

## **DIVISION 16 ELECTRICAL SYSTEMS**

For new, additional requirements, refer to D11 Design and Construction Standard: “Division 28 (Electronic Safety and Security) 2019 Wording Draft”.

**Red-colored text** found in this document may be duplicated, enhanced or otherwise addressed by the Division 28 Working Draft.

If any discrepancies are found between District 11 Division 16 and Division 28 standards, please advise District 11 Project Manager (COTR).

### **A. GENERAL**

This section contains general guidelines for design and installation of electrical systems. Design team and Contractors shall incorporate these guidelines as applicable to specific projects and fully coordinate these requirements with other related specification sections including but not limited to Divisions 1, 2, 11, and 15.

Terms used herein shall have the following connotation:

- a. Will, provide, shall, and must: an absolute requirement
- b. Preferred or desired: Indicates Owner’s preference if other conditions are about equal.

#### **1. Definitions:**

- a. Clean power: Electrical power that does not contain any potentially harmful variations from the established 120-volt 60 Hz patterns. Different equipment from various manufacturers will have different requirements for clean power.
- b. Dedicated circuit: A complete circuit consisting of hot, neutral, and ground wire. Three conductors in this circuit are not shared with any other equipment.
- c. Designated circuit: A circuit that shares a neutral and ground with other circuits.
- d. Isolated ground circuit: A circuit for which the ground connector is connected without interruption directly from the power receptacle to where the electrical services enter the building. A conventional ground circuit would be connected to the nearest secondary distribution panel. This type of wiring is designed to reduce the amount of noise introduced into the ground circuit by other electrical equipment.

Any variance from these guidelines must be approved by the District 11 Project Manager (COTR) or other authorized representative from the District Facilities Department.

Asbestos shall not be used in any part of the electrical system. Solder containing lead shall not be used anywhere in the building. Contractor does not need to assume responsibility for performing asbestos abatement but will be responsible to advise Owner if presence of asbestos is anticipated in any locations where penetrations will be made. District 11 employs an environmentalist certified for asbestos removal who will review shop drawings and conduit routing schematics prior to any coring operations to determine if abatement will be required in any location. If required, abatement will be performed by or contracted separately by Owner. Contractor shall read the Asbestos Notification

Letter provided in the Construction Documents and shall demonstrate acknowledgement of receipt upon execution of contract.

Functions and educational requirements as pertaining to electrical systems are described under General Requirements and Room Requirements listed herein. The design engineer shall review these sections carefully to establish intent and scope of educational function for each area.

The following design criteria and recommendations summarize the various engineering aspects of planning, design, installation, and maintenance which are to be considered in achieving the following objectives:

- a. Maximum safety
- b. Performance and reliability
- c. Energy efficiency
- d. Ease of maintenance
- e. Cost (first cost, operating cost, and life-cycle cost)

Colorado Springs School District 11 strives with these specifications to receive designs and equipment that will provide the best overall value and life-cycle cost for the District within the available project budgets. These criteria, coupled with specified educational and functional requirements, form the basic guidelines for electrical planning. They are not intended to restrict the design team in the application of other concepts that are consistent with the educational and functional needs and the objectives listed above. Design Consultants and Contractors are encouraged to offer suggestions for alternate products or solutions when applicable for review and approval by the District.

## 2. Electrical Design and Installation Criteria.

There is a basic need for electric flexibility, especially with regard to space provisions for routing and terminating potential future power, data, and communications requirements.

- a. Protection:
  - i. Provide Lightning Protection for building electrical systems
  - ii. Provide Phase Protection for all 3-Phase equipment
  - iii. Provide Power Factor Correction to maintain power factors to  $\pm 95\%$  lagging.
- b. Code Compliance: All electrical work shall conform to the minimum standards set forth by the most recent edition of the National Electrical Code (NEC) unless a more stringent standard has been set by the District in this specification. The Design Team and Contractors shall be responsible for determining and meeting all applicable national and local code requirements and shall further identify and propose building service and meter locations for review and approval by the District Facilities Department. All Contractors performing work for CSSD 11 shall hold all applicable state and local licenses and shall further be required to obtain permits and inspections from Colorado State Electrical Board.
- c. Contractor Qualifications and Requirements:

- i. All Contractors performing work for District 11 shall be Licensed Electrical Contractors in the State of Colorado.
  - ii. Provide Journeyman Electrical Foreman in charge of work at all times. Foreman shall have experience in installing not less than 5 such electrical systems of equal or greater complexity. Maintain Journeyman/Apprentice ratio as required by Colorado State Electrical Board at all times.
  - iii. **Only professional quality workmanship will be accepted. Haphazard or poor installation practice will be cause for rejection of work.**
3. Future Utility Expansion
  - a. Design team and Contractors shall consider future additions when sizing utilities. A minimum of 25% spare service capacity and panel board space shall be provided for future expansion and addition of circuits to all distribution equipment and panel boards.
  - b. Include the following:
    - i. Electrical service shall be sized for 1.25 times the total design load for the proposed facility unless otherwise approved by COTR.
    - ii. Provide a minimum of 20% spare capacity for related systems including the clock/bell system, security system, intercom system, fire alarm system, and data systems for future expansion.
    - iii. The as-built locations of all utilities shall be measured to a  $\pm 6$ " accuracy in two (2) directions to the center line of the pipe or box below grade. Measurements shall be taken from building lines, exterior walls, or poured concrete walks. All measurements shall be shown on the asbuilt drawings. This is a requirement for final payment.
    - iv. No conduits shall contain more than 40% maximum fill.
4. Harmonic Distortion: Design wiring and specify equipment so that electronic devices that distort harmonics of sine wave power such as computer power supply units, variable speed drives (elevators, fans and pumps) or solid state LED ballasts do not adversely affect each other or the building power circuits, particularly the neutral ground wiring.
5. Lighting Design: Design all lighting to specifications provided by Colorado Springs School District 11, Energy Manager. Review lighting designs, levels and equipment selection with Energy Manager at earliest opportunity.
6. **Security System and Fire Alarm System Design: Design all new security and fire alarm systems to be compatible with existing systems and equipment. Contractor shall consult with the School District Alarms Shop Foreman to ensure compliance with this requirement.**
7. **Labeling: Provide typewritten or computer generated labels for all panel boards. Clearly identify circuit numbers and locations served.**
8. **As-Built Drawings: Prepare the listed final As-Built drawings. Use the redlined drawings maintained by the contractor during construction.**
  - a. **One-line diagrams.**
  - b. **Accurate routing of wiring.**
  - c. **Locations of panels and loads.**
  - d. **Point to point connection diagrams.**
  - e. **Accurately locate buried conduit.**

