

MERRITT COLLEGE SCIENCE & ALLIED HEALTH BUILDING CLASSROOM AUDIO VIDEO

DOCUMENT 00 9113

ADDENDA

PROJECT NO. 2353, BID NO. 14-15/19

Peralta Community College District

Merritt College Science & Allied Health Building Classroom Audio Video
333 East 8th Street, Oakland, CA 94606

January 13, 2015

ADDENDUM No. 2

This addendum supersedes items of the original contract documents wherein it is inconsistent with it. All other conditions remain unchanged. The following changes, modifications, corrections, additions or clarifications shall apply to the contract documents and shall be made a part of and subject to all of the requirements thereof as if originally specified or shown. It is the responsibility of the bidder to review the list of attachments to ensure that the addendum is full and complete. This Addendum modifies the original Bid Documents for the above Bid. **Acknowledge receipt of this addendum in the space provided on the BID FORM. Failure to do so may subject Bidder to disqualification.**

Revisions to Bid Documents

1. Document 00 41 13 Bid Form has been revised to include a line item for an Additive Alternate.
2. Document 00 11 13 Notice Inviting Bids, Article 2, 2.01. The required license to bid has been revised to include **B, C10 and C7 with a C10 sub-contractor.**

Additional Specifications:

- 26 01 00 – Basic Electrical Requirements – Add section in its entirety.
- 26 05 00 – Materials and Methods – Add section in its entirety.
- 26 05 19 – Conductors and Cables – Add section in its entirety.
- 26 05 26 – Grounding and Bonding – Add section in its entirety.
- 26 05 29 – Seismic Controls for Electrical Work – Add section in its entirety.
- 26 13 00 – Raceways and Boxes – Add section in its entirety.
- 26 27 26 – Wiring Devices – Add section in its entirety.

Revised Specifications:

- 27 41 00 – Audio Visual Systems – Replace section in its entirety. Revisions are noted in underlined, bold, and italic.

Revised Drawings:

Reference Sheet AV0.00

- Clarification – Detail 2, “TYPICAL AUDIO/VISUAL CONDUIT RISER DIAGRAM” - Empty conduit stubs from AV cabinets to accessible ceilings have been provided by others for low voltage systems.
- Clarification – Detail 3, “CMS-440 MOUNTING DETAIL” and Detail 4, “PROJECTOR MOUNTING DETAIL” – Bidding AV contractor is responsible for the installation of projectors and required connection to power and low voltage systems.

Reference Sheet AV3.01

- Revise Level 1B designation on legend to Level 1.

Reference Sheet AV5.01B (AD2-AV5.01B, 30”x42”):

- Add additional components for video archiving.

Reference Sheet AV5.02B (AD2-AV5.02B, 30”x42”):

- Add additional components for video archiving.

Reference Sheet AV5.03B (AD2-AV5.03B, 30”x42”):

- Add additional components for video archiving.

Reference Sheet AV5.04B (AD2-AV5.04B, 30”x42”):

- Add additional components for video archiving.

Reference Sheet AV5.05B (AD2-AV5.05B, 30”x42”):

- Add additional components for video archiving.

Reference Sheet AV5.06B (AD2-AV5.05B, 30”x42”):

- Add additional components for video archiving.

Answers to bid questions:

1. **Question:** According to the notice inviting bids, article 2, 2.01, the bidding contractor is required to have a C10 or a B license. Would it be acceptable if the bidding contractor (who attended the mandatory pre bid meeting) holds a C7 license, and subcontracted an Electrical contractor (who did not attend the mandatory pre bid meeting) that holds a C10 license? If that arrangement is not acceptable, would it be acceptable if the bidding contractor (who did not attend the mandatory pre bid meeting) held a C10 license, and subcontracted a contractor (who did attend the mandatory pre bid meeting) with a C7 license?

Answer: A C7 licensed contractor can bid with a C10 licensed subcontractor.

2. **Question:** Section 2.01 of the notice to bidders states that the license requirements for this project are classifications "B" and "C10". Will the district accept "C7" license classifications for the scope of work on this project?

Answer: A C7 license is acceptable with a C10 licensed sub-contractor. See question 1 above.

3. **Question:** Section 27 41 00, 1.3 refers to section 3.8 for a description of the various technology levels, but the specifications only go up to section 3.7. Is there some information missing from the specifications or this a typographical error?

Answer: This should refer to section 2.3. See revised specification issued in Addendum 2.

4. **Question:** Classroom Computers – There are computers shown on at the teacher's desk in every classroom, but they are not part of the equipment list on attachment A. Are these part of the scope of work by the contractor or owner furnished? If part of the scope, please provide specification requirements for these computers?

Answer: The computers are owner furnished.

5. **Question:** Bluetooth Pen & Bluetooth Receiver – Are bidders to assume that these items shown on the functional riser diagrams are what the interactive projectors come equipped with or something else? If something else, please provide information on what to quote as they are not listed on the equipment list.

Answer: These items are to be provided with the interactive projectors. See addendum 2 revised specification for wireless dongle addition.

6. **Question:** Technology System Level 1 – Section 27 41 00, Audio Visual System level 1 system components are outlined. Item H describes a presentation switcher (Extron IN 1608 MA) which provides amplification functionality for the system. Does that mean the system does not require items I, K and L? The functional diagram on plan sheet AV5.01B only shows the presentation switcher also.

Answer: Items I, K and L are not required. See addendum 2 revised specification.

7. Question: Technology System Level 1B – The legend on plan sheet AV3.01 calls for level 1B systems for room 3106 and 3112. This system is not identified on the plans and specifications. A level 1A system is described, but no 1B. Please provide information about the configuration parameters of the level 1B systems.

Answer: The Level 1B reference shall be changed to level 1. See addendum 2.

ADDITIVE ALTERNATE:

Reference Sheet AV3.02:

- In Classroom 3409 “DEMO FOOD SERVICE SKILLS” Provide and install one (1) PTZ Camera above cooking demonstration desk. Camera shall be provided for viewing of demonstrations at desk and shall be projected to whiteboard via projector. Video archiving shall also be provided. Bidder note: sketches have not been provided on plans or riser diagrams for this item. Contractor shall provide all required components and shall provide on shop drawings and as-builts if alternate is awarded.

END OF DOCUMENT

MERRITT COLLEGE SCIENCE & ALLIED HEALTH BUILDING CLASSROOM AUDIO VIDEO

DOCUMENT 00 4113

BID FORM

TO THE BOARD OF TRUSTEES OF THE PERALTA COMMUNITY COLLEGE DISTRICT
THIS BID IS SUBMITTED BY:

(Firm/Company Name)

Re: Merritt College Science & Allied Health Building Classroom Audio Video, at 12500 Campus Drive, Oakland, CA 94619, Project No. 2353, Bid No. 14-15/19

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with **THE PERALTA COMMUNITY COLLEGE DISTRICT** in the form included in the Contract Documents, Document 00 5200 (Agreement), to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Sum and within the Contract Time indicated in this Bid and in accordance with all other terms and conditions of the Contract Documents.
2. Bidder accepts all of the terms and conditions of the Contract Documents, Document 00 1113 (Notice Inviting Bids), and Document 00 2113 (Instructions to Bidders), including, without limitation, those dealing with the disposition of Bid Security. This Bid will remain subject to acceptance for 60 Days after the day of Bid opening, unless there is a bid protest, then 90 days after the day of bid opening.
3. In submitting this Bid, Bidder represents that Bidder has examined all of the Contract Documents, performed all necessary Pre-Bid investigations, received the Pre-Bid conference minutes (if any), and received the following Addenda:

Addendum Number	<u>ADDENDUM DATE</u>	Signature of Bidder

4. Based on the foregoing, Bidder proposes and agrees to fully perform the Work within the time stated and in strict accordance with the Contract Documents for the following sums of money listed in the following Schedule of Bid Prices:

BID PRICE

Bid items are described in Section 01 1100 (Summary of Work).

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>ESTIMATED QUANTITY</u>	<u>UNIT</u>	<u>UNIT PRICE</u>	<u>TOTAL</u>
1.	Allowance	----	----	----	\$94,000.00
2.	Additive Alternate – 1 PTZ camera in Classroom 3409	----	----	----	
3.	All Work of Contract Documents other than Work separately provided for under other Bid items	----	----	----	\$
<u>TOTAL</u>				TOTAL BID PRICE	\$

Total Bid Price:

(Total Bid Price in Words)

5. Subcontractors for work included in all Bid items are listed on Document 00 4330 (Subcontractors List) submitted herewith.
6. The undersigned Bidder understands that Owner reserves the right to reject this Bid.
7. If written notice of the acceptance of this Bid, hereinafter referred to as Notice of Award, is mailed or delivered to the undersigned Bidder within the time described in Paragraph 2 of this Document 00 4113 or at any other time thereafter before it is withdrawn, the undersigned Bidder will execute and deliver the documents required by Document 00 2113 (Instructions to Bidders) within the times specified therein.
8. Notice of Award or request for additional information may be addressed to the undersigned Bidder at the address set forth below.
9. The undersigned Bidder herewith encloses cash, a cashier's check, or certified check of or on a responsible bank in the United States, or a corporate surety bond furnished by a surety authorized to do a surety business in the State of California, in form specified in Document 00 2113 (Instructions to Bidders), in the amount of ten percent (10%) of the Total Bid Price and made payable to **THE PERALTA COMMUNITY COLLEGE DISTRICT**.
10. The undersigned Bidder agrees to commence Work under the Contract Documents on the date established in Document 00 7200 (General Conditions) and to complete all Work within the time specified in Document 00 5200 (Agreement).
11. The undersigned Bidder agrees that, in accordance with Document 00 7200 (General Conditions), liquidated damages for failure to complete all Work in the Contract within the time specified in Document 00 5200 (Agreement) shall be as set forth in Document 00 5200.
12. The names of all persons interested in the foregoing Bid as principals are:

IMPORTANT NOTICE:

If Bidder or other interested person is a corporation, give the legal name of corporation, state where incorporated, and names of president and secretary thereof; if a partnership, give name of the firm and names of all individual co-partners composing the firm; if Bidder or other interested person is an individual, give first and last names in full.

