

SECTION 27 40 00 – AUDIO-VIDEO SYSTEMS

PART 1 - GENERAL

1.1 REFERENCES

- A. General provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections.
- B. Architectural, Electrical, and Technology Drawings. Other systems drawings may apply. Division 26 Basic Electrical Materials and Methods sections apply to work of this section.

1.2 SUBMITTALS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.3 QUALITY ASSURANCE

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.5 SEQUENCING AND SCHEDULING

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.6 PROJECT SITE CONDITIONS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.7 WARRANTY

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.8 SPECIFICATION RESPONSE

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

1.9 DEFINITIONS

- A. Refer to Section 27 05 00 for requirements that shall be fulfilled as part of this specification section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Subject to compliance with requirements provide products by the following:
 - 1. Cables:
 - a. Video Coax: (Conduit) 8281A Belden, or equal
 - b. Video Coax: (Plenum) 88281 Belden, or equal
 - c. Audio: (Conduit) 8762 Belden, or equal

- d. Audio: (Plenum) 88761 Belden, or equal
- e. Speaker Cable: 9717 Belden or equal
- f. RGB Coax Cables: 308-319-1167A
- g. RGB Coax Cables: 1167B Belden
- h. RGB Coax Cables: V4-3C
- i. (a,b,c) Equivalent: Anixter
- j. (a,b,c) Equivalent: Carol
- k. (a,b,c) Equivalent: Manhattan
- l. (a,b,c) Equivalent: Chester
- m. AT&T 62.5/125 micron, FDDI, grade fiber terminated in ST connectors
- n. Structured Cabling For DigitalMedia & HDBaseT: Crestron DM-CBL-8G-P
- o. Crestron Control Network Cabling: Cresnet-P

2.2 APPROVED INSTALLERS/INTEGRATORS

- A. Xcite Audiovisuals – 7167 S. Alton Way, Centennial, CO 80112 (720-771-1011) Contact: Brian Seid (brian@xciteav.com)
- B. Ford AV – 4230 Carson Street, Denver, CO 80239 (720-374-2345) Contact: Eric Paulsen (paule@fordav.com)
- C. AVI/SPL – 15700 Parkerhouse Road, Suite 200, Parker, CO 80134(303-792-3090) Contact: Howard Zucker (howard.zucker@avispl.com)

PART 3 - EXECUTION

A. System Performance Requirements

1. General:

- a. The University Office of Information Technology - Technology Support Services has been assigned responsibility for providing audiovisual services to the University entities. This includes, but is not limited to: audio systems, video systems, integrated audiovisual control systems, and audio/video distribution systems. This includes determining suitability of proposed uses, compliance with appropriate codes and standards, periodic removal and/or replacement of components and extensions or additions to distribution systems.
- b. The Technology Support Services office will work with all the The University entities to assist in the audiovisual design of classrooms, distance learning classrooms, lecture halls, control/monitoring rooms and conference rooms as needed for the The University campus and shall be consulted extensively during the project design through the The University Project Manager.

2. Procedures:

- a. To facilitate provisioning of audiovisual design services to the The University entities, The University Facilities Projects will provide the Technology Support Services Office with preliminary floor plan drawings for all new building construction and/or major remodel projects.
- b. Technology Support Services engineering staff members will meet with new building occupants, audiovisual system end-users, The University Facilities Planning and other interested parties to determine audiovisual needs and/or requirements.

- c. The preliminary floor plans provided to the Technology Support Services will be marked to show service locations and space requirements and will be returned to Facilities Planning for inclusion in final plans.
3. Classrooms:
- a. Each audiovisual classroom may be connected to a central audio / video distribution room, patching and/or routing system as required. Connections to and from each classroom should include, but not be limited to: (2) RG-6 coaxial cables, (2) CAT5/6 UTP cables, and 2 fiber-optic cables. Infrastructure for this location shall be a triple-gang low voltage electrical box mounted at receptacle height with (2) 1.25" EMT conduits extending to an accessible location above ceiling. These distributed connections may not be required for all AV installations due to emerging and proliferating videoconference bridging technologies on campus, and will be specified as required by Technology Support Services. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:
 - 1) Liberty/PanelCrafters – Standard and Custom Fabricated
 - 2) BTX Technologies, Inc – Standard and Custom Fabricated
 - 3) Extron – AAP/MAAP Standard Plate Modules
 - b. Each classroom shall include on the front wall a LAN / Telco "A / B" jack per campus IT standard. These network lines must be installed by or under the direction and control of The University Office of Information Technology. There shall be located directly adjacent to this "A/B" jack, a duplex power receptacle and audiovisual input plate. Infrastructure for this location shall be a single-gang, low voltage electrical box mounted at standard receptacle height, with (1) .75" EMT conduit extending to an accessible ceiling location. This requirement may be in lieu of, or in addition to, connectivity of an instructor podium / instructor desk via an audiovisual floor box.
 - c. Each classroom will have a dedicated audiovisual input plate for connection of presenter computers and other audiovisual presentation sources as required. A dedicated audiovisual input plate shall be installed on the front wall of the room directly adjacent to a LAN / Telco jack and duplex receptacle. Additional audiovisual input locations may be required depending on the layout and specific need for each classroom. Each classroom audiovisual input plate location shall be triple-gang low-voltage electrical box, with (2) 1.25" EMT conduits extending to an accessible location above ceiling. This requirement may be in lieu of, or in addition to, connectivity of an instructor podium / instructor desk via an audiovisual floor box. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:
 - 1) Liberty/PanelCrafters – Standard and Custom Fabricated
 - 2) BTX Technologies, Inc – Standard and Custom Fabricated
 - 3) Extron – AAP/MAAP
 - d. Each classroom shall include a ceiling mounted projection screen or projection screen(s) depending on the size dimensions and viewing requirements for the audience. Recommended projection screen size is to be determined with the following formula: Maximum viewing distance from the screen to the furthest viewer divided by 6 = recommended screen height. All projection screens shall be widescreen 16:10, 16:9, or 15:10 aspect ratio. The bottom of the projection screen may extend no less than 40" AFF for adequate audience viewing. Projection Screens should be ceiling and/or wall mounted to extend in front of classroom whiteboards, chalkboards, and etcetera wall obstacles. All projection screens shall be motorized electric models. Screen motors shall include integrated low voltage control interfaces and low voltage

control wall switches for external/remote operation. Infrastructure for the screen switch location includes a single-gang low voltage box mounted at standard switch height with a single .75" EMT conduit extending above ceiling to an accessible location. The low voltage screen switch shall be installed in close proximity to the room entry lights and system control panel. Screen electrical junction boxes shall be installed in an accessible ceiling location. Acceptable projection screen models include but are not limited to:

- 1) Da-Lite - Tensioned Advantage Electrol w/ Integrated LVC
- 2) Da-Lite - Advantage Electrol w/ Integrated LVC
- 3) Da-Lite – Tensioned Contour Electrol w/ Integrated LVC

- e. Each classroom shall include a ceiling mounted LCD graphics projector or projector(s) depending on the size dimensions and viewing requirements for the audience. All graphics projectors shall be widescreen 16:10, or 15:10 aspect ratio with a minimum (WXGA 1280x800) native resolution. All graphics projectors should be of adequate brightness and contrast to overcome standard classroom ambient lighting conditions. LCD projectors 3000 ANSI lumens and above are specifically required for all classrooms. Infrastructure for this location includes an un-switched duplex power receptacle to be located in an above ceiling plenum enclosure, located directly above, or adjacent to the projector mounting location. Additional infrastructure includes building network connectivity via The University standard "A/B" (surface mount) data jack to be located in an above ceiling plenum enclosure located directly above, or adjacent to the projector mounting location. Graphics projector models include, but are not limited to:

- 1) Panasonic – PT-EW550U / EW730ZU / EZ590U – 4000-7000 Lumen, WXGA
- 2) Panasonic – PT-LW 312U / 330U / FW430U – 3000-4000 Lumen, WXGA
- 3) NEC – PA-571W / 672W / 452W – 4000-7000 Lumen, WXGA
- 4) NEC – ME-M301W / 331W / 361W / 401W - 3000-4000 Lumen, WXGA

All ceiling projectors are to be securely mounted using The University standard mounting hardware. Suspended ceiling tile-bridge mounts are acceptable for mounting projectors of less than 35 pounds. All tile bridge mounts must be securely tied to the ceiling structure. All mounting points included with the ceiling tile bridge must be secured. All projectors should be mechanically mounted to be center aligned with the projection screen. Mechanical, horizontal and vertical lens shift may be used to optimize the image. Digital keystone and pixel correction options are not acceptable options to overcome mechanical mounting alignment errors. Acceptable projector mounting hardware models include:

- 1) Chief Manufacturing – RPMA Projector Mount Bracket
- 2) Chief Manufacturing – CMS Series Mounting Hardware

All ceiling projector accessories and equipment, such as HDBaseT receivers, video baluns, audio amplifiers, power supplies, etc. must be mounted and secured in an accessible above ceiling plenum enclosure. Visible below ceiling connections to the projector must be cleanly installed, without AV devices mounted to the top of the projector, or to the projector mounting pole, etc. Duplex power and A/B data jacks described above, shall be coordinated and installed along with the plenum ceiling enclosure and required AV devices. The plenum ceiling enclosure shall be sized appropriately for the project.