- f. **Accurate circuit connection designations.**
9. Site Inspection and Site Conditions:
- a. Site visits shall be required by all bidders prior to submission of bids. Contractors shall be familiar and aware of all discernible conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
  - b. Lines of other services and/or equipment that are damaged, as a result of work performed by Contractors shall be repaired promptly at no expense to Owner.
  - c. Code compliance is mandatory. Nothing in the drawings and specifications permits work not conforming to the most recent NEC or other applicable building codes.
10. Minor changes: The Owner reserves the right to make minor changes in the locations of outlets and equipment up to the time of electrical rough-in without any cost to the Owner.

## B. ROOM REQUIREMENTS

- 1. It is the Designers and Contractors responsibility to coordinate the locations of all outlets, switches, devices, etc., with other equipment such as wall cabinets, marker and tack boards, back splashes, gymnasium safety mats, mechanical equipment, etc. Owner will not pay for any relocation of such items if conflict is caused by improper coordination.
- 2. Standard Classrooms and Instructional Areas.
  - a. Provide standard duplex outlets not more than 6' from corner or broken wall space such as doors and unit ventilators and not more than 12' o.c. around perimeter of classroom.
  - b. Make provisions for computers, television, overhead projectors, and SMART boards for all instructional areas. Coordinate room layout with District PM and/or IT department to identify proper locations and current requirements for these items.
  - c. Provide not more than 4 each 20 amp receptacles per 20 amp circuit. All general use branch circuits shall be rated at 20 amps.
  - d. Provide electrical and TV signal distribution outlets high on wall in each classroom, possibly above marker/tack board, toward a "front" corner, for TV monitor. Position monitor to avoid sources of glare. Consult with owner for coordination of TV monitor location. Coordinate with Architect to see that adequate backing exists behind wall for monitor mounting.
  - e. Provide computer network and telephone outlet boxes and conduit stubs into ceiling area for each room. Coordinate location, quantity, and other current requirements with District PM and/or IT department. Avoid placement of network outlets under marker boards.
  - f. Floor outlets are discouraged, but when no other alternative is available should utilize flip-up cover locking or waterproof type. Provide carpet flange in carpeted areas.
  - g. Provide 3-way light switches near each entrance to instructional areas to facilitate functional use of these areas. Provide occupancy sensor control in all rooms. Light switches to override occupancy sensors.
  - h. Provide Owner-specified atomic clock, intercom speaker (also used for program signal) and call-in switch (for remodel projects) for all instructional areas. Coordinate with the Districts Facilities and Technology Departments for requirements for new buildings. Intercom Speakers shall be provided to

give sound coverage of the individual teaching areas. Locate call-in switch or handset near its respective speaker.

3. Special Use Instructional Areas: Design requirements vary depending upon specific program uses for spaces. Coordinate with District COTR, Facilities Office, Technology Department, and Department Heads for Instructional Programs to identify and specify products and functional requirements for Science Labs, Tech Labs, Special Education Areas, Industrial Arts Areas, Art Rooms, Music Rooms, Auditoriums, gymnasiums, locker rooms, and other physical education or specialty use classrooms.
4. Auditoriums. Coordinate and meet with District 11 Auditorium Manager to discuss and review Auditorium lighting, power, and sound system requirements and specifications for each specific project. General design guidelines are as follows:
  - a. LED house lighting is preferred for all auditorium seating areas. LED lighting should be as closely matched as possible to color, temperature, and feel of incandescent lighting. LED house lighting should be dimmable and controllable via both the “entry” architectural type system with entry stations at primary traffic doors and by the stage lighting console.
  - b. If LED lighting is not feasible for house lighting, two separate lighting systems should be installed over the seating area – an incandescent house lighting system and a high efficiency “work light” type system. Each system should be installed with minimal visual impact to the architectural design of the auditorium. If the work light system is LED or LED based, this system should be dimmable and integrated into the stage lighting controls systems. All incandescent house light systems must be integrated into the stage dimming system. All control devices must have an electronic lockout function from the master station to all other entry stations.
  - c. All auditorium and stage lighting should be designed and installed in a manner that provides ease of maintenance and re-lamping without the use of scaffolding. Winch driven lowering devices for house lighting fixtures are acceptable.
  - d. Provide outlets for cleaning and projector use. Provide projector outlet approximately 40 feet back from stage. Provide outlet for large-screen television on stage and at face of stage. Provide outlet for motorized projection screen at stage.
  - e. Provide a complete sound system. Amplifier to have provision for radio, tapes, compact discs. Consider projector sound through public address speakers. Provide direct line to main intercom console for transmitting programs both ways for distribution to the entire school. Install amplifier in cabinet. Provide three microphone jacks on apron, equally spaced, and provisions for an overhead suspension microphone. Review and coordinate additional special requirements with District Auditorium Manager.
  - f. Review and coordinate stage lighting requirements with District Auditorium Manager. Current stage lighting standards are as follows:
    - i. Incandescent stage lighting fixtures or stage lighting instruments should be ETC source 4 series to align with current district stage standards. ETC LED fixtures may be acceptable but should be discussed on a project basis.
    - ii. Stage dimmer racks, ETC Sensor racks are highly encouraged.
    - iii. ETC control consoles are district standard. ETC Ion at the high schools ETC smart fade at the middle and elementary. ETC Ion shall be supplied with two 19” monitors and an Ethernet based wireless multiport router to facilitate wireless ipod / ipad apps as well as Client connections.
    - iv. Stage lighting data distribution.