NAME OF BIDDER: _____

licensed in accordance with an act for the registration of Contractors, and with license number: _____ Expiration: _____.

(Place of Incorporation, if Applicable)	(Principal)
	(Principal)
	(Principal)

I certify (or declare) under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

(Signature of Bidder)

NOTE: If Bidder is a corporation, set forth the legal name of the corporation together with the signature of the officer or officers authorized to sign contracts on behalf of the corporation. If Bidder is a partnership, set forth the name of the firm together with the signature of the partner or partners authorized to sign contracts on behalf of the partnership.

Business Address: _____

Contractor's Representative(s): _____
(Name/Title)

(Name/Title)

(Name/Title)

Officers Authorized to Sign Contracts

(Name/Title)

(Name/Title)

(Name/Title)

Telephone Number(s):

(Area Code) (Number)

(Area Code) (Number)

Fax Number(s):

(Area Code) (Number)

(Area Code) (Number)

Date of Bid:

END OF DOCUMENT

SECTION 26 01 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The requirements of the General Conditions and Division 1, General Requirements, apply to the work specified in this section.

1.2 DESCRIPTION OF WORK

- A. Related Work in Other Sections, but not limited to the following:
 - 1. Audio Visual System and Devices.
- B. Work Included in Contract
 - 1. Grounding and bonding per NEC.
 - 2. Provide conduit, wiring, boxes and electrical connection where deemed necessary during installation of new Audio Visual System.

1.3 CODES AND STANDARDS

- A. In addition to Codes and Standards - Division 1, the following shall apply to this Division:
 - National Electrical Code with California amendments
 - California Admin. Code, Titles 17, 19, 24, Part 3.
 - U.L. Electrical Construction Materials List
 - Codes, rules and regulations as specified hereinafter
 - Local city and county agencies
 - International Building Code

1.4 SUBMITTALS

- A. Submittals shall be made in conformance with the General Conditions. The list shall include, for each item, the manufacturer, manufacturer's catalog number, type of class, the rating, capacity, size, etc. Submittals shall include:
 - 1. Conduit & Fittings
 - 2. Boxes & Covers
 - 3. Wire & Cable
 - 4. Wiring Devices
- B. Shop Drawings: Submit for approval, detailed construction drawings for each item of fabricated equipment required for the electrical installation. All drawings shall be to scale, fully dimensioned, and provide sufficient detail to clearly indicate the arrangement of the equipment and its component parts. Construction of the equipment shown shall be revised to comply with the drawings and specifications as required by the Architect after review of the shop drawings, and the drawings submitted when requested by the Architect. Shop drawings shall be submitted for the following:
 - 1. Not applicable.
- C. Substitution: Provide substitutions as outlined.

1.5 SUPERVISION OF ELECTRICAL WORK

- A. Contractor shall personally, or through an authorized and competent representative, constantly supervise the work from beginning to completion and final acceptance. So far as possible, keep same foreman and workmen throughout the project duration. Work shall be subject to inspection and approval by Architect. Promptly furnish related information when so requested by Architect.

1.6 EQUIPMENT AND SYSTEMS IDENTIFICATION

- A. General: All panels, terminal cabinets, etc., shall be labeled as to identification and use. In general, equipment shall be identified in accordance with drawings. Identification tags, signs, labels and markers shall comply with OSHA and ANSI requirements.

- B. Nameplates: All equipment, terminal cabinets, panels and systems shall be identified by laminated, engraved plastic, white on black plates permanently attached to the equipment. Voltage and phase shall be listed on these plates.
- C. All terminal cabinets to have terminal strips and all wiring in terminal cabinets shall be tagged.
- D. Directories: Provide for power circuits, typewritten, neatly arranged in numerical order, and permanently fixed inside all new and existing panels.
- E. Provide lamecoid label on all receptacle and switch covers indicating complete circuit number.
- F. Provide lamecoid label on all blank cover plates indicating circuit number or low voltage system (i.e. future data, intrusion, etc.).
- G. Provide lamecoid label on all fire alarm device covers indicating complete device number.

1.7 OPERATING INSTRUCTIONS ON-SITE

- A. At time of occupancy, arrange for manufacturer's representatives to instruct building operating and maintenance personnel in use of any equipment requiring operating and maintenance. Arrange for all personnel to be instructed at one time. Pay all costs for such service (minimum of 4 hours).

1.8 ADJACENT WORK

- A. Coordinate work and complete with others in furnishing and placing this work.
- B. Work to approved shop drawings for work by others and to field measurements as necessary to properly fit the work.
- C. Project adjacent work as necessary; adjacent construction or exposed surfaces or surfaces damaged by use of materials or operations under this Section shall be repaired or replaced as directed by Architect.

1.9 DRAWINGS

- A. The electrical drawings, which constitute an integral part of this contract, shall serve as the working drawings. They indicate diagrammatically the general layout of the complete electrical system, including the arrangement of feeders, circuits, panelboards, service equipment, and other work. Field verifications of scale dimensions taken from the drawings are directed since actual field locations, distances and elevations will be governed by actual field conditions. Review architectural, structural, mechanical and plumbing drawings and adjust work to conform to all conditions indicated thereon. Discrepancies shown on different plans or between plans and actual field conditions, or between plans and specifications, shall promptly be brought to the attention of the Architect for a decision.

1.10 COORDINATION AND COOPERATION

- A. Drawings and specifications are both supplementary and complementary. Taken together, they are intended to define complete working installations of the systems represented, in accordance with approved practice in the trade, and in conformity with all applicable requirements of local jurisdictional offices and officers and codes and enforcing bodies.
- B. It shall be presumed that any bid offered under this Division of the Specifications is based on a careful examination of the job site, and of the plans and specifications; that the person(s) or firm(s) awarded a contract hereunder is/are experienced and qualified in the type of work represented; that every effort has been made to prepare complete, accurate and correct plans and specifications; and that reasonable diligence will be exercised in planning and scheduling the work to anticipate conflicts and/or detect errors or omissions. All such shall be immediately reported, and proper resolution agreed on between concerned parties before the work affected is performed. If due to lack of diligence, or to incompetence, failure to anticipate such problems shall not create a valid claim for extra costs or charges.
- C. Requirements of other trades, of utility companies, and of fire departments, protective services, communication systems, or other facilities of a utility nature, shall be determined prior to installation of systems, equipment, devices or materials affected by or dependent on such requirements.
- D. Unapproved deviations or changes based on a presumption of error or code violation, or work not suitable

for its intended function, may not be accepted.

- E. Nothing herein shall act to prevent or discourage the contractor from suggesting or discussing possible changes in the work where such might be beneficial to the contractor or the owner, or might facilitate the work of this or other trades.
- F. Any work resulting in a claim for a change in the contract price must be approved and fully documented.

1.11 VISIT TO SITE

- A. Visit the project site, take requisite measurements, and verify exact location of buildings, utilities, and other facilities, and obtain such other information as is necessary for an intelligent bid. No allowance will subsequently be made by the Architect or Owner for any error or omission on the part of the bidder in this connection.

1.12 RECORD DRAWINGS

- A. Record of Job Progress: Keep an accurate dimensional record of the "as-built" locations and of all work; all as required. This record shall be kept up-to-date on blue-line prints as the job progresses and shall be available for inspection at all times. It shall be reviewed by inspector prior to each monthly application for payment.
- B. Record of Installation: Refer to Supplementary General Conditions.
- C. Include on "as-built" drawings:
 - 1. Routing of all buried or concealed electrical feeders and conduits.
- D. Upon completion of the work, a completed set of as-built reproducible vellums and electronic file (ACAD 2010) on Cd/DVD disk(s) shall be delivered to the Architect.

1.13 GUARANTEE

- A. All work shall be guaranteed for a minimum period of one year from either the official date of completion or from the date of acceptance by the Owner, whichever is the later date. The guarantee period for certain items shall be longer, as indicated in the specification for those items.
- B. Should any trouble develop during the guarantee time due to defective material, faulty workmanship, or non-compliance with plans, specifications, codes or directions of the Owner, Architect, Engineer or Inspector, the Contractor shall furnish all necessary labor and materials to correct the trouble without additional charges.

END OF SECTION

SECTION 26 05 00

MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Electrical identification.
 - 2. Cutting and patching for electrical construction.

1.2 SUBMITTALS

- A. Product Data: For utility company electricity-metering components.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts and single-line diagram of electricity-metering component assemblies specific to this Project.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Devices for Utility Company Electricity Metering: Comply with utility company published standards.
- C. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building.
- C. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.
- D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel: Flange edges turned toward web, and 9/16-inch- diameter slotted holes at a maximum of 2 inches o.c., in webs. Strength rating to suit structural loading.
- D. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
 - 1. Materials: Same as channels and angles, except metal items may be stainless steel.
- E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- F. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- G. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of

conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

- H. Expansion Anchors: Carbon-steel wedge or sleeve type.
- I. Toggle Bolts: All-steel springhead type.
- J. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 ELECTRICAL IDENTIFICATION

- A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick.
- C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Embedded continuous metallic strip or core.
 - 3. Printed legend that indicates type of underground line.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch minimum thickness for signs up to 20 sq. in. and 1/8-inch minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.
 - 1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
 - 2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with 0.0396-inch, galvanized-steel backing. 1/4-inch grommets in corners for mounting.
- H. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, slotted channel system components.
- B. Dry Locations: Steel materials.
- C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb minimum design load for each support element.