Acceptable ceiling projector plenum enclosure models include:

- 1) Chief Manufacturing – CMA-470 / 471 / 472
- 2) Chief Manufacturing – CMS-491P2 / CMS492CP2
- 3) FSR – CB-12 / 22 / 224

All ceiling projectors shall be locked for security from theft. A key-locking, anti-theft alarm shall be professionally installed at each ceiling projector location. All alarm keys must be coordinated with Technology Support Services for uniformity and ease of service. All alarm

keys shall be labeled and delivered to Technology Support Services at the conclusion of a project or major project phase.

Acceptable security alarm models include:

- 1) Secure-It – Sonic Shock Alarm 5 (Key # By Campus/Area)

- f. Smaller classrooms may include a direct-view television monitor in lieu of, or in addition to, a video projection system depending on the size dimensions and viewing requirements for the audience. All direct-view televisions shall be widescreen 16:9, 16:10, or 15:10 aspect ratio with a minimum 1080p native video resolution. Infrastructure for this location includes an un-switched, duplex power receptacle to be located inside a recessed AV enclosure directly behind the television location at 72" AFF to box center. A wall mount, recessed AV equipment enclosure shall be installed behind each television location, at 72" AFF to box center. (1) 1.25" EMT conduit shall extend from the recessed AV box to above ceiling, in an accessible location. A duplex receptacle and LAN / Telco "A/B" jack, shall be installed inside each recessed wall box. See TV wall box specifications, below. Acceptable television models include, but are not limited to:

- 1) Sharp - Aquos LC Series Televisions
- 2) Samsung – UN Series

All direct-view television displays are to be securely wall-mounted using The University standard mounting hardware. Television mounts must be secured to metal wall-studs not more than 16" from center to center with Hilti ¼" HTB Hollow Wall Anchors. All supplied hardware mounting points must be securely anchored to studs. Wall backing may be required as necessary under direction from Technology Support Services. Ceiling mount installation of direct-view displays is not preferred, although it may be required in unique situations as necessary, under direction from Technology Support Services. Acceptable television mount models include:

- 1) Chief Manufacturing – LTM, XTM Fusion Series Tilt Wall Mounts
- 2) Chief Manufacturing – MWR Series Swing-Arm Wall Mounts

All classroom television locations must include a deep, recessed, wall enclosure for electrical infrastructure, data infrastructure, and AV devices. The recessed wall enclosure should be adequately sized for the project. Acceptable wall recessed TV boxes include:

- 1) Chief Manufacturing – PAC-525 / 526
- 2) FSR – PWB-100 / 200 / 250 / 450

- g. Sound reinforcement systems shall be built into larger classrooms as required. A pair of surface mount speakers shall be installed on the front wall or ceiling of each classroom – facing the audience. Wall mounted speakers shall require a single-gang low-voltage electrical box mounted directly behind the speaker location at 96" AFF with (1) .75" EMT conduit extending to above ceiling in an accessible location. Depending on the size of the classroom, additional distributed 70V ceiling speakers may be employed for adequate sound coverage. Acceptable surface mount speaker models include:

- 1) JBL – Control Contractor Series Surface Mount Speaker
- 2) Tannoy – I Series Surface Mount Speaker
- 3) Tannoy – DI Series Surface Mount Speaker

- h. Each classroom shall have a central audiovisual equipment rack location within. Smaller classroom designs may locate equipment within a multimedia podium/lectern. Larger systems may require an external wall-mount or floor-standing equipment rack. All AV rack locations shall include a dedicated 20A duplex receptacle with no shared ground or neutral electrical

wiring. All AV equipment rack locations shall at minimum include an 8" x 8" screw cover (Hoffman Type) pull box with (3) 1.25" EMT conduits extending to above ceiling in an accessible location. The rack pull box shall be located adjacent to the dedicated 20A duplex receptacle. Mounting heights for wall rack electrical/pull boxes shall be 50" AFF. Mounting heights for floor-standing equipment racks shall be standard receptacle height. Acceptable equipment rack models include, but are not limited to:

- 1) Middle Atlantic – WRK Series Floor Standing Equipment Rack
- 2) Middle Atlantic – ERK Series Floor Standing Equipment Rack
- 3) Middle Atlantic – DWR Series Sectional Wall Mount Equipment Rack
- 4) Middle Atlantic – EWR Series Sectional Wall Mount Equipment Rack
- 5) Middle Atlantic – WRS Series Low Profile Equipment Rack

- i. Each classroom that requires a podium will include an audiovisual floor box, which shall be located directly underneath the podium location. The audiovisual floor box will include knockouts and conduit pathways for dedicated network "A/B", audio / video cabling, and AC power cabling. A similar layout would be used for other floor box locations as required within the classroom. Acceptable audiovisual floor box models include:

- 1) Wiremold / Legrand - Evolution 6AT / 8AT Series Poke-Thru Floor Devices
- 2) Wiremold / Legrand – RFB4 On Grade Floor Boxes
- 3) FSR – FL Series Concrete Pour In / Raised Access Boxes

- j. Each classroom shall include a pan/tilt/zoom camera location for the purposes of lecture capture and portable videoconference integration. The camera shall typically be located at the rear or side wall of the classroom with a clear view of the presenter desk / podium location. Infrastructure for this location includes a single-gang, low voltage electrical box mounted at 96" AFF with (1) .75" EMT conduit extending to above ceiling in an accessible location. A duplex receptacle shall be installed directly adjacent to the camera location at 96" AFF.

- k. Each typical classroom shall include a wall mounted audiovisual system control panel. Infrastructure for this location includes a triple-gang low voltage electrical box mounted at standard switch height with (1) 1.00" EMT conduit extending to above ceiling in an accessible location. The control panel shall typically be installed adjacent to the low-voltage projection screen switch and room lighting controls. Acceptable audiovisual control panel models include:

- 1) Crestron – MPC-M5 / M10 / M20 / M25 / M50

- l. Classroom lighting zones should be arranged to be dimmable and/or on/off controllable from the front of the room to the rear of the room. Specifically, the first row of classroom lighting shall be on a separate lighting zone so that excessive light does not degrade the quality of the video display systems typically located on the front wall of the classroom. Light switches, dimmer controls, etc. shall typically be mounted at standard switch height in close proximity behind the presenters desk / podium, and shall be directly adjacent to the low voltage screen control switch and system control panel.