Current district standards: Elementary / Middle / High schools DMX-512 is the norm using a 5 pin XLR connection on all input and output locations. DMX 512 data input “second universe” should be supplied at the location of the stage lighting console (light booth). DMX 512 repeater(s) are required at or near the location of the stage dimmer rack and must be installed inside a wall mount equipment rack. If the equipment rack is not in a secured room or closet, a lockable front cabinet door must be supplied. A dedicated individual DMX 512 output should be located at all areas where stage lights are designed to be mounted or hung. This may include but may not be limited to the following locations: front of house lighting catwalk or lighting positions, all on above stage lighting pipes, orchestra pit, stage left and stage right walls both upstage and down stage, and balcony rails (if applicable). All DMX 512 data drops should be run using Cat 5 wire allowing for future alterations to ETCNet or Ethernet type data networks. All DMX 512 data drops should terminate with a 5 pin XLR connection face plate.

- v. Stage lighting positions where dimmed connections are located should also have constant power non-dimmed “Edison” connections. Each stage “electric” should have two dedicated 20 amp non-dimmed circuits per 12 dimmed stage circuits. Stage lighting positions that have less than 12 dimmed circuits should have 1 non-dimmed 20 amp “Edison” circuit. Nondimmed circuits should be controlled by relay type cards in the stage dimmer rack. Stage dimmer rack should be configured to “turn on” all relay non-dim cards when control signal from the stage lighting console is present and “turn off” when signal is lost after an appropriate delay time has expired.
  - g. In addition to regular stage lighting, provide LED task lighting at normal classroom lighting levels on all stages. Task lighting shall be required behind curtain and at sides of stage and shall be controlled at the highest traffic entrance to the stage area and near the stage lighting control console. Work lights above the stage (if exposed) should have a protective metal grill to protect light tubes.
  - h. Provide outlets in the second stair riser on the front of stage on 8'-0" centers.
  - i. Circuits for mechanical and cleaning equipment must be fed from separate panel and not connected to lighting or auditorium panel.
  - j. Provide outlets for band use. Consider floor pockets on each side of stage.
  - k. Provide lighting outlets for portable lights at catwalk areas.
  - l. To accommodate audiovisual equipment, provide floor outlets for 120 volt power and audio cabling for projection of movies in the auditoriums, multipurpose rooms, and other large spaces where wall outlets cannot be used.
5. Gymnasium and Locker Rooms.
- a. Gym lighting fixtures should be high bay LEDs rigidly constructed with clear acrylic lenses and metal guards. Design for ease of lamp replacement. All lighting to be switched beyond circuit breaker panels, with Owner-specified keyed switches.
  - b. Provide scoreboards in middle and high schools, 9" minimum letter size. Verify length of periods required. Wrestling attachment on one scoreboard for high school only. Separate controls when more than one board is used. Mount scoreboards so that bottom is a maximum of 20' above floor. Control plugs shall be readily accessible - not under bleachers. Provide protection of the scoreboard from gymnasium activities (damage by balls, etc.).
  - c. Provide large clock, minimum 15" diameter, with guard, size, and location to be visible from maximum area.

- d. All cross-court backstops to be motorized fold-up type in middle and high schools, in main gym only. Provide thermal overload protection, limit switches, and momentary contact key switches. Use minimum ½ HP drive motors, one backstop per motor.
  - e. Provide complete sound system in middle and high school gymnasiums. Provide direct line from main console for transmitting programs both ways and for distribution to entire school. Sound systems for elementary school gymnasiums shall include at least two ceiling speakers or as required, which shall be tied into the main console and intercom system. In addition, these speakers shall be connected so as to permit alternate use with a local amplifier and microphones, or in connections with the sound for movies. Include a microphone jack at: center of platform, each side of platform, and at rear of gymnasium for use with movies. Rough-in for local amplifier which will be furnished by the School District.
  - f. Provide clock and program (audible) signals in locker rooms.
  - g. Provide outlets for audio equipment, projectors, recorders, etc. Also, provide at least two outlets for 30 amp custodial machines. Each outlet should be 208 volt single phase.
  - h. Provide minimum two recessed type convenience outlets (to minimize damage from balls, etc.) per wall in gym, with outlets for each wall fed from a separate circuit.
  - i. Any fire alarm devices in gym or locker areas shall have protective metal guards.
6. Offices and Administration Areas:
- a. Provide minimum of one (1) standard duplex outlet per wall in standard “hard-wall” office areas. Provide standard duplex outlets not more than 6’ from corner or broken wall space such as doors and unit ventilators and not more than 12’ o.c. around perimeter of office.
  - b. Provide 1 tele/data box with conduit stub to ceiling area per office. Coordinate location with District COTR.
  - c. Coordinate open office area power and data plans and device locations with District COTR and/or furnishings provider. Designers and Contractors shall be required to make provisions for energized systems furnishings and panel systems when used.
  - d. Consider provision of recessed floor boxes for secretarial desk areas and/or other areas where planned work stations are away from wall surface areas.
  - e. CATV drops may be required for some offices. Review requirements with District COTR.
7. Media Centers:
- a. Coordinate power and data plan with District COTR, District Technology Department, LTE, and media center furnishings provider.
  - b. Plan for book security systems.
  - c. Provide intercom station and public address speakers in the media center.
  - d. Provide outlets in floor, walls, or ceilings as required for projectors, SMART boards, and other specialized media center equipment.
8. Miscellaneous.