3.3 SUPPORT INSTALLATION

- A. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- B. Size supports for multiple raceway or cable runs so capacity can be increased by a 25 percent minimum in the future.
- C. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps except use spring-steel fasteners for 1-1/2-inch and smaller single raceways above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- E. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated:
 - 1. Wood: Wood screws or screw-type nails.
 - 2. Gypsum Board: Toggle bolts. Seal around sleeves with joint compound, both sides of wall.
 - 3. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
 - 4. New Concrete: Concrete inserts with machine screws and bolts.
 - 5. Existing Concrete: Expansion bolts.
 - 6. Structural Steel: Spring-tension clamps.
 - a. Comply with AWS D1.1 for field welding.
 - 7. Light Steel Framing: Sheet metal screws.
 - 8. Fasteners for Damp, Wet, or Weather-Exposed Locations: Stainless steel.
 - 9. Light Steel: Sheet-metal screws.
 - 10. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying.
- D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.
- E. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.
- F. Install warning, caution, and instruction signs where required to comply with 29 CFR 1910.145, Chapter XVII, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Indoors install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- G. Install, where applicable, engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.5 FIRESTOPPING

- A. Apply firestopping to cable and raceway sleeves and other penetrations of fire-rated floor and wall assemblies to restore original undisturbed fire-resistance ratings of assemblies. Firestopping installation is specified in Division 7 Section "Through-Penetration Firestop Systems."

3.6 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair, refinish and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

END OF SECTION

SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.2 SUBMITTALS

- A. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:
 - 1. Alcan Aluminum Corporation; Alcan Cable Div.
 - 2. American Insulated Wire Corp.; a Leviton Company.
 - 3. General Cable Corporation.
 - 4. Senator Wire & Cable Company.
 - 5. Southwire Company.
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THW, THHN-THWN or XHHW complying with NEMA WC 5 or 7.

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AMP Incorporated/Tyco International.
 - 2. Hubbell/Anderson.
 - 3. O-Z/Gedney; EGS Electrical Group LLC.
 - 4. 3M Company; Electrical Products Division.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- I. Fire Alarm Circuits: Type THHN-THWN, in raceway.
- J. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- K. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- D. Install exposed feeders parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26.
- F. Seal around cables penetrating fire-rated elements according to Section "Through-Penetration Firestop Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Basic Electrical Materials and Methods."
- H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 1. Test procedures used.
 2. Test results that comply with requirements.
 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes grounding of electrical systems and equipment. Requirements specified in this Section may be supplemented by requirements of other Sections.

1.2 SUBMITTALS

- A. Product Data: Grounding Conductors.
- B. Field quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled under UL 467 as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Boggs, Inc.
 - 2. Copperweld Corp.
 - 3. Dossert Corp.
 - 4. Erico Inc.; Electrical Products Group.
 - 5. Galvan Industries, Inc.
 - 6. Harger Lightning Protection, Inc.
 - 7. Hastings Fiber Glass Products, Inc.
 - 8. Heary Brothers Lightning Protection Co.
 - 9. ILSCO.
 - 10. Kearney/Cooper Power Systems.
 - 11. Korns, C. C. Co.; Division of Robroy Industries.
 - 12. Lightning Master Corp.
 - 13. Lyncole XIT Grounding.
 - 14. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - 15. Robbins Lightning, Inc.
 - 16. Salisbury, W. H. & Co.
 - 17. Superior Grounding Systems, Inc.
 - 18. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Bare, Solid-Copper Conductors: ASTM B 3.
- G. Assembly of Bare, Stranded-Copper Conductors: ASTM B 8.

- H. Bare, Tinned-Copper Conductors: ASTM B 33.
- I. Copper Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
- J. Copper Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- K. Tinned-Copper Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- L. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulated spacer.
- M. Connectors: Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items. Exothermic-welded type, in kit form, selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- B. In raceways, use insulated equipment grounding conductors.
- C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections.
- D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
 - 2. At doors, route the bus up to the top of the door frame, across the top of the doorway, and down to the indicated height above the floor.
- E. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.
- F. Equipment Grounding Conductors: Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
 - 1. Install insulated equipment grounding conductors in feeders.
 - 2. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.
 - 3. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
 - 4. Air-Duct Equipment Circuits: Install an insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
 - 5. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install an insulated equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.
 - 6. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location and per Division 27.
 - a. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a grounding bus per Division 27.
 - b. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
 - 7. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing an insulated equipment grounding conductor with supply branch-circuit conductors.
- G. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- H. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers or supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- I. Connections: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - 6. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
 - 7. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
 - 8. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
 - 9. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
 - 10. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 - 11. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - 2. Test completed grounding system at each location where a maximum ground-resistance level is indicated and at service disconnect enclosure grounding terminal. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
 - 3. Provide drawings locating each ground rod, ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Nominal maximum values are as follows:
 - a. Equipment Rated 500 kVA and Less: 10 ohms.
 - b. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - c. Equipment Rated More Than 1000 kVA: 3 ohms.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.

END OF SECTION

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SECTION 26 05 29

SEISMIC CONTROLS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes seismic restraints and other earthquake-damage-reduction measures for electrical components. It applies to and complements optional seismic-restraint requirements in the various electrical component Sections of these Specifications.

1.2 DEFINITIONS

- A. Seismic Restraint: A fixed device (a seismic brace, an anchor bolt or stud, or a fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of an electrical system component during an earthquake.
- B. Mobile Structural Element: A part of the building structure such as a slab, floor structure, roof structure, or wall that may move independently of other structural elements during an earthquake.

1.3 SUBMITTALS

- A. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic-restraint component used. Include documentation of evaluation and approval of components by agencies acceptable to authorities having jurisdiction.
- B. Shop Drawings: For components, physical arrangements, and installation details not defined by Drawings. Indicate materials and show calculations, design analysis, details, and layouts, signed and sealed by a professional engineer.
- C. Pre-approval and Evaluation Documentation: By an agency approved by authorities having jurisdiction, showing maximum ratings of restraints.
- D. Qualification data.
- E. Field quality-control test reports.

1.4 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in California Building Code, unless requirements in this Section are more stringent.
- B. Testing Agency Qualifications: An independent testing and inspection agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the inspection indicated.

1.5 PROJECT CONDITIONS

- A. Project Seismic Zone and Zone Factor as Defined in CBC.

1.6 COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structure, architectural features, and mechanical, fire-protection, electrical, and other building systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Amber/Booth Company, Inc.
 2. B-Line Systems, Inc.
 3. Erico, Inc.
 4. GS Metals Corp.
 5. Loos & Company, Inc.

6. Mason Industries, Inc,
7. Powerstrut.
8. Thomas & Betts Corp.
9. Unistrut Corporation.

2.2 MATERIALS

- A. Use the following materials for restraints:
 1. Indoor Dry Locations: Steel, zinc plated.
 2. Outdoors and Damp Locations: Galvanized steel.
 3. Corrosive Locations: Stainless steel.

2.3 ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Strength in tension and shear of components shall be at least twice the maximum seismic forces for which they are required to be designed.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
- E. Welding Lugs: Comply with MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

2.4 SEISMIC-BRACING COMPONENTS

- A. Slotted Steel Channel: 1-5/8-by-1-5/8-inch cross section, formed from 0.1046-inch- thick steel, with 9/16-by-7/8-inch slots at a maximum of 2 inches o.c. in webs, and flange edges turned toward web.
 1. Materials for Channel: ASTM A 570, GR 33.
 2. Materials for Fittings and Accessories: ASTM A 575, ASTM A 576, or ASTM A 36.
 3. Fittings and Accessories: Products of the same manufacturer as channels and designed for use with that product.
 4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, with adjustable hinged steel brackets and bolts.
- C. Hanger Rod Stiffeners: Slotted steel channels, installed vertically, with internally bolted connections to hanger rod.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.
- B. Install structural attachments as follows:
 1. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
 2. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
 3. Attachments to Existing Concrete: Use expansion anchors.
 4. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.

5. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
 6. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
 7. Attachments to Wood Structural Members: Install bolts through members.
 8. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.
- C. Install electrical equipment anchorage as follows:
1. Anchor panelboards, motor-control centers, motor controls, switchboards, transformers, fused power-circuit devices, control, and distribution units as follows:
 - a. Anchor equipment rigidly to a single mobile structural element or to a concrete base that is structurally tied to a single mobile structural element.
 - b. Size concrete bases so expansion anchors will be a minimum of 10 bolt diameters from the edge of the concrete base.
 - c. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
 - d. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
 - e. Torque bolts and nuts on studs to values recommended by equipment manufacturer.
- D. Install seismic bracing as follows:
1. Install bracing according to spacings and strengths indicated by approved analysis.
 2. Expansion and Contraction: Install to allow for thermal movement of braced components.
 3. Attachment to Structure: If specific attachment is not indicated, anchor bracing to the structure at flanges of beams, upper truss chords of bar joists, or at concrete members.
- E. Accommodation of Differential Seismic Motion: Make flexible connections in raceways, cables, wireway, cable trays, and busway where they cross expansion- and seismic-control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to a different mobile structural element from the one supporting them.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspection agency to inspect seismic-control installation for compliance with indicated requirements.
- B. Testing Agency: Engage a qualified testing and inspection agency to inspect seismic-control installation for compliance with indicated requirements.
- C. Reinspection: Correct deficiencies and verify by reinspection that work complies with requirements.
- D. Provide written report of tests and inspections.