- m. University classrooms will typically include a small teaching stand, or a small-to medium multimedia podium, to function as a teaching station, equipment rack, equipment storage, etc. depending on need. The podium teaching station and related equipment is almost always the primary AV source in the classroom, and must be built to accommodate the user and the classroom environment. The University has worked with a podium manufacturer to facilitate a master design for classroom podiums, and this manufacturer and master design should be used whenever possible. (See Part 4 Illustration Ex. 1-2) Acceptable podium/stand models include:

- 1) DWI Enterprises – D20-32 (University of Colorado Custom Spec)
- 2) DWI Enterprises – IS-10 (University of Colorado Custom Spec)
- 3) Da-Lite – Euro Lecterns

- 4) Spectrum Industries – LINK Series
- 5) Spectrum Industries – Inspiration Plus Series

4. Lecture Halls:

- a. Each audiovisual lecture hall may be connected to a central audio / video distribution room, monitoring room, patching and/or routing system as required. Connections to and from each lecture hall should include, but not be limited to: (2) RG-6 coaxial cables, (2) CAT5/6 UTP cables, and 2 fiber-optic cables. Infrastructure for this location shall be a triple-gang low voltage electrical box mounted at receptacle height with (2) 1.25" EMT conduits extending to an accessible location above ceiling. These distributed connections may not be required in all AV installations due to emerging and proliferating videoconference bridging technologies on campus, and will be specified as required by Technology Support Services. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:
 - 1) Liberty/PanelCrafters – Standard and Custom Fabricated
 - 2) BTX Technologies, Inc – Standard and Custom Fabricated
 - 3) Extron – AAP/MAAP Standard Plate Modules
- b. Each lecture hall shall include on the front wall a LAN / Telco "A / B" jack per campus IT standard. These network lines must be installed by or under the direction and control of The University Office of Information Technology. There shall be located directly adjacent to this "A/B" jack, a duplex power receptacle and audiovisual input plate. Infrastructure for this location shall be a single-gang, low voltage electrical box mounted at standard receptacle height, with (1) .75" EMT conduit extending to an accessible ceiling location. This requirement may be in lieu of, or in addition to, connectivity of an instructor podium / instructor desk via an audiovisual floor box.
- c. Each lecture hall will have a dedicated audiovisual input plate for connection of presenter computers and other audiovisual presentation sources as required. A dedicated audiovisual input plate shall be installed on the front wall of the room directly adjacent to the LAN / Telco jack and duplex receptacle. Additional audiovisual input locations may be required depending on the layout and specific need for each lecture hall. Each lecture hall audiovisual input plate location shall be a triple-gang low-voltage electrical box mounted at standard receptacle height, with (2) 1.25" EMT conduits extending to an accessible location above ceiling. This requirement may be in lieu of, or in addition to, connectivity of an instructor podium / instructor desk via an audiovisual floor box. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:
 - 1) Liberty/PanelCrafters – Standard and Custom Fabricated
 - 2) BTX Technologies, Inc – Standard and Custom Fabricated
 - 3) Extron – AAP/MAAP
- d. Each lecture hall shall include two or more ceiling mounted projection screens depending on the size dimensions and viewing requirements for the audience. Recommended projection screen size is to be determined with the following formula: Maximum viewing distance from the screen to the furthest viewer divided by 6 = recommended screen height. All projection screens shall be widescreen 16:10, 16:9, or 15:10 aspect ratio. The bottom of the projection screen may extend no less than 40" AFF for adequate audience viewing. Projection Screens should be ceiling and/or wall mounted to extend in front of lecture hall whiteboards, chalkboards, and etcetera wall obstacles. All projection screens shall be motorized electric models. Screen motors shall include integrated low voltage control interfaces and low voltage control wall switches for external/remote operation. Infrastructure for the screen switch location

includes a single-gang, low voltage box mounted at standard switch height with a single .75" EMT conduit extending above ceiling to an accessible location. The low voltage screen switch shall be installed in close proximity to the room entry lights and system control panel. Any screen electrical junction boxes shall be installed in an accessible ceiling location. Acceptable projection screen models include but are not limited to:

- 1) Da-Lite - Tensioned Advantage Electrol w/ Integrated LVC
- 2) Da-Lite - Advantage Electrol w/ Integrated LVC
- 3) Da-Lite – Tensioned Contour Electrol w/ Integrated LVC

- e. Each lecture hall shall include two or more ceiling mounted LCD graphics projectors depending on the size dimensions and viewing requirements for the audience. All graphics projectors shall be widescreen 16:10, or 15:10 aspect ratio with a minimum (WXGA 1280x800) native resolution. Projectors with high resolution (1920 x 1200), and high brightness (7000-10000 Lumens) may be required in the Lecture Halls depending on application and architectural considerations. All graphics projectors should be of adequate brightness and contrast to overcome typical lecture hall ambient lighting conditions. LCD projectors 5000 ANSI lumens and above are specifically required for all lecture halls. Infrastructure for this location includes an un-switched duplex power receptacle to be located in an above ceiling plenum enclosure, located directly above, or adjacent to the projector mounting location. Additional infrastructure includes building network connectivity via The University standard "A/B" (surface mount) data jack to be located in an above ceiling plenum enclosure located directly above, or adjacent to the projector mounting location. Acceptable graphics projector models include, but are not limited to:

- 1) Panasonic – PT-EW730ZU – 7000 Lumens, WXGA
- 2) Panasonic - PT-EW650U - 5800 Lumens, WXGA
- 3) Panasonic - PT-EZ590U - 5000 Lumens, WUXGA
- 4) Panasonic - PT-DZ780BU - 7000 Lumens, WUXGA

All ceiling projectors are to be securely mounted using The University standard mounting hardware. Suspended ceiling tile-bridge mounts are acceptable for mounting projectors of less than 35 pounds. All tile bridge mounts must be securely tied to the ceiling structure. All mounting points included with the ceiling tile bridge must be secured. All projectors should be mechanically mounted to be center aligned with the projection screen. Mechanical, horizontal and vertical lens shift may be used to optimize the image. Digital keystone and pixel correction options are not acceptable options to overcome mechanical mounting alignment errors. Acceptable projector mounting hardware models include:

- 1) Chief Manufacturing – RPMA Projector Mount Bracket
- 2) Chief Manufacturing – CMS Series Mounting Hardware

All ceiling projector accessories and equipment, such as HDBaseT receivers, video baluns, audio amplifiers, power supplies, etc. must be mounted and secured in an accessible above ceiling plenum enclosure. Visible below ceiling connections to the projector must be cleanly installed, without AV devices mounted to the top of the projector, or to the projector mounting pole, etc. Duplex power and A/B data jacks described above, shall be coordinated and installed along with the plenum ceiling enclosure and required AV devices. The plenum ceiling enclosure shall be sized appropriately for the project.

Acceptable ceiling projector plenum enclosure models include:

- 3) Chief Manufacturing – CMA-470 / 471 / 472
- 4) Chief Manufacturing – CMS-491P2 / CMS492CP2
- 5) FSR – CB-12 / 22 / 224

All ceiling projectors shall be locked for security from theft. A key-locking, anti-theft alarm shall be professionally installed at each ceiling projector location. All alarm keys must be coordinated with Technology Support Services for uniformity and ease of service. All alarm keys shall be labeled and delivered to Technology Support Services at the conclusion of a project or major project phase.

Acceptable security alarm models include:

2) Secure-It – Sonic Shock Alarm 5 (Key # By Campus/Area)

- f. Sound reinforcement systems shall be built into lecture halls as required. A pair of surface mount speakers shall be installed on the front wall or ceiling of each lecture hall – facing the audience. Wall mounted speakers shall require a single-gang low-voltage electrical box mounted directly behind the speaker location at 96" AFF with (1) .75" EMT conduit extending to above ceiling in an accessible location. Depending on the size of the lecture hall, additional distributed 70V ceiling speakers may be employed for adequate sound coverage. Acceptable surface mount speaker models include:

- 1) JBL – Control Contractor Series Surface Mount Speaker
- 2) Tannoy – I Series Surface Mount Speaker
- 3) Tannoy – DI Series Surface Mount Speaker

- g. Each lecture hall shall have a central audiovisual equipment rack location within. Smaller lecture hall designs may locate equipment within a multimedia podium/lectern. Larger systems may require an external wall-mount or floor-standing equipment rack. All AV rack locations shall include a dedicated 20A duplex receptacle with no shared ground or neutral electrical wiring. All AV equipment rack locations shall at minimum include an 8" x 8" screw cover (Hoffman Type) pull box with (3) 1.25" EMT conduits extending to above ceiling in an accessible location. The rack pull box shall be located adjacent to the dedicated 20A duplex receptacle. Mounting heights for wall rack electrical/pull boxes shall be 50" AFF. Mounting heights for floor-standing equipment racks shall be standard receptacle height. Acceptable equipment rack models include, but are not limited to:

- 1) Middle Atlantic – WRK Series Floor Standing Equipment Rack
- 2) Middle Atlantic – ERK Series Floor Standing Equipment Rack
- 3) Middle Atlantic – DWR Series Sectional Wall Mount Equipment Rack
- 4) Middle Atlantic – EWR Series Sectional Wall Mount Equipment Rack
- 5) Middle Atlantic – WRS Series Low Profile Equipment Rack

- h. Each lecture hall that requires a podium will include an audiovisual floor box, which shall be located directly underneath the podium location. The audiovisual floor box will include knockouts and conduit pathways for dedicated network "A/B", audio / video cabling, and AC power cabling. A similar layout would be used for other floor box locations as required within the lecture hall. Acceptable audiovisual floor box models include:

- 1) Wiremold / Legrand - Evolution 6AT / 8AT Series Poke-Thru Floor Devices
- 2) Wiremold / Legrand – RFB4 On Grade Floor Boxes
- 3) FSR – FL Series Concrete Pour In / Raised Access Boxes

- i. Each lecture hall shall include one or more pan/tilt/zoom camera locations for the purposes of lecture capture and/or videoconference integration. The cameras shall typically be located on the walls of the classroom with a clear view of the presenter desk / podium location, and the audience participants. Infrastructure for each of these locations includes a single-gang, low voltage electrical box mounted at 96" AFF with (1) 1.00" EMT conduit extending to above ceiling in an accessible location. A duplex receptacle shall be installed directly adjacent to each camera location at 96" AFF.