- a. Telephones are required for all offices and teaching stations. Contractor shall provide a box with conduit stub and pull string to ceiling for use by District Staff or third-party Vendor. Make provisions for public phones. Coordinate specific locations with COTR and District Technology Department.
  - b. Verify requirements and locations for vending machine outlets in such areas as student centers, teacher lounges, main lobby, corridors, etc.
  - c. Provide separate power on separate circuit to RTU locations for temperature controls and for outlets for power tools, etc., apart from power to RTUs.
  - d. No equipment shall be installed in restrooms or locker rooms other than required devices
9. Security and BAS systems.
- a. Provide emergency circuit capacity for all BAS and Security systems including CCTV Card Access, and burglar alarms.
  - b. Provide emergency circuit double-duplex outlets high on wall for CCTV recording purposes in Owner designated CCTV recording location.
  - c. Provide for emergency circuit and fiber-optic cabling for CCTV use to provide pole-mounted CCTV coverage of all exterior perimeters of building. Coordinate with CCTV and Owner security consultants.

## C. BASIC ELECTRICAL MATERIALS AND METHODS

1. General.
  - a. All electrical work shall conform to the minimum standards set forth by the most recent edition of the National Electrical Code (NEC) unless a more stringent standard has been set in this specification section.
  - b. Examine area and conditions under which switchboards, panelboards, and enclosures are to be installed and notify Owner in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
  - c. Identification: Provide lamecoid labels for each branch device identifying load served on main switchboard. The switchboard shall have a lamecoid label including name, voltage, phase, and short circuit rating.
  - d. Provide a typed panel schedule for all new panels. Identify circuit number and location.
  - e. Provide and install a new accurate typed panel schedule when breakers or circuits are modified or changed for any reason.
2. Conduits: The following guidelines apply to the use of EMT, GRC, PVC, Liquid Tight Flex, and Flexible Metal Conduits. Use of AC, BX, or UF cable is NOT permissible.
  - a. Plans and specifications shall clearly designate type and quantity of each type of conduit to be utilized. All are subject to review and approval by District 11.
  - b. All interior conduits shall be installed in concealed locations unless specifically designated as a surface raceway system. Any surface mounted installations must be approved by the District COTR.
  - c. Conduits shall not have more than 40% fill at the completion of the installation.
  - d. PVC conduit shall not be used above grade. Transitions shall be made at least 12" below grade.
  - e. All underground bends shall be GRC.



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- f. Underground conduits shall be a minimum of 3/4" in diameter.
  - g. Non-metallic flexible conduit is NOT permitted.
  - h. Exterior surface mounted conduit shall be galvanized rigid conduit up to a height of eight (8) feet minimum above grade. Exterior conduits shall be installed flush to exterior building finish and installed or protected in a manner such that they cannot be used to climb up.
  - i. The use of MC cable is NOT permitted in wall cavities or above suspended ceilings. MC cable may be used in remodel situations above inaccessible hard lid ceilings subject to District 11 approval assuming it can be supported adequately.
  - j. All conductors must be installed in a properly sized conduit with not more than 40% maximum fill.
  - k. All conduits that penetrate firewalls shall be patched with fire stop grout. Refer to section H.6 for more details.
  - l. All conduits shall be rigidly supported to the building structure in accordance with the requirements of the National Electrical Code. Wire, perforated straps, etc. will not be accepted as a means of supporting conduits.
  - m. Conduits shall not be run across any roof area on any District facility unless specifically approved by District COTR.
  - n. Where conduits penetrate roof areas, they shall be placed as close to equipment to be served as possible. Effort should be made to route conduit through mechanical roof curbs when possible to avoid roof penetrations.
  - o. Where projects include demolition and/or renovation of existing systems, remove existing conduits (wiring, raceways, devices, etc.) back to the nearest device or junction box which is intended to remain active after the project is complete. Do not leave abandoned circuits in place. As needed, contact District COTR to ensure full coordination with District Facilities.
3. Wires and Cables: All wire shall be copper with THHN or THWN insulation. Conductor size for power distribution shall be minimum #12 AWG. Smaller conductors may be permissible for control and signal wiring. For wire sizes #10 and above conductors shall be stranded. All motor feeder conductors shall be stranded, including #12 AWG. Refer to code.
- a. Color code all conductors
  - b. 120/208 volt identify:
    - i. Black – A Phase
    - ii. Red – B Phase
    - iii. Blue – C Phase
    - iv. White – Neutral
    - v. Green – Ground
  - c. 277/480 volt identify:
    - i. Brown – A Phase
    - ii. Orange – B Phase
    - iii. Yellow – C Phase
    - iv. Grey – Neutral
    - v. Green – Ground
  - d. Voltage drop shall not be more than 3% on branch circuits.

4. Splices and Connections:
  - a. Connect No. 6 and larger wire to panels and apparatus with properly sized, solderless, approved lugs or connectors.
  - b. For splices of wire #10 AWG and smaller use insulated spring wire connectors. For splices of wire #8 AWG and larger, use steel split bolt connectors taped to 150% of insulation value with UL listed electrical tape.
  - c. Flashover or insulation value of joints shall equal that of the conductor. Connectors shall be U.L. listed, rated at 600 volts for general use and 1,000 volts for use within fixtures.
  - d. Wire connectors shall be pressure type 3-M "Scotchlok" with nylon insulator, or approved equal.
  
5. Receptacles: All receptacles must be specified and installed as follows:
  - a. For general use receptacles, use Leviton Industrial Grade #5362I back and side wired 20 amp self- grounding receptacles or equivalent.
  - b. All GFI receptacles shall be tamper resistant and weather resistant 20 amp 125VAC 60Hz.
  - c. Ground fault interrupters must be installed in accordance with the National Electrical Code to include but not limited to the following areas:
    - i. Locker/shower rooms
    - ii. All outlets above countertops with sinks in all school classrooms
    - iii. In tunnels and crawl spaces
    - iv. Within six (6) lineal feet of any water source