END OF SECTION

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SECTION 26 13 00

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.2 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets indicated.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. Alfex Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
- B. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type.
- C. FMC: Aluminum.
- D. LFMC: Flexible steel conduit with PVC jacket.
- E. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.
 - 8. Robroy Industries, Inc.; Enclosure Division.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

- C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
- G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

2.4 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components provide manufacturer's standard prime-coat finish ready for field painting.

2.5 FIRESTOPPING FOR LOW VOLTAGE SLEEVES

- A. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows.
- B. Fire Rated Cable Pathways: STI EZ-PATH™ Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) EZ-PATH™ Fire Rated Pathway.
 - 2. Specified Technologies Inc. (STI) Mini EZ-PATH™ Fire Rated Pathway.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 - 4. Damp or Wet Locations: Rigid steel conduit.
 - 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, stainless steel.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.
 - 3. For Outdoor Use – conduit hub, NEMA 4 for conduit connection/terminating to cabinet/panel/boxes.
 - 4. All connectors to be steel. Die cast connectors are not acceptable.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 - H. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 1. Run parallel or banked raceways together on common supports.
 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
 - I. Join raceways with fittings designed and approved for that purpose and make joints tight.
 1. Use insulating bushings to protect conductors on all raceways 2" and larger.
 - J. Tighten set screws of threadless fittings with suitable tools.
 - K. Terminations:
 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
 - L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
 - M. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
 - N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
 - O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
 - P. Flexible Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
 - Q. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- 3.3 PROTECTION
- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Single and duplex receptacles, ground-fault circuit interrupters.
 - 2. Device wall plates.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wiring Devices:
 - a. Bryant Electric, Inc./Hubbell Subsidiary.
 - b. Eagle Electric Manufacturing Co., Inc.
 - c. Hubbell Incorporated; Wiring Device-Kellems.
 - d. Leviton Mfg. Company Inc.
 - e. Pass & Seymour/Legrand; Wiring Devices Div.

2.2 RECEPTACLES

- A. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- B. Straight-Blade Receptacles: Hospital grade.

2.3 WALL PLATES

- A. Single and combination types to match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.035-inch thick, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.

2.4 FINISHES

- A. Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies level, plumb, and square with building lines.
- B. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on bottom. Group adjacent switches under single, multigang wall plates.

- C. Remove wall plates and protect devices and assemblies during painting.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
 - 2. Submit same for approval.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections:
 - 1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
 - 2. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION

SECTION 27 41 00

AUDIO VISUAL SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Equipment and materials provided and installed by others, unless otherwise indicated in this section or on the drawings, will include the following:

Conduits, wireways, connection boxes, pull boxes, junction boxes and outlet boxes permanently installed in walls, floors, and ceilings; Electrical branch circuit panels equipped with isolated ground bars required to power the audiovisual equipment; isolated ground type receptacle outlets with isolated ground wires separate from normal equipment ground and interconnecting wiring for these 120 V AC circuits.

1.2 WORK INCLUDED

- A. This section covers the requirements for an Integrator to provide equipment for and install instructional audio/visual technology. There will be a multimedia display as primary projection. Flexibility, integration of multiple technologies and sources, and multiple user groupings are essential to this concept. As an example, all audio and image sources should be capable of being shown on the screen and heard in the classroom. The work covered in this document consists of furnishing all labor, material and services necessary to install a complete audiovisual system as indicated on the project drawings and in these specifications.
- B. Deliverables: Prior to ordering materials or commencing any construction activities, the Integrator shall provide the Owner with a complete bill of materials, including all quantities of components, devices, equipment, and wiring required to complete this work. Submit product data, including manufacturer's data sheets for all proposed system components. Submit three copies with all specific items that will be provided clearly indicated and any options highlighted.

1.3 DESCRIPTION

Scope of Work: This specification defines certain audiovisual systems to be installed at Merritt College of the Peralta Community College District. Prior projects have established Levels of Audio Visual Design throughout the district designated as Level 1 (basic technology), Level 2 (intermediate technology), or Level 3 (advanced technology). These established levels have been duplicated with modifications for this specific project at the new Science and Allied Health Building. Additional "levels" have been added based on specialized criteria as specified by the district. The various levels are indicated as such on the drawings and in **Section 2.3. REVISED -ADDENDUM 2.**

1.4 SECTION INCLUDES:

- A. Supply and install completely operational audiovisual systems, including all system electronics, equipment racks, circuitry, power supplies, etc., to include all equipment and materials, whether specifically mentioned herein or not, to ensure a complete and operational audiovisual presentation system in the rooms described in this specification and on the plans.
- B. Generate submittal information for the complete fabrication, installation and wiring of the system.
- C. Provide the on-site installation and wiring, and provide on-going supervision and coordination. Provide for the final adjustment of the systems as herein prescribed and provide test equipment for the system demonstration and acceptance testing. Prior to the systems demonstration and acceptance testing, submit a final testing and tuning report showing methods and results for tests performed.
- D. Provide a minimum of 8 hours of on-the-job training in the operation and maintenance of the systems for personnel designated by the Owner at the campus.
- E. Provide equipment manuals as well and complete system operation manuals. Provide complete and accurate as-built drawings.
- F. Provide a one-year warranty for systems installed.

1.5 APPLICABLE CODES:

Work shall be performed in accordance with applicable requirements of governing codes, rules and regulations including the following minimum standards, whether statutory or not:

1. Uniform Building Code (UBC)
2. National Electric Code (NEC)
3. National Fire Protection Association (NFPA)
4. Federal Communications Commission (FCC)
5. City, and other local codes and requirements

1.6 STANDARDS:

Equipment and materials specified shall conform to the current edition of the following standards where applicable:

- A. UL Underwriters' Laboratories
- B. ASTM American Society for Testing Materials
- C. NEMA National Electrical Manufacturer's Association
- D. ANSI American National Standards Institute
- E. ETL Electrical Testing Laboratories
- F. SMPTE Society of Motion Picture and Television Engineers
- G. EIA Electronic Industries Association
- H. ISO International Standards Organization
- I. Sound Systems Engineering, 2nd Ed., Davis and Davis, Howard W. Sams Co., 1987.

1.7 DRAWINGS

- A. The audio visual drawings, which constitute an integral part of this contract, shall serve as the working drawings. They indicate diagrammatically the general layout of the complete audio visual system, including the arrangement of wiring, conduits, cabinets, service equipment, and other work. Field verifications of scale dimensions taken from the drawings are directed since actual field locations, distances and elevations will be governed by actual field conditions. Review architectural, structural and electrical drawings and adjust work to conform to all conditions indicated thereon. Discrepancies shown on different plans or between plans and actual field conditions, or between plans and specifications, shall promptly be brought to the attention of the Architect for a decision. Where discrepancies occur between drawings and specifications the most stringent shall apply and be provided by contractor.

1.8 COORDINATION AND COOPERATION

- A. Drawings and specifications are both supplementary and complementary. Taken together, they are intended to define complete working installations of the systems represented, in accordance with approved practice in the trade, and in conformity with all applicable requirements of local jurisdictional offices and officers and codes and enforcing bodies.
- B. It shall be presumed that any bid offered under this Division of the Specifications is based on a careful examination of the job site, and of the plans and specifications; that the person(s) or firm(s) awarded a contract hereunder is/are experienced and qualified in the type of work represented; that every effort has been made to prepare complete, accurate and correct plans and specifications; and that reasonable diligence will be exercised in planning and scheduling the work to anticipate conflicts and/or detect errors

or omissions. All such shall be immediately reported, and proper resolution agreed on between concerned parties before the work affected is performed. If due to lack of diligence, or to incompetence, failure to anticipate such problems shall not create a valid claim for extra costs or charges.

- C. Requirements of other trades, of utility companies, and of fire departments, protective services, communication systems, or other facilities of a utility nature, shall be determined prior to installation of systems, equipment, devices or materials affected by or dependent on such requirements.
- D. Unapproved deviations or changes based on a presumption of error or code violation, or work not suitable for its intended function, may not be accepted.
- E. Nothing herein shall act to prevent or discourage the contractor from suggesting or discussing possible changes in the work where such might be beneficial to the contractor or the owner, or might facilitate the work of this or other trades.
- F. Any work resulting in a claim for a change in the contract price must be approved and fully documented.

1.9 SYSTEM DESCRIPTION

General: Provide and install turnkey audiovisual systems for the spaces listed in Part 2 of this specification, to include equipment, mounting, conductors and materials, whether specifically mentioned herein or not to ensure complete and operating audiovisual systems, including but not limited to audio reproduction, video displays, audio/video cables plates and infrastructure, audio/video distribution and control systems. Provide all necessary control programming.