- j. Lecture hall lighting zones should be arranged to be dimmable and/or on/off controllable from the front of the room to the rear of the room. Specifically, the first row of classroom lighting shall be on a separate lighting zone so that excessive light does not degrade the quality of the video display systems typically located on the front wall of the classroom. Light switches, dimmer controls, etc. shall typically be mounted at standard switch height in close proximity behind the presenters desk / podium, and shall be directly adjacent to the low voltage screen control switch and system control panel.
 - k. University Lecture Halls will typically include a small-to-large multimedia podium, to function as a teaching station, equipment rack, equipment storage, etc. depending on need. The podium teaching station and related equipment is almost always the primary AV source in the lecture hall, and must be built to accommodate the user and the lecture hall environment. The University has worked with a podium manufacturer to facilitate a master design for lecture hall podiums, and this manufacturer and master design should be used whenever possible. (See Part 4 Illustration Ex. 2-3) Acceptable podium/stand models include:
 - 1) DWI Enterprises - D20-32 (University of Colorado Custom Spec)
 - 2) DWI Enterprises - DM-200 (University of Colorado Custom Spec)
 - 3) DWI Enterprises - IS-10 (University of Colorado Custom Spec)
 - 4) Spectrum Industries – Link Lectern
5. Conference Rooms:
- a. Each audiovisual conference room may be connected to a central audio / video distribution room, monitoring room, patching and/or routing system as required. Connections to and from each conference room should include, but not be limited to: (2) RG-6 coaxial cables, (2) CAT5/6 UTP cables, and 2 fiber-optic cables. Infrastructure for this location shall be a triple-gang low voltage electrical box mounted at receptacle height with (2) 1.25" EMT conduits extending to an accessible location above ceiling. These distributed connections may not be required for all AV installations due to emerging and proliferating videoconference and bridging technologies on campus, and will be specified as required by Technology Support Services. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:
 - 1) Liberty/PanelCrafters – Standard and Custom Fabricated
 - 2) BTX Technologies, Inc. – Standard and Custom Fabricated
 - 3) Extron – AAP/MAAP Standard Plate Modules
 - b. Each conference room shall include on the front wall, a LAN / Telco "A / B" jack per campus IT standard. These network lines must be installed by or under the direction and control of CU Denver Office of Information Technology. There shall be located directly adjacent to this "A/B" jack, a duplex power receptacle and audiovisual input plate. Infrastructure for this location shall be a single-gang, low voltage electrical box mounted at standard receptacle height, with (1) .75" EMT conduit extending to an accessible ceiling location. This requirement may be in lieu of, or in addition to, connectivity of conference table audiovisual inputs via an audiovisual floor box.
 - c. Each conference room will have a dedicated audiovisual input plate for connection of presenter computers and other audiovisual presentation sources as required. A dedicated audiovisual input plate shall be installed on the front wall of the room directly adjacent to the LAN / Telco jack and duplex receptacle. Additional audiovisual input locations may be required depending on the layout and specific need for each conference room. Each conference room audiovisual input plate location shall be a triple-gang low-voltage electrical box mounted at standard receptacle height, with (2) 1.25" EMT conduits extending to an accessible location above ceiling. This requirement may be in lieu of, or in addition to, connectivity of conference table

audiovisual inputs via an audiovisual floor box. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:

- 1) Liberty/PanelCrafters – Standard and Custom Fabricated
- 2) BTX Technologies, Inc. – Standard and Custom Fabricated
- 3) Extron – AAP/MAAP Standard Plate Modules

- d. Conference rooms with large central conference tables, will typically include an audiovisual floor box, which shall be located directly underneath the table pedestal location. The audiovisual floor box will include knockouts and conduit pathways for dedicated network “A/B”, audio / video cabling, and AC power cabling. A similar layout would be used for other floor box locations as required under the conference table as needed. Acceptable audiovisual floor box models include:

- 1) Wiremold / Legrand - Evolution 6AT / 8AT Series Poke-Thru Floor Devices
- 2) Wiremold / Legrand – RFB4 On Grade Floor Boxes
- 3) FSR – FL Series Concrete Pour In / Raised Access Boxes

- e. Each conference room shall include a ceiling mounted projection screen depending on the size dimensions and viewing requirements for the audience. Recommended projection screen size is to be determined with the following formula: Maximum viewing distance from the screen to the furthest viewer divided by 6 = recommended screen height. All projection screens shall be widescreen 16:10, 16:9, or 15:10 aspect ratio. The bottom of the projection screen may extend no less than 40” AFF for adequate audience viewing. Projection Screens should be ceiling and/or wall mounted to extend in front of conference room wall obstacles. All projection screens shall be motorized electric models. Screen motors shall include integrated low voltage control interfaces and low voltage control wall switches for external/remote operation. Infrastructure for the screen switch location includes a single-gang, low voltage box mounted at standard switch height with a single .75” EMT conduit extending above ceiling to an accessible location. The low voltage screen switch shall be installed in close proximity to the room entry lights and system control panel. Any screen electrical junction boxes shall be installed in an accessible ceiling location. Acceptable projection screen models include but are not limited to:

- 1) Da-Lite – Tensioned Advantage Electrol w/ Integrated LVC
- 2) Da-Lite – Advantage Electrol w/ Integrated LVC
- 3) Da-Lite – Tensioned Contour w/ Integrated LVC

- f. Each conference room shall include a ceiling mounted LCD graphics projector depending on the size dimensions and viewing requirements for the audience. All graphics projectors shall be widescreen 16:10, or 15:10 aspect ratio with a minimum (WXGA 1280x800) native resolution. All graphics projectors should be of adequate brightness and contrast to overcome typical lecture hall ambient lighting conditions. LCD projectors 4000 ANSI lumens and above are specifically required for all conference rooms. Infrastructure for this location includes an un-switched duplex power receptacle to be located in an above the ceiling plenum enclosure, ~~surface~~ located directly above or adjacent to the projector mounting location. Additional infrastructure includes building network connectivity via UCD standard “A/B” (surface mount) data jack to be located in an above ceiling plenum enclosure located directly above, or adjacent to the projector mounting location. Acceptable graphics projector models include, but are not limited to:

- 1) Panasonic – PT-EW550U / EW730ZU / EZ590U – 4000-7000 Lumen, WXGA
- 2) Panasonic – PT-LW 312U / 330U / FW430U – 3000-4000 Lumen, WXGA
- 3) NEC – PA-571W / 672W / 452W – 4000-7000 Lumen, WXGA
- 4) NEC – ME-M301W / 331W / 361W / 401W - 3000-4000 Lumen, WXGA

- g. All ceiling projectors are to be securely mounted using UCD standard mounting hardware. Suspended ceiling tile-bridge mounts are acceptable for mounting projectors of less than 35 pounds. All tile bridge mounts must be securely tied to the ceiling structure. All mounting points included with the ceiling tile bridge must be secured. All projectors should be mechanically mounted to be center aligned with the projection screen. Mechanical, horizontal and vertical lens shift may be used to optimize the image. Digital keystone and pixel correction options are not acceptable options to overcome mechanical mounting alignment errors. Acceptable projector mounting hardware models include:

- 1) Chief Manufacturing – RPMA Projector Mount Bracket
- 2) Chief Manufacturing – CMS Series Mounting Hardware

All ceiling projector accessories and equipment, such as HDBaseT receivers, video baluns, audio amplifiers, power supplies, etc. must be mounted and secured in an accessible above ceiling plenum enclosure. Visible below ceiling connections to the projector must be cleanly installed, without AV devices mounted to the top of the projector, or to the projector mounting pole, etc. Duplex power and A/B data jacks described above, shall be coordinated and installed along with the plenum ceiling enclosure and required AV devices. The plenum ceiling enclosure shall be sized appropriately for the project.