- d. All outlets for new construction shall be provided with a properly sized copper equipment grounding conductor.
  - e. Receptacles shall not be used for splicing. Only one wire for phase conductors, neutral, and ground is allowed.
  - f. If a device box is not flush with the wall surface, an arc shield must be provided and installed.
  - g. Where outlets are installed in steel stud type wall systems, provide additional cross bracing, bridging, and/or straps as required to make the outlet completely rigid prior to the application of the wall facing materials.
  - h. All receptacles shall be Ivory in color unless otherwise noted.
  - i. All receptacles in designated pre-school or kindergarten rooms shall be tamper-resistant.
6. Wall Switches.
- a. Wall switches shall be Leviton Industrial Grade #1221-2 back and side wired 20 amp 120/277 volt AC Quiet Switches or equivalent.
  - b. Key switches shall be Leviton Industrial Grade #1221-2L back and side wired 20 amp 120/277 volt AC Quiet Switches or equivalent.
  - c. Two pole, 3-way and 4-way switches shall be Industrial Grade of the same construction.
  - d. Use key operated switches for lights in all student toilets, gymnasiums, corridors, locker rooms, and other locations where subject to student manipulation, or as directed by District Facilities Department.
  - e. Switches shall not be used for splicing.
  - f. If a device box is not flush with the wall, an arc shield must be provided and installed.
  - j. Where switch boxes are installed in steel stud type wall systems, provide additional cross bracing, bridging, and/or straps as required to make the switch box completely rigid prior to the application of the wall facing materials.
  - g. All switches shall be Ivory in color unless otherwise noted.
7. Device Plates.
- a. All device plates must be stainless steel.
  - b. Device plates must be installed flush with wall surface and cover entire box and cutout. Oversized device plates are permissible as needed.
  - c. Install device plates as required for all device boxes and blanked outlet boxes.
  - d. Contractor shall obtain written approval from District COTR for the material, finish and color of any exposed conduit or wire mold in occupied spaces.
8. Indoor Surface Mounted Raceways and Power Poles.
- a. Surface mounted raceways or power poles shall not be used for new construction unless approved by District COTR.

- e.
- b. The use of surface mounted raceways and power poles shall be permissible for remodel and renovation projects subject to review and approval by District COTR.
- c. When approved, interior surface mounted raceways for power and data shall be Wiremold 4000 or equivalent Ivory colored metal dual channel raceway.
- d. When approved, single channel surface mounted raceways for power only shall be Wiremold 700 or equivalent Ivory colored metal.  
When approved, power poles shall be Wiremold or equivalent Ivory colored metal with divided channels as required for specific installation.

9. Motors.

- a. Specify clearly that all motors furnished on all Contractor-furnished equipment shall be single phase 120 volt or single phase 208/220 when under ½ H.P. and shall be three phase for ½ H.P. and larger, unless otherwise specifically approved by the District Facilities Department. Use Variable Frequency Drives (VFD) for all motors where appropriate. All motors shall be “high efficiency” type and shall be Energy Star rated.
- b. Motors will be furnished under other sections of the work, but shall be wired under this section of the work. Motors shall be of sufficient size for the duty performed and shall not exceed their full rated load when the driven equipment is operating as specified capacity under the most severe conditions likely to be encountered. Motors shall be open type, drip-proof, splash proof, totally enclosed, explosion proof or submersible as applicable, with insulation required for the type of motor and for continuous duty based on a 40° C temperature rise. Motors shall conform to design, construction, and performance requirements of the latest edition of The Rotating Electrical Machinery Standard of the American Standards Association. Call for overload protection at all motors ½ H.P. or larger. Utilize high efficiency motors with minimum efficiency as follows:

Horsepower	TEFC	ODP
5	89.5	88.5
7.5	91.0	90.2
10	91.0	90.2
15	92.4	90.2
20	93	91.0

- c. Provide phase loss protection for all 3 phase motors.
- d. All three-phase motors shall be specifically designed for 480 or 208 volt service, as applicable, to operate satisfactorily on ± 10 percent voltage variations and with an increased service factor. Nameplates shall be placed on the motor by the manufacturer at the factory. Motors shall carry code letters as per Section 430-7 of the National Electrical Code.
- e. Line voltage to motors finished and installed by the general, mechanical, and electrical contractors should be connected by the electrical contractor, and control voltage should be connected by the mechanical contractor. See Section 16900, Controls.

10. Starters.

- e.
- a. All starters, pushbutton stations, and pilot control devices should be of one manufacturer. This requirement is to apply to all equipment furnished by the general contractor, the electrical and mechanical subcontractors. Contractor must submit shop drawings to reflect this requirement.
- b. Starters shall be as manufactured by General Electric, Cutler Hammer, Allen-Bradley, Square D, or Furnas.
- c. Controller rated in horsepower with Class 10 overload relay, red pilot light, and toggle operator.
- d. Magnetic motor starter shall be NEMA ICS-2, general purpose, Class A, rated in horsepower, 120 volt coil operating voltage with thermal overload pushbutton operator and pilot lights in cover. Thermal overload relays shall be block type with built-in heaters and adjustable dial or dip switch.  
Variable speed drive (VFD) manufacturers must be ABB, AC Tech, Allen-Bradley, Safetronic, or as approved by Owner.
- f. VFDs shall be fully programmable and shall be equipped with manual bypass.

11. Access Panels:

- a. Access panels shall be provided and installed in locations where electrical equipment must be accessible for maintenance and as required by applicable codes.
- b. Access panels should be minimum 24" x 24" unless otherwise approved by District COTR.
- c. Access panels shall be fire-rated where applicable.
- d. Access panels shall be painted with DISTRICT 11 "Ironstone White" paint unless otherwise noted or approved.

D. SERVICE AND DISTRIBUTION

1. Service and Distribution.

- a. Submit preliminary design study for new electrical service and/or remodeling of existing distribution equipment. Submit recommendations regarding electrical system for an addition to an existing building.
- b. Single meter service for lights and power to be used on all new projects.
- c. For an addition to an existing building, include statement in specifications to the effect that services to the existing building are not to be disrupted during regular school use. Work shall be scheduled so that service disruption occurs only during school holiday and vacation periods. The Owner shall be advised in writing at least seven (7) days in advance of any such disruption.
- d. Examine area and conditions under which switchboards, panelboards, and enclosures are to be installed and notify Owner in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- e. Identification: Provide lamecoid labels for each branch device identifying load served on main switchboard. The switchboard shall have a lamecoid label including name, voltage, phase, and short circuit rating.