1.10 SUBMITTALS

- A. Provide in accordance with project Bidding Requirements, in addition to the items in this section.
- B. Provide General Firm Qualifications: Refer to and submit information required in section 2.1, Suppliers/ Installers.
- C. Equipment Costs: Furnish a schedule of unit costs for equipment to be supplied. Each piece of equipment shall be individually priced. Equipment costs shall reflect required modifications and accessories.
- D. Non-Equipment Costs: Furnish a list of equipment and non-equipment costs for the work by the following categories:
 - 1. Engineering: Including required design, drawings, run sheets, instruction manuals, etc.
 - 2. Pre-Installation: Including fabrication, modification, assembly, rack wiring, etc., performed on the Contractor's premises.
 - 3. Installation: Including on-site installation and wiring, coordination and supervision, testing, checkout, Owner training, etc., performed on the Owner's premises.
 - 4. Software Development: Including required design, testing, debugging, documentation, etc.
 - 5. Documentation: Including equipment manuals, as-built drawings, software instruction manuals and program listings, user instruction panels, etc.
 - 6. Training: Including training sessions with owner staff as noted in this specification.
 - 7. General and Administrative: Including G & A expenses, shipping, insurance, and guarantees.
 - 8. Project Management: Including weekly written reports, project schedule management, and resource management.
 - 9. Warranty and first year's service: See section 1.14 for warranty requirements.

10. Separate second year service contract for the second year maintenance: Covering installed systems, new and Owner-furnished, include in this contract quarterly site visits to inspect, repair, and adjust systems to restore them to as-new operation. This service contract shall commence immediately after expiration of the warranty period. The cost for this service contract shall not be commingled with the costs for the systems base bid.

11. Taxes: Including applicable Local, State, and Federal taxes.

E. Substitutions: Submit bid for the work of this section on the basis of the specified equipment. Submit proposals for substitutions separate and apart from the costs of the equipment "as specified."

1. Proposals for substitutions will receive careful and equitable consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Owner.

2. Proposed substitutions shall be accompanied by full technical information, cut sheets, and specifications for the equipment so proposed.

3. Proposed substitutions shall be provided with the initial bid submittal not as part of the shop drawing process.

4. Any requested value engineering, proposed by the contractor, shall be coordinated through, reviewed by and approved by the consultant and district.

1.11 SHOP DRAWING SUBMITTALS

A. General: Provide submittals and shop drawings according to this section. All electronic drawings, except base building backgrounds received from the owner, shall be original drawings by the audiovisual contractor. The consultant will not be providing electronic drawing files.

B. Drawings:

1. System functional block drawings: For video, audio, and control systems, include equipment names and model numbers (e.g., "Program Amplifier - Crown CTs- 2000"). Clearly label each item of equipment shown on the drawing with the manufacturer's terminal number or input/output designation (e.g., "Mic 1 In", or "Record Out Left").

2. Run sheets or field wiring drawings: Clearly show at each terminal point the type of connector to be used and include typical wiring details of each connector. Note where shields are connected and where they will float to ensure the integrity of the grounding system. Call out wire types and color codes where appropriate. Assign wire numbers to every wire in the drawing.

3. Panels, plates, and designation strips, including details and samples relating to terminology, engraving, finish and color.

4. Equipment rack drawings: Provide scaled equipment rack elevations and proposed labeling. Labeling on the functional diagrams, rack elevations, and on the equipment controls shall be consistent and uniform.

5. Provide full-scale drawings of custom plates and panels indicating exact lettering, critical dimensions, and finish.

6. Custom designed carts.

7. Schematic drawings of custom circuitry.

8. Unusual equipment modifications.

9. Preliminary layouts of all remote control devices (touch panels, remote controls, etc.), submitted on disk and hard copy in a graphics file format.

10. For each piece of equipment, a list of functions under control of the remote control system and a list of all equipment in the remote control system.
11. Equipment modification drawings: Include details of modifications that change or void manufacturer's warranties.
12. Final schematic drawings of custom circuitry: Include receptacle pin numbers and component callouts. Show details of custom resistive combining networks, filters, or pads which may be required in the assembly. Show point-to-point wiring drawings for control system modules and interfaces, and for switches and relays in audio, video, or control systems.
13. Test Equipment: Provide a list of test equipment, including manufacturer, description, and model number, of equipment that is expected to be employed in the demonstration and acceptance testing of the systems specified.
14. Provide shop drawings showing projector mounting details with structural calculations by the audiovisual contractors' structural engineer where required by the owner.

C. WARRANTIES AND OPERATIONS MANUALS:

1. Notification: Provide written notification to the Owner and Consultant when final adjustment of the system is complete, normal settings are documented, as-built and operational documentation are complete, and systems are available for demonstration and acceptance testing. Provide a completed copy of the final testing report in accordance with section 3.3.
2. Submit equipment manufacturer's operation and maintenance manuals for each piece of equipment.
3. Submit "as-built" drawings for systems and items indicated as "Custom".
4. Submit a copy of control system programming, including touch screen layouts, in electronic form and one printout hardcopy of the complete control system program.
5. Submit System Operation and Maintenance Manual:
6. Describe in the "Operation" section, typical procedures necessary to activate each system to provide for the functional requirements as listed under the System Description. Include normal settings for equalizer, amplifier, signal processing, and user-operated controls (as established during system check-out) in tabular or pictorial form.
7. Provide in the "Maintenance" section, a recommended maintenance schedule with reference to the applicable pages in the manufacturer's maintenance manuals. Where inadequate information is provided by the manufacturer, provide the information necessary for proper maintenance.
8. List of Replacement Parts: Provide a list of necessary and recommended replacement parts for a normal maintenance period of one year.
9. Assume the reader of this manual to be technically competent, but unfamiliar with this particular facility. It is estimated that this manual should require a minimum of 25 pages.
10. System Software: Provide copy of control system software program printout and CDROM or Flash Memory device containing source code and comments.

1.12 PERFORMANCE STANDARDS

- A. Meet the following performance standards with each system, unless restricted by the published specifications of a particular piece of equipment:
- B. Audio Signal:

1. Signal-to-Noise Ratio (including crosstalk): 85 dB minimum.
 2. Total Harmonic Distortion: 0.1% maximum from 20 Hz to 20,000 Hz.
 3. Frequency Response: +/- 3.0 dB, 20 Hz to 20,000 Hz.
- C. Audio Reproduction:
1. Signal-to-Noise Ratio (including crosstalk): 65 dB minimum.
 2. Total Harmonic Distortion: 1% maximum from 30 Hz to 15,000 Hz.
 3. Sound Output Capability: Provide program levels of not less than 85 dB without objectionable distortion, rattles, or buzzes, employing as test signals several different samples of recorded music and microphones applied at each system input.
 4. Hum and Noise: Hum and noise shall be inaudible (below the background noise level of the space) under normal operation and as observed in normal seat locations.
- D. Video Signal:
1. Signal-to-Noise Ratio (peak to RMS) Un-weighted DC to 4.2 MHz: 55 dB minimum.
 2. Crosstalk: Crosstalk (Un-weighted DC to 4.2 MHz): 45 dB minimum
 3. Frequency Response: Within plus-or-minus 0.5 dB to 4.2 MHz
 4. Line and Field Tilt: 2% minimum
 5. Differential Gain: 3% maximum
 6. Differential Phase: 2o maximum
 7. No video or grounding roll is acceptable
- E. Video Timing:
1. System Timing: Sync coincidence in 50 nanoseconds
 2. Color Timing: Within 2o at 3.58 MHz
- F. Touch Panel Control System:
1. Refer to section 2.3, for system description.
 2. Verify functional operation for specified control operations.
 3. The following guidelines should be followed:
 - a. Touch panel graphical interfaces and programming shall be produced by a certified programmer.
 - b. Maintain background to lettering contrast.
 - c. Timing: Avoid the possibility for two or more serial macros or actions being sent simultaneously to the same piece of equipment through flag checking/setting routines.
 - d. Defaults: Establish default conditions for the system at power-up including device audio levels, warm-up routine, power conditions, receiver status and other default conditions as required by the Owner.

1.13 DELIVERY, STORAGE AND HANDLING

Bear costs of shipping to the site, and of unusual storage requirements. Make appropriate arrangements, and coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

1.14 WARRANTY

- A. Warranty the entire system for a minimum of one year from the date of system acceptance by the Owner. Component warranties shall be honored for the term established by the manufacturer, if greater than one year. Include in the warranty quarterly site visits to check and adjust equipment and restore systems to original performance standards.
- B. Activate manufacturer's equipment warranties in Owner's name to commence on the date of acceptance. In the case of Contractor- modified equipment, the manufacturer's warranty is normally voided. In such cases, provide the Owner with a warranty equivalent to that of the original manufacturer.
- C. Respond to all warranty problems, provided by the owner in writing, within 3 business days of notification, with a site service call or other owner acceptable resolution. All warranty problems shall be completely addressed by the contractor within a timely manner. If a piece of equipment needs to be sent out for service, the contractor shall provide a substitute piece of equipment that is equal in feature and quality, for the duration of the equipment absence. The contractor shall re-install any and all pieces of equipment that was repaired, restoring all internal DSP and external switch settings to their original state.

1.15 SERVICE CONTRACT:

- A. Furnish the cost for a separate one-year service contract for the second year maintenance, covering installed systems, new and Owner-furnished. Include in this contract quarterly site visits to inspect, repair, and adjust systems to restore them to as-new operation. Parts and shop labor are assumed to be additional charges beyond the scope of this contract. This service contract shall commence immediately after expiration of the warranty period. The cost for this service contract shall not be commingled with the costs for the systems base bid.
- B. Furnish separate costs for "on-call" service, both on-site and in-shop, and response time.
- C. Substitutions: Submit bid for the work of this section on the basis of the specified equipment. Submit proposals for substitutions separate and apart from the costs of the equipment "as specified."
 - 1. Proposals for substitutions will receive careful and equitable consideration if the differences do not depart from the overall intent of the design and operation of the system, and are in the best interests of the Owner.
 - 2. Proposed substitutions should be accompanied by full technical information, "cuts", and specifications for the equipment so proposed.
 - 3. Proposed substitutions shall be provided with the initial bid submittal not as part of the shop drawing process.
 - 4. Any requested value engineering, proposed by the contractor, shall be coordinated through, reviewed by and approved by the consultant.

