimum list of criteria:

1) No two walls are to be parallel
2) A Fan shaped room is ideal when possible, with the presenter situated at the small end of the room.
3) Ceiling at front of room to be tall enough to accommodate screen height and mounting height as discussed in the display section.
4) Ceiling profile should slope up and away from the presenter with angles calculated to allow sound to be reflected out into the room.

5) Ceiling panels angled to reflect sound should be designed for speech frequencies and reviewed by an acoustician and or Academic Technologies.

6) Avoid concave curvature of the rear wall, and if necessary radius of curvature should exceed the depth dimension of the room.

13.3 Mechanical

Equally important as the materials in the room is the baseline or ambient noise level. Provide a background level not exceeding NC-35 or 40 dB(A), per ANSI Standard S12.60-2002. In a classroom space this ambient noise level will be determined by the HVAC noise. Contributors to the mechanical noise in the room could be, but are not limited to, diffuser noise, duct noise, transmitted air-handler noise, fan-powered terminal unit noise, and even plumbing noise.

When laying out diffusers ensure that no diffusers distribute air onto the plane of the projection screen as this will cause the screen to move or ripple, causing difficulty in focusing on the screen.

13.4 Lighting

As LEED guidelines illustrate, day lighting provides, “…building occupants with a connection between indoor spaces and the outdoors…” and is to be encouraged. Lighting levels at work surfaces are to be coordinated with GW University standards.

However daylight, like artificial light must be controlled and taken into account when locating projection screens and sizing projectors. The ambient light level on the screen is based on the total combination of daylight and artificial light. Utilizing motorized shades and dimmable lights will facilitate using a projector with a lower energy requirement and provide greater flexibility in the classroom.

Using a combination of shades, dimmable lighting and projector/lamp selection, ensure a minimum contrast ratio of 10:1 between the light level (foot candles) from the projector and ambient light level measured at the screen.

When a projection screen must be placed in front of windows the projection screen should be provided with a black backing, regardless of window coverings being in place.

Any shade control or light dimming is to be controlled by the AV control system. This will ensure that the proper room environment is automatically set based on the type of presentation selected from the touch panel. Also provide a basic lighting control wall station near the lectern for direct local control of the lighting that will maintain synchronization with the overall lighting control system.

Lighting zones shall be established to allow separate control of general task lighting independent of lighting in proximity to displays.
13.5 IT Accommodations
The following accommodations are required to support the lecture and associated presentation abilities
1) A VoIP telephone is required at the presenter location for support center communications.
2) Provide a trunk port at the equipment location for a managed switch. The capacity of that switch shall be determined by the number and type of classrooms being centralized.

13.6 Electrical and Pathway
Pathway
Conduit shall be sized not to exceed 40% cable fill ratio based on day one plus 20% for future growth. Plan multiple conduits where required to maintain separation between each of the following signal types throughout the system: microphone, line level audio, loudspeaker, video and RF, and control signals. Conduit shall be rigid metal conduit. Do not exceed 100 feet or a 180 degree change in direction without a properly sized pull-box.

Each room section contains a description of the To/From conduit requirements. In addition, reference the appropriate riser diagram for a graphical representation, and provide cable pathway as required.

Where conduit is not required for accessibility or EMI reasons, J-hooks may be used. When using J-hooks:
1) Provide cable supports at 4 to 5 foot intervals wherever cable tray or conduit is not present.
2) Ceiling ties and rods: Not allowed to hang cable or cable supports.

3) Load supports as recommended by manufacturer. Provide supports side by side on common bracket where cable quantities require.
4) Do not install cables loose above accessible ceilings.
5) Do not support cable from ceiling system tie wires or grid in fire rated systems.
6) Install at a minimum of 3 inches above ceiling tiles, support channels, vertical supports and other components on the suspended ceiling, and at 6 inches where sufficient space is available.
7) Cables shall not come in contact with the ceiling or ceiling components.
8) Use independent low-voltage dedicated support wires and fasteners, no attachment to other systems acceptable.

Back Boxes and Poke-thru’s
Wall and floor boxes shall be separated to divide power and low-voltage. Any in-floor terminations will require a deep enough box or poke-thru to accommodate the terminations/electronics behind the plate. Wall boxes for AV shall be sized in accordance with the depth of the electronics behind the plate and the length of the connectors.

Provide wall boxes with blank covers and conduit to equipment rack or accessible ceiling at VTC camera locations as preparation for future VTC option.

Power
At the lectern, provide a dedicated circuit for the AV equipment and a separate dedicated circuit for the IT...
equipment including the local PC, monitor, and convenience receptacles mounted in the lectern.

At the rack, calculate the load requirement based on the wattages of the rack mounted AV equipment and provide a dedicated circuit(s) for this load.

Terminate power for the ceiling projector flush with the ceiling. Do not locate the receptacle above the finished ceiling surface.

13.7 Structural

All ceiling mounted equipment shall be provided with proper supporting structure to accommodate the weight.

Equipment supported from accessible ceiling tile grid shall be provided with a tile bridge, and shall have a separate back-up support wire anchored to building structure.

Wall mounted equipment shall be provided with appropriate anchors and, where appropriate, backing.

Permanently attach equipment to the building structure with a minimum safety factor of 5. Suspended components that move or are otherwise subjected to continuous wear or friction shall be supported with a minimum safety factor of 8. When a higher safety factor is recommended by an equipment manufacturer or required by the AHJ, the more stringent requirement shall be met.
14.0 TYPICAL PLANS

Figure 14.1 – Under 30 Front Wall Elevation
Figure 14.2 – Under 30 Sight Line Analysis
Figure 14.3 – 50 to 100 Floor Plan and RCP
Figure 14.4 – 50 to 100 Front Wall Elevation
Figure 14.5 – 50 to 100 Site Line Analysis
Figure 14.5 – Collaborative Classroom Layout
15.0 TYPICAL FUNCTIONALS

Figure 15.1 – Under 30 Video Functional Diagram
Figure 15.2 – Under 30 Audio Functional Diagram
Figure 15.3 – Under 30 Control Functional Diagram
Figure 15.4 – 30 to 50 Video Functional Diagram
Figure 15.5 – 30 to 50 Audio Functional Diagram
Figure 15.6 – 30 to 50 Control Functional Diagram
Figure 15.7 – 50 to 100 Video Functional Drawing
Figure 15.8 – 50 to 100 Audio Functional Drawing
Figure 15.9 – 50 to 100 Control Functional Drawing
Figure 15.10 – Collaborative Classroom Video Functional Drawing
Figure 15.11 – Collaborative Classroom Audio Functional Drawing
Figure 15.12 – Collaborative Classroom Control Functional Drawing
Figure 15.13 – Collaborative Classroom Networking Functional Drawing
16.0 TYPICAL RISERS

Figure 16.1 – Conduit Riser for VTC and Enhanced Lecture Capture
17.0 TYPICAL RACK AND LECTERN DETAILS

Figure 17.1 – Under 30 Lectern Detail
Figure 17.2 – 30 to 50 Rack and Lectern Detail
Figure 17.3 – 30 to 50 Panel Layout
Figure 17.4 – 50 to 100 Lectern and Rack Detail
Figure 17.5 – 50 to 100 Panel Layout
Figure 17.6 – Lectern Detail for 50+ Seat Classrooms
Figure 17.7 – Lectern Detail for 50 + Seat Classrooms
Figure 17.8 – Collaborative Classroom Rack and Lectern Elevations
18.0 TYPICAL EQUIPMENT LISTS

See separate attached equipment lists.