Acceptable ceiling projector plenum enclosure models include:

- 3) Chief Manufacturing – CMA-470 / 471 / 472
- 4) Chief Manufacturing – CMS-491P2 / CMS492CP2
- 5) FSR – CB-12 / 22 / 224

All ceiling projectors shall be locked for security from theft. A key-locking, anti-theft alarm shall be professionally installed at each ceiling projector location. All alarm keys must be coordinated with Technology Support Services for uniformity and ease of service. All alarm keys shall be labeled and delivered to Technology Support Services at the conclusion of a project or major project phase.

Acceptable security alarm models include:

- 3) Secure-It – Sonic Shock Alarm 5 (Key # By Campus/Area)

- h. Smaller conference rooms may include a direct-view television monitor in lieu of, or in addition to, a video projection system depending on the size dimensions and viewing requirements for the audience. All direct-view televisions shall be widescreen 16:9, 16:10, or 15:10 aspect ratio with a minimum 1080p native video resolution. Infrastructure for this location includes an un-switched, duplex power receptacle to be located inside a recessed AV enclosure directly behind the television location at 72" AFF to box center. A double-gang, low voltage electrical box with (1) 1.25" EMT conduit shall extend from the recessed AV box to above ceiling in an accessible location. A duplex receptacle and LAN / Telco "A/B" jack, shall be installed inside each recessed wall box. See TV wall box specifications, below. Acceptable television models include, but are not limited to:

- 1) Sharp - Aquos LC Series Televisions
- 2) Samsung – UN Series

- i. All direct-view television displays are to be securely wall-mounted using The University standard mounting hardware. Television mounts must be secured to metal wall-studs not more than 16" from center to center with Hilti 1/4" HTB Hollow Wall Anchors. All supplied hardware mounting points must be securely anchored to studs. Wall backing may be required as necessary under direction from Technology Support Services. Ceiling mount installation of direct-view displays is not preferred, although it may be required in unique situations as

necessary, under direction from Technology Support Services. Acceptable television mount models include:

- 1) Chief Manufacturing – LTM, XTM Fusion Series Tilt Wall Mounts
- 2) Chief Manufacturing – MWR Series Swing-Arm Wall Mounts

All classroom television locations must include a deep, recessed, wall enclosure for electrical infrastructure, data infrastructure, and AV devices. The recessed wall enclosure should be adequately sized for the project. Acceptable wall recessed TV boxes include:

- 3) Chief Manufacturing – PAC-525 / 526
- 4) FSR – PWB-100 / 200 / 250 / 450

- j. Sound reinforcement systems shall be built into conference rooms as required. Ceiling microphones are typically utilized for small conference rooms with videoconference capability. A pair of surface mount speakers shall be installed on the front wall or ceiling of each conference room – facing the audience. Wall mounted speakers shall require a single-gang low-voltage electrical box mounted directly behind the speaker location at 96" AFF with (1) .75" EMT conduit extending to above ceiling in an accessible location. Depending on the size of the conference room, additional distributed 70V ceiling speakers may be employed for adequate sound coverage. Acceptable surface mount speaker models include:

- 1) JBL – Control Contractor Series Surface Mount Speaker
- 2) Tannoy – I Series Surface Mount Speaker
- 3) Tannoy – DI Series Surface Mount Speaker

- k. Each conference room shall have a central audiovisual equipment rack location within. Smaller conference room designs may locate equipment within a multimedia podium/lectern/credenza. Larger systems may require an external wall-mount or floor-standing equipment rack. All audiovisual equipment rack enclosures and/or closets shall be properly ventilated to maintain the equipment at a suitable operating temperature. All AV rack locations shall include a dedicated 20A duplex receptacle with no shared ground or neutral electrical wiring. All AV equipment rack locations shall at minimum include an 8" x 8" screw cover (Hoffman Type) pull box with (3) 1.25" EMT conduits extending to above ceiling in an accessible location. The rack pull box shall be located adjacent to a dedicated 20A duplex receptacle and A/B data jack. Mounting heights for wall rack electrical/pull boxes shall be 50" AFF. Mounting heights for floor-standing equipment racks shall be standard receptacle height. Acceptable equipment rack models include, but are not limited to:

- 1) Middle Atlantic – WRK Series Floor Standing Equipment Rack
- 2) Middle Atlantic – ERK Series Floor Standing Equipment Rack
- 3) Middle Atlantic – DWR Series Sectional Wall Mount Equipment Rack
- 4) Middle Atlantic – EWR Series Sectional Wall Mount Equipment Rack
- 5) Middle Atlantic – WRS Series Low Profile Equipment Rack

- l. Each conference room that that requires a podium will include an audiovisual floor box, which shall be located directly underneath the podium location. Each conference room that includes a central conference table will include one or more floor boxes located directly under the conference table location. The audiovisual floor box will include knockouts and conduit pathways for dedicated network "A/B", audio / video cabling, and AC power cabling. A similar layout would be used for other floor box locations as required within the conference room. Acceptable audiovisual floor box models include:

- 1) Wiremold / Legrand - Evolution 6AT / 8AT Series Poke-Thru Floor Devices
- 2) Wiremold / Legrand – RFB4 On Grade Floor Boxes
- 3) FSR – FL Series Concrete Pour In / Raised Access Boxes

- m. Each conference room may include one or more pan/tilt/zoom camera locations for the purposes of video capture and/or videoconference integration. A pan/tilt/zoom camera shall typically be located on the front wall of the conference room with a clear view of the seated audience. The front, “audience view” camera shall typically be located in close proximity to the far-site “people” display – for optimal eye contact with the far audience. A secondary, “presenter view” camera may be utilized for additional conferencing capability. The secondary camera shall typically be located on the back wall or ceiling with an unobstructed view of the presenter. Infrastructure for each of these locations includes a double-gang, low voltage electrical box mounted at 72” AFF with (1) 1.25” EMT conduit extending to above ceiling in an accessible location. A duplex receptacle shall be installed directly adjacent to each camera location at 72” AFF.
 - n. Conference room lighting zones should be arranged to be dimmable and/or on/off controllable from the front of the room to the rear of the room. Specifically, the first row of conference room lighting shall be on a separate lighting zone so that excessive light does not degrade the quality of the video display systems typically located on the front wall of the conference room. Any pendant lighting and/or suspended lighting fixtures must not interfere with the projection system, which is typically centered with the room center. Light switches, dimmer controls, etc. shall typically be mounted at standard switch height in close proximity behind the presenters desk / podium, and shall be directly adjacent to the low voltage screen control switch and system control panel.
6. Control/Monitoring Rooms:
- a. For remote or building-wide, audio/video monitoring, audio/video recording, audio/video routing, and/or system control capability to be realized, a centralized building audiovisual control/monitoring room may be required. Control/monitoring room requirements will typically be identified per project under the direction of CU Denver Office of Information Technology – Technology Support Services. The control/monitoring room shall typically be located on the first floor of the building within an acceptable distance of building IDF and/or MDF closets. The control/monitoring room shall be adequately cooled and ventilated to keep audiovisual equipment at a safe operating temperature. The control room will typically have a single array of large (44RU) audiovisual equipment racks containing the majority of the necessary routing, switching, and etc. equipment. Additional recording equipment, LCD monitors, etc. may be located in smaller (14RU) audiovisual equipment racks around the control room at various monitoring stations to accommodate the recording/monitoring capacity required. A heavy-duty counter surface will be installed on at least one wall of the control room for placement of audiovisual control/monitoring equipment.
 - b. Each control monitoring room shall include multiple LAN / Telco “A / B” jacks distributed around the room per campus IT standard. These network lines must be installed by or under the direction and control of CU Denver Office of Information Technology. In most cases there shall be located directly adjacent to this “A/B” jack, a duplex power receptacle and audiovisual input plate. Infrastructure for this location shall be a single-gang, low voltage electrical box mounted at standard receptacle height, with (1) .75” EMT conduit extending to an accessible ceiling location.
 - c. The control/monitoring room requires substantial EMT conduit infrastructure for various audiovisual equipment locations. A deep, screw cover (Hoffman Type) pull box “collection box” of at least 4’ in length shall be installed above the ceiling in the control/monitoring room with a minimum of (6) 2.00” EMT conduits connected directly to a nearby large capacity cable tray. Additional above ceiling pull boxes may be used for larger systems as required. All audiovisual infrastructure shall connect via the above ceiling collection box to various locations within the room.
 - d. The control/monitoring room will have audiovisual input/output plates distributed above the equipment counter surface for connection of audio / video monitoring, recording, and source

equipment. The input plate will typically be installed adjacent to a LAN / Telco jack and duplex receptacle. Each input plate location shall be a triple-gang low-voltage electrical box mounted at standard receptacle height, with (3) 1.25" EMT conduit connection to the above ceiling collection box. Active (powered) input plates such as Crestron DM-TX-200-C-2G are not acceptable for wall / floor input plate applications. A passive input plate should be used with an active transmitter mounted above the ceiling or in nearby junction box if required. Acceptable input plate/panel models include:

- 1) Liberty/PanelCrafters – Standard and Custom Fabricated
- 2) BTX Technologies, Inc. – Standard and Custom Fabricated
- 3) Extron – AAP/MAAP

- e. The control/monitoring room will have audiovisual input/output plates distributed below the equipment counter surface for connection of audio / video monitoring, recording, and source equipment. The input plate will typically be installed adjacent to a LAN / Telco jack and duplex receptacle. Each input plate location shall be a triple-gang low-voltage electrical box mounted at standard receptacle height, with (3) 1.25" EMT conduit connection to the above ceiling collection box. Acceptable input plate/panel models include:

- 1) Liberty/PanelCrafters – Standard and Custom Fabricated
- 2) BTX Technologies, Inc. – Standard and Custom Fabricated
- 3) Extron – AAP/MAAP

- f. The control/monitoring room may have several audiovisual equipment racks location within, depending on the project scope. All audiovisual equipment rack enclosures and/or closets shall be properly ventilated to maintain the equipment at a suitable operating temperature. All AV rack locations shall include a dedicated 20A quad receptacle with no shared ground or neutral electrical wiring. All AV equipment rack locations shall at minimum include a 12" x 12" screw cover (Hoffman Type) pull box mounted flush in wall with (6) 1.25" EMT conduit connection to above ceiling collection box. The rack pull box shall typically be located adjacent to a dedicated 20A quad receptacle and A/B data jack. All equipment rack locations should include proper grounding nearby via ground spike and/or ground bus system. Mounting heights for floor-standing equipment racks shall be standard receptacle height. Acceptable equipment rack models include, but are not limited to:

- 1) Middle Atlantic – WRK Series Floor Standing Equipment Rack
- 2) Middle Atlantic – ERK Series Floor Standing Equipment Rack

7. Digital Signage:

- a. Digital signage hardware / software information systems may be used to offer CU Denver classroom scheduling, current events, etc. information to faculty, staff and students. Typical signage locations include high traffic, high visibility areas such as reception areas, elevator lobbies, foyers, and corridors. A typical signage location shall include a wall mounted LCD television with a built in, or associated signage player. The signage player shall accept signage content information via the building network. All signage screens are typically passive, non-interactive models. Interactive kiosk displays may be required for special applications under the direction of CU Denver Office of Information Technology – Technology Support Services.
- b. Each digital signage location shall include behind the television monitor, a recessed AV enclosure, with a LAN / Telco "A / B" jack installed inside the enclosure per campus IT standard. These network lines must be installed by or under the direction and control of Office of Information Technology. A duplex power receptacle shall also be mounted inside the recessed AV enclosure. Mount recessed AV enclosure at standard 55" AFF to device center, with (1) .75" EMT conduit, and (1) 1.25" EMT conduit extending to an accessible above ceiling location.

- c. All direct-view televisions shall be widescreen 16:9, 16:10, or 15:10 aspect ratio with a minimum 1080p native video resolution. Infrastructure for this location includes an un-switched, recessed AV enclosure, to be located in the wall directly behind the television location at 55" AFF to device center. (1) 1.25" EMT conduit will extend from the recessed AV enclosure to above ceiling in an accessible location. (1) .75" EMT conduit shall also be provided and installed to extend from the recessed AV enclosure to above ceiling in accessible location for the LAN / Telco "A/B" jacks. See TV wall box specifications below. Acceptable television models include, but are not limited to:

- 1) Sharp - Aquos LC Series Televisions
- 2) Samsung – UN Series

- d. All direct-view television displays are to be securely wall-mounted using University standard mounting hardware. Television mounts must be secured to metal wall-studs not more than 16" from center to center with Hilti ¼" HTB Hollow Wall Anchors. All supplied hardware mounting points must be securely anchored to studs. Wall backing may be required as necessary under direction from Technology Support Services. Ceiling mount installation of direct-view displays is not preferred, although it may be required in unique situations as necessary, under direction from Technology Support Services. In all cases, the Department of Justice's 2010 ADA Standards must be employed. Particular attention shall be given to coordinate and install digital sign and kiosk locations that are acceptable under the ADA guidelines for "Protruding Objects" (DOJ ADA 307.1) Acceptable television mount models include:

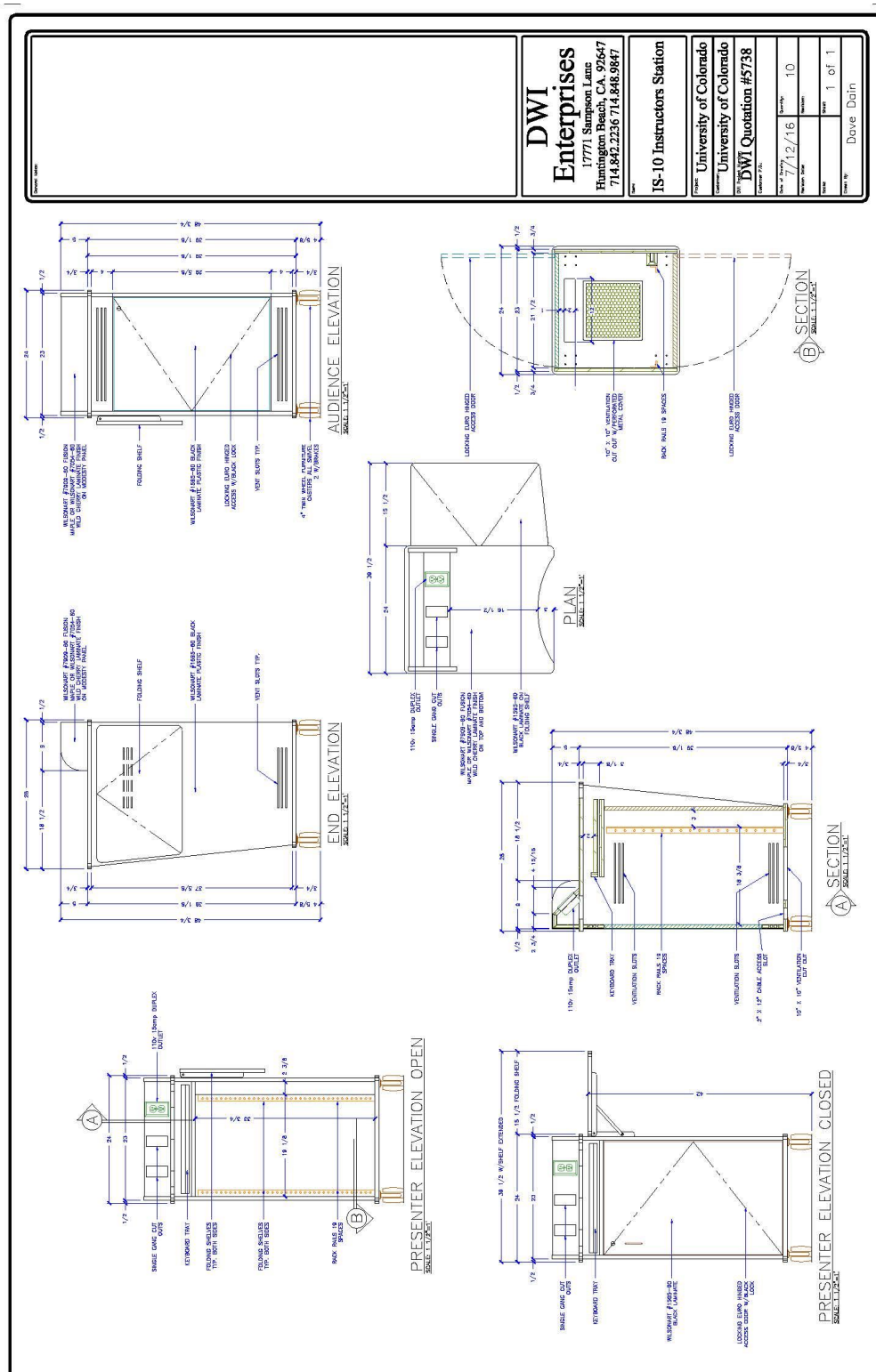
- 1) Chief Manufacturing – Thinstall - TS525TU, LSTU, LTTU, MSTU, MTTU