PART 2 - PRODUCTS

2.1 SUPPLIER/INSTALLERS

General Qualifications: Integrator has been in business providing similar audiovisual installation services required by this section, as a primary area of business, for not less than five consecutive years. Additionally, staff assigned to the project (managing, engineering and installing), shall have a minimum of five consecutive years experience with similar type AV technology and installations.

- A. Integrator can and shall outline the general scope of past projects, normal staffing levels, and union status of shop and field installation personnel.
- B. Integrator can and shall list a minimum of three (3) projects of similar scope successfully completed indicating the location, type of systems installed, total contract amount, date completed, the names of current staff who engineered, installed and worked on those projects and what their roles were. Also, include reference persons and telephone numbers to contact.
- C. Integrator can and shall submit confirmation of current state and local contracting licenses, as required to perform the work under this section.
- D. Integrator can and shall submit confirmation of any and all bond and insurance requirements.
- E. Integrator shall submit confirmation of shop & drawing submittal capabilities.
- F. Integrator shall submit confirmation of factory approved & qualified control system programming and graphic layout capabilities as outlined in this specification.

2.2 EQUIPMENT

- A. Provide equipment as specified. See Attachment A.
- B. Supply the latest model, available at the time of bidding, of each piece of equipment.
- C. Materials: Supply materials and equipment that shall be new and shall meet or exceed the latest published specifications of the manufacturer.
- D. Provide security devices for document cameras, cameras, projectors, and flat panel displays as approved by PCCD.

2.3 SYSTEM PARAMETERS

Audio Visual System - Level 1

- A. Provide and install a short throw video program projector capable of projecting 16:9 aspect ratio from an HDMI signal output. The projector shall be 3500 ANSI. Provide and install security cable. Security cables to be keyed alike.
- B. Provide and install an interactive short throw projector for use with the projector friendly white board capable of projecting 16:9 aspect ratio from an HDMI signal output. The projector shall have Bluetooth wireless camera stylus and moveable magnetic icon strip that interfaces with computer system. The stylus shall provide electronic ink image generated from computer driver that is projected onto whiteboard with a video projector in a manner to allow interaction with existing images and content originating from the computer. The system should be capable of simultaneous use of 3 styli and should be compatible with both Microsoft Windows and Apple Mac OS X operating systems. Provide and install security cable. Security cables to be keyed alike. **PROVIDE WIRELESS DONGLE OPTION WITH PROJECTOR. ADDED ADDENDUM 2.**
- C. Provide and install a push-button control panel for use with the audiovisual system. In addition to (4) user selectable backlit input source select buttons, the controller shall have two bidirectional serial ports for display and switcher control, three unidirectional serial/IR control ports, six relays, and support for optional

IRCM - Infrared Control Modules to control VCRs, DVDs, and other IR controllable equipment. The control panel shall be housed in the audiovisual cabinet.

- D. Provide and install a secured AV cabinet mounted touch panel controller with a graphic user interface. The interface programming shall be icon-based and intuitive. Connection from the touch panel to the central controller shall be wireless LAN. The touch panel must ADA accessible per ADA requirements.
 - E. Provide and install a DVD/VCR combo player with HDMI output. DVD player shall be capable of playing DVD-R, DVD-RW, DVD+RW, DVD+R, CD, and MP3 audio files.
 - F. Provide and install ceiling-mounted loudspeakers in a pattern as indicated in the drawings.
 - G. Provide and install a "gooseneck" style document camera. The Document camera shall be 1.39 Mega Pixel 48X zoom, real-time HD (1280X1044) video display and USB 2.0 port.
 - H. Provide and install an 8 input HDCP-Compliant Scaling Presentation switcher with DTP Extension. The switcher shall allow for switching between digital and analog. Switcher shall include 2 DTP inputs, 4 HDMI inputs and 2 universal analog inputs and shall provide for 3 simultaneous video outputs.
 - I. **DELETED – ADDENDUM 2.**
 - J. Provide and install a single-chassis,digital, wireless microphone system. The wireless system shall operate in the UHF band between 470 MHz and 952 MHz, with specific available frequency range being dependent on the users' locale. The system shall allow selection of 1440 operating frequencies across 36 MHz of bandwidth in order to avoid RF interference. Each transmitter shall have a power on/off/mute switch, as well as a timed LCD showing frequency group and channel, locked/unlocked status, and battery. Transmitter shall include a body pack for use with lavalier, headset, or handheld microphones. The body pack shall include a 3-position switch to compensate for higher or lower gain devices. The receiver shall have a multi-function display showing group, channel, frequency, transmitter battery strength, and locked/unlocked status. The system shall use diversity technology to improve reception, minimize signal dropouts, and achieve the best possible signal-to-noise ratio.
 - K. **DELETED – ADDENDUM 2.**
 - L. **DELETED – ADDENDUM 2.**
 - M. Provide and install HDMI, RGBHV and component video inputs at teachers desk. Inputs shall transmit HDMI, analog video control and analog audio. Provide and install recessed desk mount cubby for housing and connection of connectivity devices at teachers desks. Installation shall be coordinated with furniture supplier and architect prior to installation. Any unauthorized work resulting in damage to furniture shall require replacement of the damaged furniture by contractor installing device(s).
 - N. Provide and install an Assisted Listening System. RF, 72 MHz based. Provide charging cases for body packs, fixed antennae. Determine quantities based on current ADA requirements compared to class sizes. Verify pickup limited to each individual classroom.
 - O. Provide and install a secure rack for all equipment including a locking door, locking internal drawer, security covers on system-control devices, and a method by which the rack is secured to the room architecture. Rack shall be self-vented for air circulation in lieu of fans.
 - P. Provide and install poles and video projector mounts for mounting of projector(s).
- Audio Visual System - Level 1A
- A. Level 1A shall contain all components and functionality of Level 1, except that it shall have one (1) interactive projector and no program projector.

Audio Visual System - Level 2

- A. Provide and install a short throw video program projector capable of projecting 16:9 aspect ratio from an HDMI signal output. The projector shall be 3500 ANSI. Provide and install security cable. Security cables to be keyed alike.
- B. Provide and install an interactive short throw projector for use with the projector friendly white board capable of projecting 16:9 aspect ratio from an HDMI signal output. The projector shall have Bluetooth wireless camera stylus and moveable magnetic icon strip that interfaces with computer system. The stylus shall provide electronic ink image generated from computer driver that is projected onto whiteboard with a video projector in a manner to allow interaction with existing images and content originating from the computer. The system should be capable of simultaneous use of 3 styli and should be compatible with both Microsoft Windows and Apple Mac OS X operating systems. Provide and install security cable. Security cables to be keyed alike. **PROVIDE WIRELESS DONGLE OPTION WITH PROJECTOR. ADDED ADDENDUM 2.**
- C. Provide and install a push-button control panel for use with the audiovisual system. In addition to (4) user selectable backlit input source select buttons, the controller shall have two bidirectional serial ports for display and switcher control, three unidirectional serial/IR control ports, six relays, and support for optional IRCM - Infrared Control Modules to control VCRs, DVDs, and other IR controllable equipment.
- D. Provide and install a secured AV cabinet mounted touch panel controller with a graphic user interface. The interface programming shall be icon-based and intuitive. Connection from the touch panel to the central controller shall be wireless LAN. The touch panel must ADA accessible per ADA requirements.
- E. Provide and install a DVD/VCR combo player with HDMI output. DVD player shall be capable of playing DVD-R, DVD-RW, DVD+RW, DVD+R, CD, and MP3 audio files.
- F. Provide and install ceiling-mounted loudspeakers in a pattern as indicated in the drawings.
- G. Provide and install a "gooseneck" style document camera. The Document camera shall be 1.39 Mega Pixel 48X zoom, real-time HD (1280X1044) video display and USB 2.0 port.
- H. Provide and install an 8 input HDCP-Compliant Scaling Presentation switcher with DTP Extension. The switcher shall allow for switching between digital and analog. Switcher shall include 2 DTP inputs, 4 HDMI inputs and 2 universal analog inputs and shall provide for 3 simultaneous video outputs
- I. Provide and install a 4X2 DSP audio matrix with the following: 4 standard balanced mic/line inputs, 2 balanced mic/line outputs, codec interface with balanced line input & output, Ethernet port for software configuration/control, serial port for third-party RS-232 remote control.
- J. **DELETED – ADDENDUM 2.**
- K. Provide and install an audio-video codec. The codec shall have HDMI inputs and outputs, microphone and line-level audio inputs, multiple outputs capable of feeding multiple display devices, and network and RS-232 control connections.
- L. Provide and install one Pan/Tilt/Zoom controllable camera for video conferencing and lecture archiving. The cameras shall have a separate control/signal device converting their signal format to HDMI. Camera shall be mounted either from the ceiling or the rear wall so as to allow the presenter and any media to be seen remotely.
- M. Provide and install a wireless computer extender allowing a laptop or similar computer to send video, audio, and USB signals to the system from a remote location within the classroom. The system shall have an effective range of no less than 20 feet from the rack location.