- e.
  - f. Provide a typed panel schedule for all new panels. Identify circuit number and location.
  - g. Provide and install a new accurate typed panel schedule when breakers or circuits are modified or changed for any reason.
2. Electric Service.
- a. Owner will contract directly with the local utility provider for underground primary feed or any change necessary into transformer at pad or vault. Contractor's work will start at transformer pad or vault on all new construction.
  - b. Engineer will consult with the local utility provider to determine the most economical and feasible means (if required) of changing existing aerial to underground primary power to the building transformer pad or vault and estimated cost.
  - c. Route service feeder underground from utility company overhead lines to transformers and service equipment. Provide cable markers to identify route of underground lines. All underground cables to be in waterproof conduits protected from corrosive action by soil. Pad-mounted transformers preferred, or transformers located on poles off school property. If transformer vault is considered, provide first floor or grade location with exterior access. Vault shall be fire-resistive and locked. Use non-flammable liquid-filled transformers.
  - d. Coordinate and establish ownership of various services with Owner and Utility Companies.  
Provide for interconnection of power meter to BAS, including specifications for pulse boards or other gear for signal interface.
  - f. Secondary voltage to be selected on basis of function and economy. Four-wire wye service preferred. Coordinate variations in nominal 277/480 volt, 3-phase, 4-wire wye connected service voltages with specified electrical equipment voltages.
3. Distribution Switchboard.
- a. Main Distribution Switchboard. Provide free standing, floor-mounted, breaker-type distribution switchboard. Location to be indicated on the drawings.
  - b. Install on a 4" concrete platform.
  - c. Load centers are not acceptable.
  - d. Unit shall be completed, fabricated by the manufacturer, shall be of the dead front design, entirely front connected and designed for minimum assembly in the field.
  - e. Switchboard shall have provisions for the addition of future sections.
  - f. Only bolt-in breakers are acceptable.
  - g. Interior bussing shall be copper.
  - h. The main cross bus shall be full-sized throughout. Internal cabling will not be permitted. Main and branch switch quantities, frame sizes and number of poles shall be indicated on the drawings.
  - i. All switches shall be bolted to the bus bars.
  - j. Switchboard shall be as manufactured by Square D, General Electric, Siemens or equivalent listed by Underwriters' Laboratories. Ground bus shall extend the entire length of switchboard.
  - k. Coordinate fault protection with short-circuit current available. Consider use of current limiting fuse, combination hi-interrupting capacity fuses with molded case breakers, etc.

- e.
- l. At the main distribution center provide space for one 200 ampere and one 400 ampere spare switch or breaker for future expansion, include additional bussed space at MDC. Design room to allow one additional section of switchgear as a minimum. Size and configure room considering code required exiting issues from the Electrical Room.
- m. Service shall be designed to have a power factor of 0.95 or greater without use of capacitor banks.

4. Disconnect Safety Switches.

Safety switches shall be heavy duty rated quick-make, quick-break, load interrupter knife switch with externally operated handle and enclosure. Switches shall be fused or non-fused as called for on the drawings. The handle shall be capable of locking in the OFF position. The enclosure shall be rated as suitable for the environment in which it is installed. Approved manufacturers shall be Square D, General Electric, Siemens or equivalent.

5. Fuses.

- a. Fuses, except control circuit fuses, shall be dual element, Fusetron as manufactured by the Bussman Manufacturing Co. or approved equal.
- b. The Electrical Contractor shall furnish and install one complete set of fuses for all fuse holding devices sized in accordance with associated motor and/or conductors to be protected.
- c. Specifications should require the Contractor to furnish Owner a minimum of one spare for each size installed, and a cabinet for spare fuses to be located near the Main Distribution Panel.

6. Branch Circuit Panelboards.

- a. Provide circuit breaker type panelboards with main breakers where required. Number and size of fullwidth, thermal magnetic bolted branch circuit breakers shall be indicated on drawings.
  - b. Panelboards are to be flush-mounted wherever possible. Install panels up to 6'-8" ( $\pm 2"$ ) to top of trim.
  - c. Arrange number of disconnects to reflect maximum economy (including future load requirements) and requirements of the most recent edition of the National Electrical Code.
  - d. Where panel switching is used, do not feed fans, pumps, heating equipment controls, etc., from the same panel enclosure; i.e., breakers that control equipment which should remain "ON" shall be behind a separate hinged door.
  - e. Provide panel schedules on drawings (not specifications) showing breakers, sizes, poles, wire size load and feeder sizes.
  - f. Panelboards shall be Square-D, General Electric, Siemens, or approved equivalent with bolt-in breakers. Breakers and panelboards should be consistent throughout building or addition.
  - g. Panelboards shall have door-in door type hinged covers and shall be keyed alike. Panelboards are to be constructed of code gauge galvanized steel with factory applied enamel finish. Fronts shall have adjustable trim clamps and directory frames.
  - h. All panelboards shall have copper bus bars throughout. Provide separate ground bus in all panelboards.
  - i. All electrical panel locations shall be shown on the as-built drawings. Include schedule of each panel on drawings.
  - j. All panelboards and feeders shall be oversized to allow an increase of 25% over connected loads.
  - k. Two and three pole breakers shall have common trip and single operating handle.
  - l. Provide one spare 3/4" conduit for every four unused poles in all flush-mounted panelboard--extended from panelboards to an accessible point beyond the area of finish wall or ceiling construction and cap.
  - m. Identify panelboards in accordance with identifications on main distribution switchboard.
  - n. All electrical cabinets shall have locking hinged covers. All locks shall be keyed alike.
7. Where a single disconnecting method is required within the room for Technical Arts, Homemaking, Science Laboratories, etc., to cut off power to equipment, consider the use of a mushroom button located within the room. Provide a pilot light, which is illuminated when the main switch is on. Lighting, heating and ventilating equipment or other horsepower requirements should not be disconnected with this switch.
8. Grounding:
- a. Ground rods shall be copper clad steel not less than 5/8" in diameter, 8' long, driven full length into earth.
  - b. Ground bushings shall be rated for application.
  - c. For new installations, conduits of any kind shall not be used to provide the equipment grounding path. A properly sized equipment grounding conductor shall be installed with each conduit.
9. Transformers:
- a. Dry type.
  - b. Transformers feeding computer panels shall be K rated.
  - c. 3-phase, 60 cycle, 480 volt primary, 120/208 or 120/240 volt secondary with grounded neutral.
  - d. Others considered, contact CSSD COTR.