All digital signage television locations must include a deep, recessed, wall enclosure for electrical infrastructure, data infrastructure, and AV devices. The recessed wall enclosure should be adequately sized for the project. Acceptable wall recessed TV boxes include:

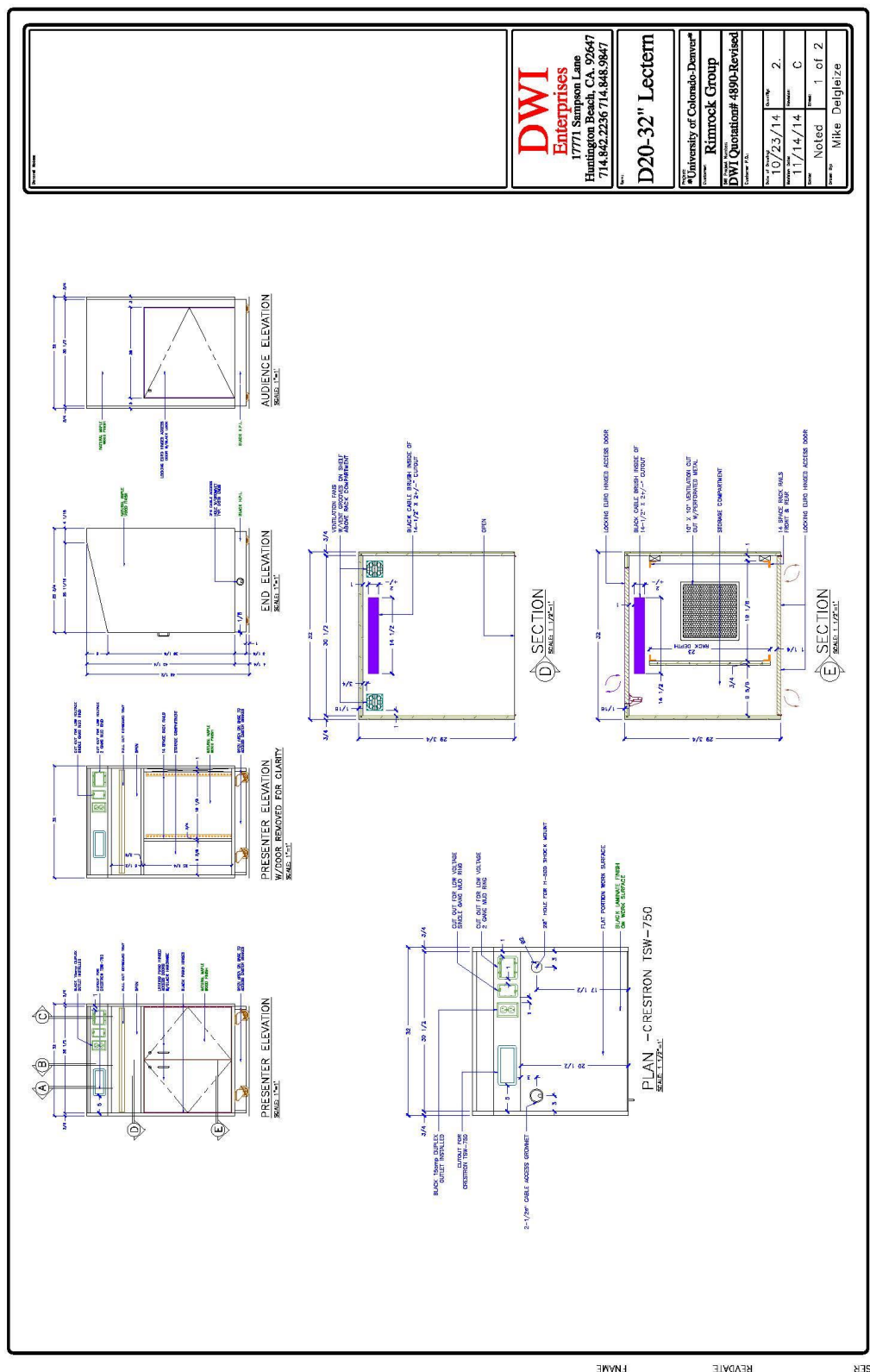
- 1) Chief Manufacturing – PAC-525 / 526
- 2) FSR – PWB-100 / 200 / 250 / 450

PART 4 - ILLUSTRATIONS

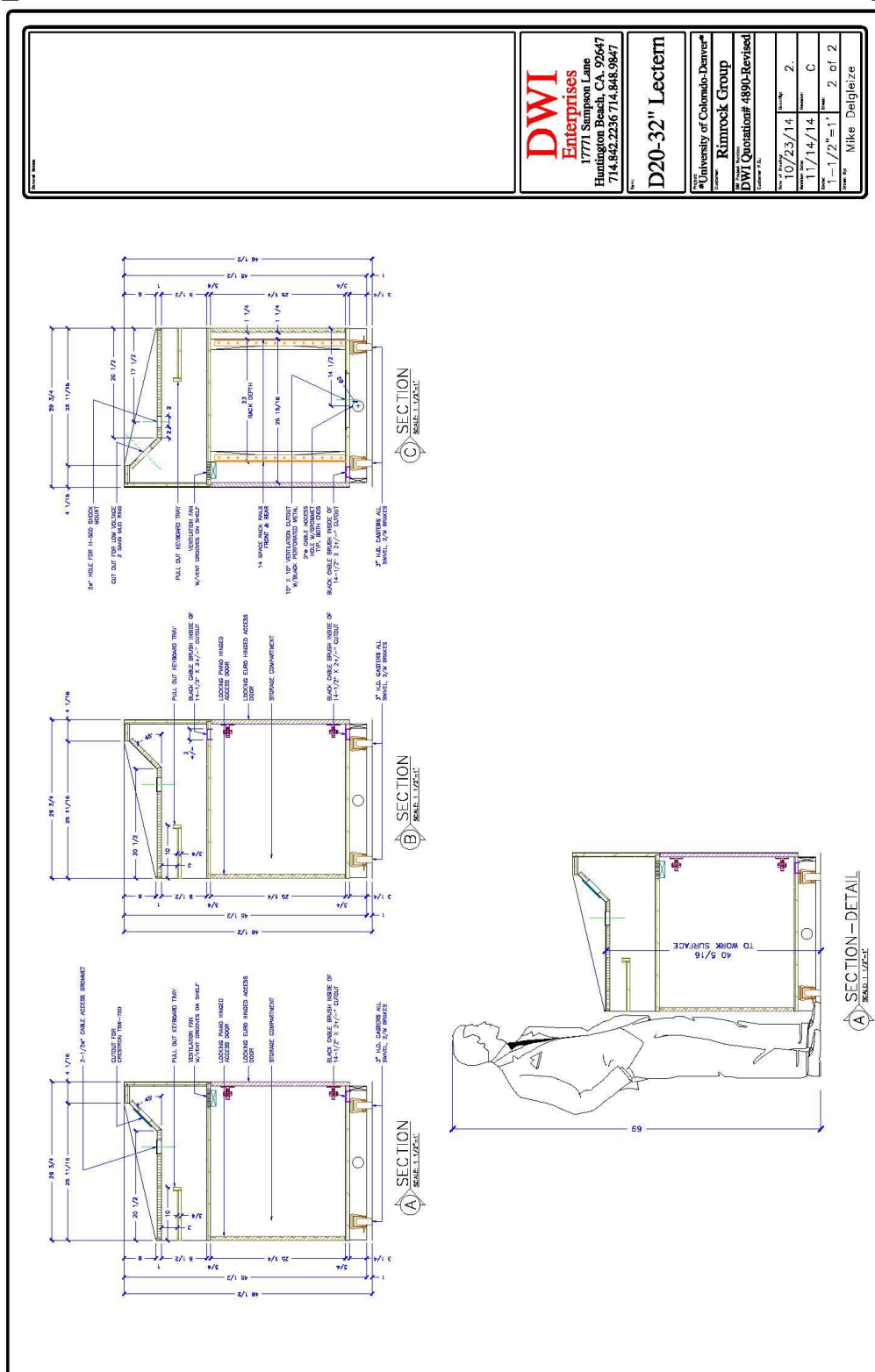
1.Example Lectern Configurations – Small Podium (Illustration Ex. 1)