- N. Provide and install a central device controller with 4 X Com (RS-232), 4 X Relay, 4 X IR, and LAN capabilities.
- O. Provide and install a secured, desktop-mounted touch panel controller with a graphic user interface. The interface programming shall be icon-based and intuitive. Connection from the touch panel to the central controller shall be wireless LAN. The touch panel must be securable from theft and easily accessible per ADA requirements.
- P. Provide and install a single-chassis, digital, wireless microphone system. The wireless system shall operate in the UHF band between 470 MHz and 952 MHz, with specific available frequency range being dependent on the users' locale. The system shall allow selection of 1440 operating frequencies across 36 MHz of bandwidth in order to avoid RF interference. Each transmitter shall have a power on/off/mute switch, as well as a timed LCD showing frequency group and channel, locked/unlocked status, and battery. Transmitter shall include a body pack for use with lavalier, headset, or handheld microphones. The body pack shall include a 3-position switch to compensate for higher or lower gain devices. The receiver shall have a multi-function display showing group, channel, frequency, transmitter battery strength, and locked/unlocked status. The system shall use diversity technology to improve reception, minimize signal dropouts, and achieve the best possible signal-to-noise ratio.
- Q. **DELETED – ADDENDUM 2.**
- R. **DELETED – ADDENDUM 2.**
- S. Provide and install HDMI, RGBHV and component video inputs at teachers desk. Inputs shall transmit HDMI, analog video control and analog audio. Provide and install recessed desk mount cubby for housing and connection of connectivity devices at teachers desks. Installation shall be coordinated with furniture supplier and architect prior to installation. Any unauthorized work resulting in damage to furniture shall require replacement of the damaged furniture by contractor installing device(s)).
- T. Provide and install an Assisted Listening System. RF, 72 MHz based. Provide charging cases for body packs, fixed antennae. Determine quantities based on current ADA requirements compared to class sizes. Verify pickup limited to each individual classroom.
- U. Provide and install a secure rack for all equipment including a locking door, locking internal drawer, security covers on system-control devices, and a method by which the rack is secured to the room architecture. Rack shall be self-vented for air circulation in lieu of fans.
- V. Provide and install poles and video projector mounts for mounting of projector(s).

Audio Visual System - Level 2A

- A. Level 2A shall contain all components and functionality of Level 2, except that it shall have one (1) interactive projector and no program projector.

Audio Visual System - Level 3

- A. Classrooms 3201 and 3204 shall each have Level 2 Design in each room but shall be interconnected so that the audiovisual systems will operate for single control of both rooms when the divider in the room is open for single room use.
- B. Provide and install all required peripherals and programming for simultaneous control of both rooms.

Audio Visual System - Level 4

- A. Classrooms 2104 and 2106 shall have Level 1 Design in each room but shall be integrated to view live video feed to the Cadaver Room 2015. The following shall be installed in Cadaver Room 2015.
- B. Provide and install two Pan/Tilt/Zoom controllable cameras for video conferencing and lecture archiving. The cameras shall each have a separate control/signal device converting their signal format to CAT5e.

Cameras shall be mounted either from the ceiling or the rear wall so as to allow the presenter and any media to be seen remotely. Final location shall be coordinated with the users/district prior to installation/rough-in.

- C. Provide and install all required peripherals for control of cameras and audio in room and for integration to adjacent rooms 2104 and 2106.

Audio Visual System – Level 5

- A. Conference Room 4302 shall have Level 2 but shall have one interactive short throw projector and will not have a non-interactive program projector.

Audio Visual System - Level 6

- A. Classroom 3404 “ADN Skills 1” shall have Level 1A design but shall be integrated to view live video feed to rooms 3405 and 3407.
- B. Classroom 3405 “ADN Skills 2” shall have Level 2A but shall be integrated for live viewing of procedures in progress in ADN Sim Room 3407.
- C. Classroom 3407 “ADN Sim” shall have Level 1A design. Additionally, it shall have seven (7) Pan/Tilt/Zoom controllable cameras for video conferencing and lecture archiving. The cameras shall have a separate control/signal device converting their signal format to CAT5e. Cameras shall be mounted either from the ceiling or the rear wall so as to allow the presenter and any media to be seen remotely. These cameras also shall be remotely controlled from the Control Room for live instructor viewing of each bed. Final location of cameras shall be coordinated with user/district prior to installation.

2.4 CUSTOM FABRICATION

- A. Electrical Power Connections: Electrical power, junction boxes, and circuits will be provided by others. Provide required interconnections to the power system from these junction boxes to the equipment and equipment racks.
- B. Remote Control Panels and Receptacle Plates. Fabricate with 1/8-inch thick #6061-T6 aluminum material. Finish brushed with 150 grit paper. Anodized finish to be approved by the Owner.
- C. Equipment Rack: Provide 120 V power distribution within the rack. Insulate power receptacle strips from the rack. Power receptacle strips shall be SGL Waber Company or approved equal.
- D. Audio Transformers: Provide appropriate impedance ratio and power handling capacity for the function intended of audio transformers specified in the system.
- E. Networks and Pads: Provide networks and pads as shown on the drawings or as required to achieve proper impedance matching and levels. Networks and pads shall be balanced. 0.5 watt, 5% composition resistors shall be soldered to fixed connection points at each end.
- F. Loudspeaker Tiles: Guarantee that there are no rattles or buzzes from the tile loudspeakers. Trouble shoot and remedy any buzzes or rattles caused by ceiling loudspeakers emitting audio.
- G. Rack Mount Adapters and Security Covers: Provide the appropriate factory or custom rack mount adapters for equipment installed in the audiovisual equipment rack, whether specifically itemized or not. Provide security covers for equipment with adjustable controls.
- H. Seismic Safety: Mount and brace permanently installed equipment to the building structure to minimize potential damage to personnel or equipment from foreseeable seismic events. Physically bolt audiovisual equipment racks to the floor and/or wall to prevent toppling. Secure all hanging equipment such as projectors, plasmas, loudspeakers, etc, both to minimize sway and to prevent detachment from the overhead structure. All supports require review by the audiovisual contractor’s structural engineer with their stamp, certifying acceptance of the proposed mounting design by the audiovisual contractor where required by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that electrical requirements including junction boxes, empty conduit and power circuits and receptacles are in place as shown on the drawings. Contractor shall coordinate final positions of equipment, power circuits, junction boxes, furniture, and any other A/V related facilities with the Owner and the Consultant.
- B. If there is a conflict with existing wall boards, notify the District of such conflicts. Take direction from the District.

3.2 INSTALLATION

General: Include the delivery, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and other work, whether or not expressly required, which is necessary to result in complete operational systems.

- A. Firmly secure equipment in place unless requirements of portability dictate otherwise.
- B. Permanently mount and/or provide a mechanical index insuring precise alignment of the projected image of optical projectors.
- C. Provide all required mounting hardware and adequate support for fastenings and supports with a safety load factor of at least three.
- D. Secure plumb and square boxes, equipment, etc.
- E. Give consideration, not only to operational efficiency, but also to overall aesthetic factors in the installation of equipment and cable.
- F. Allow no bracing or support members greater than 1/8" in front of the loudspeaker components where they would interfere with proper sound coverage.
- G. Cable Installation:
 - 1. Mark cables, regardless of length, with permanent, non-handwritten number or letter cable markers within six inches of both ends. There shall be no unmarked cables in the system.
 - 2. Marking codes used on cables shall correspond to codes shown on drawings and/or run sheets.
 - 3. Furnish screw-type terminal blocks, boards, strips, or connectors, for cables which interface with racks, cabinets, or equipment modules. Terminate wires terminating at screw-type terminals with crimp-on lugs. "Telephone-style" punch-down blocks are not acceptable for signal or data wiring.
 - 4. Group cables according to the signals being carried. In order to reduce signal contamination, form separate groups for the following cables:
 - a. Power cables
 - b. Video cables/Camera cables/ Broadband RF cables/ Data Lines/Control cables
 - c. Audio cables carrying signals less than minus 30 dBm. (Microphone Level)
 - d. Audio cables carrying signals above plus 30 dBm. (Line Level and Intercom)
 - 5. As a general practice, run power cables, control cables, and high-level cables on the left side of an equipment rack as viewed from the rear. Run other cables on the right side of an equipment rack, as viewed from the rear.

6. Unless otherwise called for in these specifications and the drawings, use the following cables, or their approved equals, in these systems:
 - a. Composite video cable runs: Belden 1505A
 - b. S-Video video cable runs: (2) Belden 1505A
 - c. Component video cable runs: Belden 1164B
 - d. RGBHV and VGA video cable runs: Belden 1418B
 - e. Infrared/Serial Digital: Belden 1583 or Equal
 - f. Microphone and line-level audio cable in conduit: Belden 8762 or West Penn 77292
 - g. Microphone and line-level audio cable for rack wiring: Belden 8761
 - h. 70-volt speaker cable: Belden 8471
 - i. Plenum-rated 70-volt speaker cable: Belden 89740
 - j. Control cable: Liberty
 - k. Data Cable, CAT6: Belden DataTwist 4800 or Equal
 - l. HDMI cable Belden HD2007
7. Cut cables (except video, camera and RGBS cables which must be cut to an electrical length) to the length dictated by the run. For equipment mounted in drawers or on slides, provide the interconnecting cables with a service loop of appropriate length.
8. Install no cable with a bend radius less than that recommended by the cable manufacturer.
9. Use plenum-rated cable in plenum-rated spaces. Where plenum-rated cable is used, provide plenum-rated and approved tie-wraps and supports (Thomas & Betts #TYV525M, or approved equal).
10. Where cable is used above accessible ceilings, provide tie-wraps and supports (Thomas & Betts #TYV525M, or approved equal).