E. LIGHTING

1. Lighting must be consistent with the District's energy-conservation lighting program and standards. All lighting design and product specifications shall be reviewed and approved by District 11 Electrical Shop and Energy Manager.
2. Background.
  - a. The District energy management program is aimed at reducing energy consumption. Design teams and Contractors shall be required to continue the intent of this program in all new buildings, additions and remodeling.
  - b. Power consumption for lighting only shall be limited to a maximum of one (1) watt per square foot of gross building area.
  - c. Standardization of lamps and ballasts throughout the District has been another aim of this program. Design teams and Contractors shall specify and utilize materials consistent with District standards.
3. Suggested Illumination Levels. 0.15 FC (foot candles) from natural lighting sources.

Note that the illumination levels listed here are below Illuminating Engineering Society recommendations, but are consistent with recommendations of the Colorado Department of Health. These levels have been used successfully in the lighting design done in the School District's recent Lighting Modernization Program. Specific recommended levels at desk height:

- |  |  |
|--|--|
| a. Entries - 10fc  | g. Offices – 30fc  |
| b. Classrooms: <ol style="list-style-type: none"><li>a. Arts (Art/Kiln) – 50fc (dimnable)</li><li>b. Music – 30fc</li><li>c. General – 30fc</li><li>d. Science – 50fc (dimnable)</li><li>e. Shops – 100fc (dimnable)</li><li>f. Study Halls – 30fc</li></ol> | h. Gymnasiums: <ol style="list-style-type: none"><li>a. Elementary / Middle School – 50fc</li><li>b. High School – 75fc</li><li>c. Locker rooms/restrooms – 30fc</li></ol> |
| c. Stairwells/Corridors – 10fc   | i. Restrooms – 30fc  |
| d. Kitchens: <ol style="list-style-type: none"><li>a. General – 30fc</li><li>b. Food Prep – 50fc</li></ol>   | j. Auditoriums: <ol style="list-style-type: none"><li>a. As a classroom – 30fc</li><li>b. House lighting – 10fc</li></ol>  |
| e. Library – 30fc  | k. Workrooms/Lounges – 30fc  |
| f. Computer Lab – 30fc   | l. Natatorium – 35-40fc  |
- Max:Min ratio = 1 – 2.75  
Avg:Min ratio = 1-2

4. General Considerations in Lighting.
  - a. Fixtures in gymnasium and general multi-purpose rooms shall be specified with acrylic lenses, guards, and safety chains. Consideration shall be given to re-lamping procedures.
  - b. Exterior Lighting.

- i. Exterior lighting specifications must be reviewed and approved by District 11 Electric Shop and Energy Manager.
- ii. All circuits for outside lighting, including marquee signs, shall have a photo cell and an electronic time clock combination to control the lighting circuit. Electronic time switch shall not rely on batteries for backup power. Time switch shall be Tork E-Series model #EWZ201C Hour Digital Time Switch or approved equal.
- iii. Exterior site lighting shall not exceed 30 feet in height to top of the pole mounted luminaire and not more than 20 feet if there is not direct access underneath the luminaire.
- iv. Concrete bases for exterior pole mounted lighting shall be steel reinforced with a #6 copper bare grounding wire to bond the concrete reinforcing steel to the steel pole mounted on the concrete base.
- v. All exterior light poles shall be steel, bronze in color.
- vi. Parking lot light poles or any other exterior light poles shall have a steel reinforced concrete base that is 30" above grade if they are located within a parking lot area or within 36" perimeter outside of the edge of the parking area. The depth, diameter, and burial requirement for light pole bases shall be determined by the manufacturer of the light pole or a structural engineer.
- vii. All exterior lighting installations shall meet the most recent requirements of the Colorado Springs Guidelines pertaining to terrestrial lighting standards.
- viii. Exterior building mounted fixtures (wall packs) shall be easily accessible for maintenance and re-lamping. Preferred height approximately 12' above grade. Maximum height 20' above grade.
- ix. Provide lighting as required for visibility and security in parking areas, walkways, from parking to building.
- x. Protect exterior lights from vandalism by use of vandal proof materials, guards, etc.
- xi. At athletic fields, provide LED lighting with 50 FC measured at four feet above the playing surface with a maximum to minimum ratio of 2.5:1. Arrange lights so that any number may be turned on as desired. All wiring shall be underground and in conduits. Mount lights on poles of sufficient height to be higher than 30 degrees above a point 1/3 the distance across the field. Where the athletic field is also used for soccer the lighting design criteria should be 50 FC horizontal with a maximum to minimum ratio of 2:1.
- xii. Provide for lighting behind exterior CCTV cameras to provide illumination without glare to the camera lens.

5. Interior Lighting:

- a. Corridor lighting which is not on the emergency light circuit shall be controlled by an occupancy sensor and a keyed workman switch. Coordinate sensor locations with owner.
- b. In special areas such as instrumental music rooms where higher light intensities are required use LED fixtures.
- c. Provide emergency and exit illumination in accordance with latest edition of International Building Code. LED exit fixtures are required. Provide exit lights at stage (platform), kitchen and all exterior exits. Provide additional emergency lighting in interior classrooms or classrooms without windows or skylights.
- d. Provide wire guards on exit lights in gyms, multipurpose rooms, and locker rooms.
- e. Non-powered exit lighting shall not be permitted in any District facility.
- f. Provide gasketed lens type LED fixtures in kitchen storage, walk-in coolers, exhaust hoods, locker rooms and shower rooms.