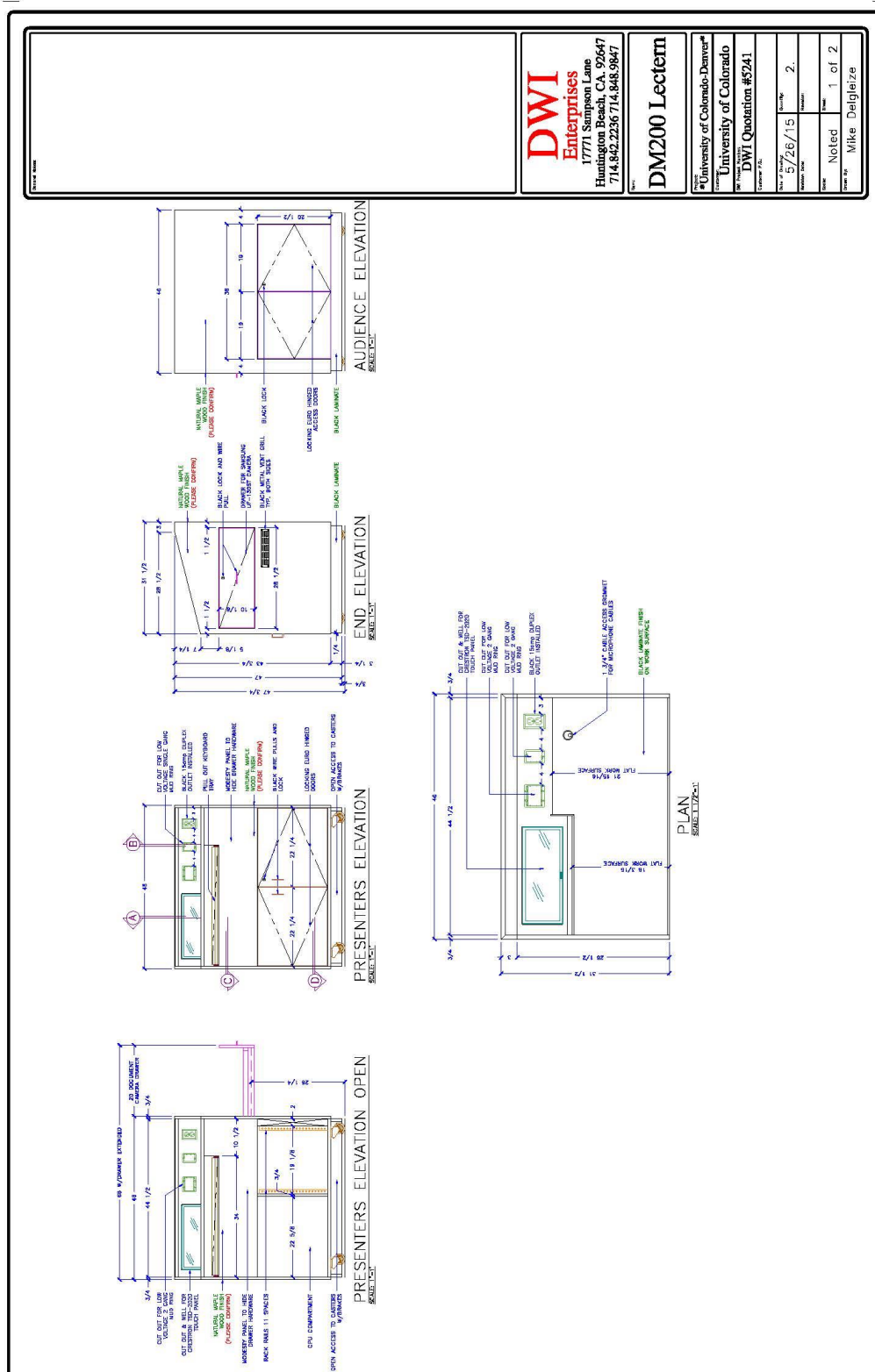
2.Example Lectern Configurations – Medium Podium (Illustration Ex. 2)



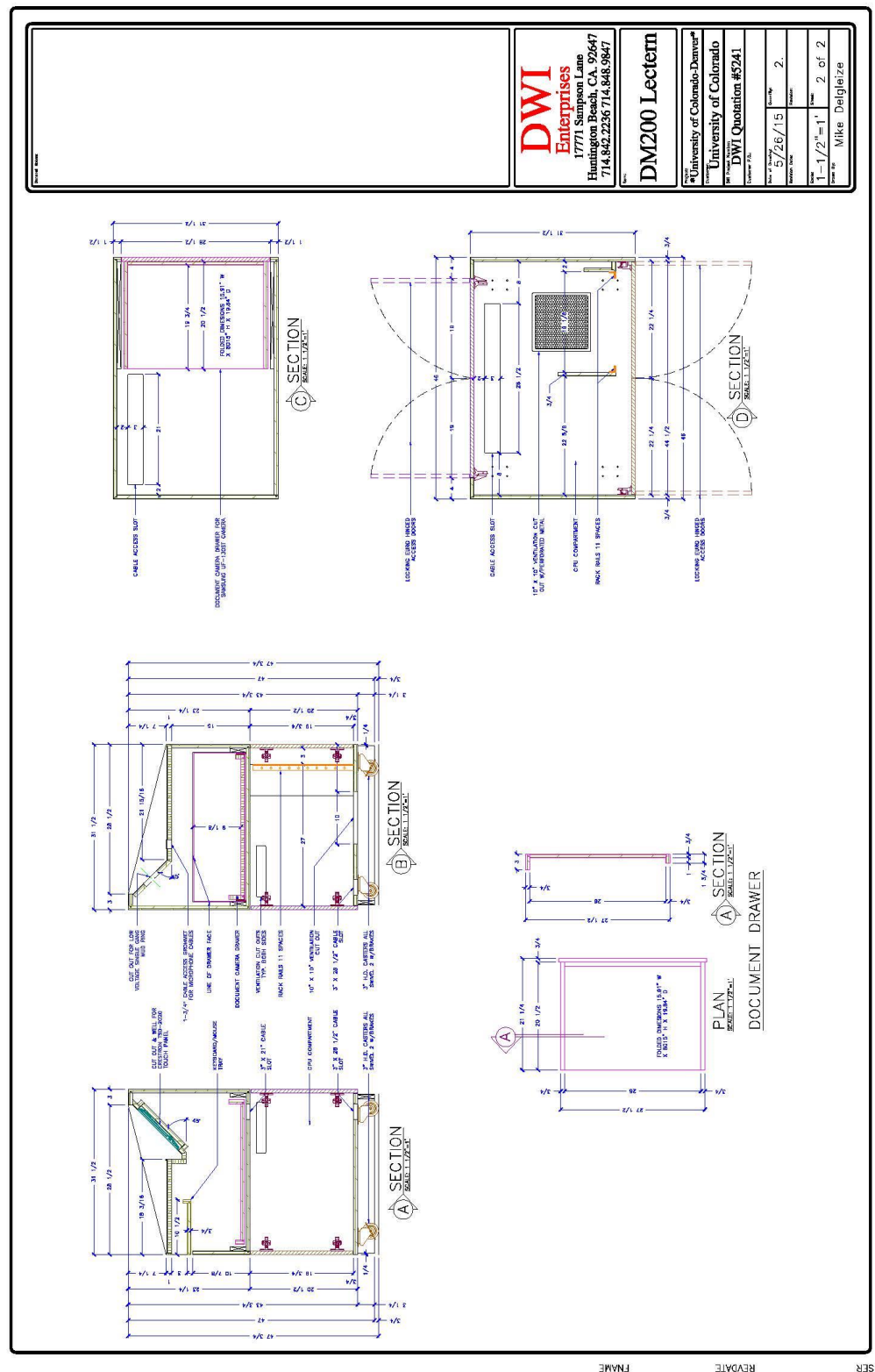
Part 2 Continued



3.Example Lectern Configurations – Large Multimedia Podium (Illustration Ex. 3)



Part 3 Continued



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