H. Receptacle Plate Connectors:

1. Unless otherwise detailed herein, use the following types of panel receptacles on connection boxes, panels, plates, and wire ways:
 - a. Neutrik and Canare connectors are the preferred standard.
 - b. Audio (microphone): Neutrik or equal.
 - c. Video: Canare or Equal BNC type. Insulated from panel.
2. Receptacle Plate Designation: Clearly engrave wall mounted receptacle plates with alphanumeric identification of input type (i.e., mic, line, speaker, video etc).
3. Grounding Procedures: In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, adhere to the following grounding procedures:
4. General: Because of the great number of possible variations in grounding systems, follow good engineering practice, as outlined above, and deviate from these practices only when necessary to minimize crosstalk and to maximize signal-to-noise ratios in the audio, video, and control systems.

5. System Grounds: Establish a single primary "system ground" for the systems in each particular area. Connect grounding conductors in that area to this primary system ground. Provide the system ground in the audio equipment rack for the area. The ground shall consist of a copper bar of sufficient size to accommodate secondary ground conductors.
6. Rack Ground:
 - a. Equipment Grounds: Grounding methods used will be dependent upon individual equipment interconnection of chassis ground, circuit common, and power supply common within the units. Provide ground method for equipment types as follows:
 - b. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis (Signal common is not internally connected to chassis): Make no connection from chassis ground to primary systems ground busbar in Equipment Rack.
 - c. Equipment having a 3-wire power cord with green wire of the power cord connected to chassis: Make no connection from chassis ground to primary system busbar, but do make connection with 14AWG insulated wire from circuit common to primary system ground busbar in Equipment Rack. Separate circuit common from chassis ground.
 - d. Equipment having a 2-wire power cord, no green wire, neutral is not tied to chassis, and circuit common is tied to chassis: Make connection from chassis to primary system ground busbar using 14AWG insulated wire Audio Cable Shields: round audio cable shields at one point only. There are no exceptions. For inter- and intra-rack wiring connect the shield at one end only. For ungrounded portable equipment, such as microphones, connect the shield at both ends but grounded at only one end.
7. Video Receptacles: Insulate video receptacles from the panel, outlet box, or wire way. Unless otherwise detailed herein, use insulated-from-panel type receptacles.
- I. Security: Install security devices to document cameras, cameras, projectors, and flat panel displays.

3.3 FIELD QUALITY CONTROL

Demonstration and acceptance testing: Before demonstration and acceptance testing are scheduled, perform system checkout. Furnish required test equipment and perform work necessary to determine and/or modify performance of the system to meet the requirements of this specification. Submit a written report summarizing test results to the Owner and Consultant. Include the following:

- A. Test audio, video, RF, Network, and remote control systems for compliance with the functional requirements and Performance Standards.
- B. Adjust, balance, and align equipment for optimum quality and to meet the manufacturer's published specifications.
- C. Prepare and maintain documentation of performance tests, including numerical values of established equipment settings, for reference during demonstration and acceptance testing. Submit final results prior to scheduling demonstration and acceptance testing.
- D. Audio System:
 1. Loudspeaker-Line Impedance: Measure the impedance at 250 Hz, 1 kHz, and 4 kHz and the resistance of each loudspeaker line leaving the AV equipment rack with the line disconnected from its normal driving source. For lines to full-range distributed loudspeaker systems, measure the magnitude of impedance at 1 kHz.
 2. Hum and Noise Level: Measure the hum and noise levels of the overall system for each microphone input channel and line-level input channel.

3. Adjust gain controls for optimum signal-to-noise ratio so that full amplifier output will be achieved with 0 dBm at a line-level input.
4. Terminate line-level inputs with shielded resistors of 150 and 600 ohms, respectively, for these measurements.
5. Disconnect the loudspeaker lines and terminate the power-amplifier outputs with power resistors for these measurements. The value of the load resistor shall be within 5% of the nominal load impedance of the amplifier under test. The power rating of the resistor shall equal the power rating of the amplifier.
6. Frequency Response of the System: Measure the frequency response using the audio systems as described in Part 1. Adjust gain controls and equalizers to provide the one third octave-band sound levels as specified.
7. Programmable Equalizers: Provide necessary controller with full audio spectrum display for the adjustment of programmable equalizers during system checkout. Do not provide equalizer programmers with the systems.
8. Uniformity of Coverage: Measure octave band of pink noise test signal, centered at 2 kHz, played through loudspeaker system.
9. Power-Output and Signal-Level Adjustment within System:
 - a. Measure the electrical distortion of the overall system for each line-level input channel.
 - b. Adjust gain control as for the tests specified herein.
 - c. Apply a 1-kHz sine-wave signal from an oscillator having less than 0.5% total harmonic distortion at the input tested, at a level required to produce full amplifier output. Note that a pad with 150-ohm output impedance is required for driving the microphone-level input in accordance with the EIA standard.
 - d. Use a distortion analyzer to measure the output level and the total harmonic distortion of the amplification and control equipment. In the absence of a distortion analyzer, a high input impedance measuring device such as a DMM may be used to measure the output level. Lack of clipping or apparent deformation of a sine-wave input signal at the power-amplifier output, as seen on the oscilloscope, may serve as evidence that distortion of amplification and control equipment is within acceptable limits.
 - e. Make measurements with loads actually incurred in the system operation. Power-amplifier loads shall be power resistors equal to the nominal load impedance of the output terminals used in the system.
10. Loudspeaker Polarity
 - a. Perform polarity checks of loudspeaker lines by means of a polarity tester or use DC source at one end of each line and a voltmeter at the other end. Loudspeaker lines shall be identically polarized with respect to color coding.
 - b. Test polarity of the loudspeakers using a sine-wave test signal warbled about 500 Hz. The listener shall be located on axis of the loudspeaker. Switch the loudspeakers from nominally in polarity to nominally out of polarity with respect to the selected loudspeaker. With the loudspeakers in proper polarity, the quality and clarity of the music or speech should be greater, and the warble test signal should clearly come to the surrounding space from the loudspeaker.
11. Freedom From Parasitic Oscillation and Radio-Frequency Pickup:

- a. With systems set up for each mode of operation specified in the functional requirements, check to ensure that systems are free from spurious oscillation and radio-frequency pickup, in the absence of audio input signal and when the system is driven to full output at 100 Hz.
 - b. Employ an oscilloscope having at least 5 MHz bandwidth for these checks.
 - c. Apply slow sine-wave sweep from 50 Hz to 5 kHz at a level of 6 dB below rated power-amplifier output voltage to each system. Listen carefully for buzzes, rattles and objectionable distortion.
 - d. Correct causes of these defects unless the cause is clearly from other than the AV system's equipment and installation, in which case bring the cause to the attention of the Owner and Consultant.
12. Audio Test Signal Paths: Verify operation from source inputs (for microphones, audio tape units, video tape units, etc.) through ADAs, mixers, switchers, etc., to signal destinations.
13. Video System:
- a. Input Signal Level: Measure standard composite signal level to be 1.0 volt peak-to-peak with oscilloscope, across standard input impedance.
 - b. Signal-to-Noise: Operate system at standard input and output levels. Terminate with standard load impedance. Measure noise level using oscilloscope for signals from 10 kHz to 4.2 MHz and an RMS voltmeter for signals from 0 to 10 kHz, and calculate signal-to-noise ratio.
 - c. Differential Gain: Using a step generator and waveform monitor measure chrominance, luminance, and normal synchronizing and blanking signals. Measure variation in amplitude of the chroma sub-carrier at 10%, 50%, and 90% luminance.
 - d. Differential Phase: Operate system as defined above and measure variation in phase of the chroma sub-carrier at 10%, 50%, and 90% luminance.
14. Control System:
- a. Verify the wireless control system is free from interference.
 - b. Verify operational functions of the control system and interfaced devices.

3.4 OWNER TRAINING

- A. Provide on-the-job training by a suitably qualified instructor, to designated personnel, to instruct them in the operation and maintenance of the systems.
- B. Arrange with the equipment manufacturer for such instruction, at no additional cost, in the event qualified instructors are not available on staff for certain sophisticated equipment.
- C. Schedule the first training after the systems are operational. Provide a minimum of 8 hours of on the job training in the operation and maintenance of the systems for personnel designated by the Owner at each campus (32 hours training total).

3.5 DEMONSTRATION AND ACCEPTANCE TESTING

- A. System acceptance tests shall not be performed until the Contractor's final system checkout and the final testing and tuning report (see Specification Section 3.3) has been completed by the Contractor. The system acceptance tests consist of the following:
- B. Take a physical inventory of equipment on site and compare to equipment lists in the contract documents.

- C. Demonstrate the operation of system equipment.
- D. Both subjective and objective tests will be required to determine compliance with the specifications. Provide test equipment specified for these tests.
- E. Provide final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part 1.
- F. In the event further adjustment is required, or defective equipment must be repaired or replaced, tests may be suspended or continued at the option of the Owner.
- G. If the need for further adjustments becomes evident during the demonstration and testing, continue work until the installation operates properly. Included in the continued work shall include, but not be limited to, changes to or installation of resistive pads, readjustment of loudspeaker aiming, adjustment of system equalizers, programming changes to the control system, convergence of the video projector, if these adjustments are required.
- H. If acceptance of the system is delayed because of defective equipment or because the equipment does not fulfill this specification, reimburse the Owner for time and expenses for these tests during extensions of the acceptance-testing period.

3.6 CLEANUP AND REPAIR

Upon completion of the work, remove refuse and rubbish from and about the premises, and shall leave the relevant areas and equipment clean and in an operational state. Repair damage caused to the premises by the installation activities, at no cost to the Owner.

3.7 PROTECTION OF WORK

During the installation, and up to the date of final acceptance, protect finished and unfinished work against damage and loss. In the event of such damage or loss, replace or repair such work at no cost to the Owner.

END OF SECTION