- g. Provide lighting in crawl spaces and at access hatches. Lighting to be LED type with shielding or wire guards.
  - h. Mounting heights and methods should discourage vandalism. Fixtures should not be in locations where students can jump and hang or swing from the fixture.
6. Lighting Controls:
- a. Classroom and/or Office dimmers will be considered an add additional or add alternate based on the request, review and approval of the CSSD #11 Electrical Shop and the Energy Manager.
  - b. Corridor and/or Classroom/Office occupancy sensors will be considered an add additional or add alternate based on the request, review and approval of the CSSD #11 Electrical Shop and the Energy Manager and if added/used will meet the following criteria:
    - i. Classroom occupancy sensors will dim to off after fifteen (15) minutes of non-use detection.
    - ii. Hallway occupancy sensors will dim from 100% to 20% after fifteen (15) minutes of non-use detection.
    - iii. Hallway occupancy sensors will dim to off after two (2) hours of non-use detection.
7. Requirements for Interior Luminaires.
- a. General:
    - i. Luminaires shall have manufacturer's standard finish unless otherwise noted. Provide "Damp Location" label where required.
    - ii. Recessed or semi-recessed luminaires shall be designed to be compatible with ceiling in which installed.
    - iii. Luminaires requiring caps, mounting spaces, hold-down clips or accessory items shall be furnished complete with same, whether the catalog numbers shown include such items or not.
    - iv. Luminaires shall be wired with type A or AA wire. Type AA shall be used where recommended by luminaire manufacturer. Minimum size shall be No. 16. Use larger wire where indicated or where recommended by luminaire manufacturer.
    - v. LED luminaires shall be connected with flexible metal conduit in accordance with the most recent NEC standards.
  - b. LED Luminaires:
    - i. Luminaires that do not utilize an optical reflector shall have metallic surfaces protected with rust-inhibiting white baked enamel. Reflective surfaces shall have minimum 85 percent reflectance, white enamel, high temperature baked. Provide all wiring channels, internal barriers, reflectors, etc.
    - ii. Lens or louvers shall be as called for on schedules. Where acrylic diffusers are specified diffusers shall be virgin acrylic, 0.125 inches thick minimum.
    - iii. Lense cover shall be capable of hinging from either side and gasketed to prevent leakage of light around doorframe edges.
8. Lamps.

- a. Acceptable LED manufacturers: Lamps shall be as manufactured by Acuity Brands, or subsidiary as agreed, Keystone, RAB, General Electric, Osram/Sylvania, Philips, or approved other. Provide for low-mercury content legally disposable lamps, including Alto Series 80.
  - b. LED lamps: Do not schedule or specify any incandescent lamps or fixtures, CFL, or fluorescent fixtures and/or lamps.
  - c. LED lamps: Shall be CRI 80%, 4000K, for interior use and CRI 80%, 3000K for exterior use, unless otherwise noted.
9. Warranties: Fixtures shall be covered by a minimum ten (10) year warranty against defects in workmanship and materials. Warranty shall include in-warranty service program for payment of authorized labor charges for replacement of inoperative, in-warranty fixtures.

#### F. EMERGENCY STANDBY POWER GENERATOR

1. General.
  - a. Emergency power is required by the State of Colorado under the provisions of local or national codes.
  - b. The acceptable method of supplying standby power is an engine generator set.
  - c. Electrical engineer should submit complete Generator Design Analysis.
  - d. Provide emergency standby power for all schools. Engine type and fuel to be coordinated with available on-site fuel to provide greatest economy and reliability: Natural gas is preferred.
  - e. Generator set should be fully caged for safety and to prevent vandalism, when located outside.
  - f. Generator set should incorporate means to automatically exercise engine on a regular basis.
2. Emergency standby power source should serve the following type loads, with space capacity for future growth:
  - a. Exit lighting
  - b. Emergency lighting: where required in corridors, auditoriums, gymnasium, cafeteria, engine generator room, etc.
  - c. Civil-defense signals and controls.
  - d. Engine-generator derangement signals.
  - e. Telephone power.
  - f. Intercom power.
  - g. Heating water circulation pumps.
  - h. Boiler.
  - i. Building Automation System (BAS).
  - j. Server/MDF and IDF closets.
  - k. Fire Alarm control panel, amplifiers, remote power supplies and other related fire alarm components served by 120VAC except for fail safe devices (ie magnetic door holders, fire/smoke dampers, etc)

#### G. COMMUNICATIONS

1. Coordinate with District Technology, Facilities, and Instructional Departments for specific requirements.

In general: Layout, design, specify, coordinate, and/or otherwise make provision for the following communications systems:

- a. **Fire Alarm System**
  - b. Security System
  - c. Automated Temperature Monitoring and Control System
  - d. Telephone System
  - e. Computer and Technology System
  - f. Intercommunication System
  - g. Public Address System
  - h. Television System
2. **Qualifications of Systems Subcontractors.** The following are suggested as minimum qualifications for systems subcontractors doing work under each part of this Section:
- a. The systems subcontractor must employ factory-trained technicians and maintain a service department within 100 miles of District facilities.
  - b. The subcontractor must have available as a reasonable optional service; 24 hour call standby.
  - c. The service organization must be able to respond to a normal emergency call within four (4) working hours.
  - d. The service organization must maintain all the required spare parts to service any problem within the equipment, on the local office level.
3. **Testing and O&M Manuals.**
- a. The manufacturer's representative shall provide to the owner's representative, documentation of the final testing and verification of system operation and compliance with the specification on acceptance of the system.
  - b. **Operation and Maintenance Manual:** Furnish the Owner two (2) Operation and Maintenance Manuals. Manuals shall be bound in standard size, three-ring, loose leaf plastic binder with contents title. Manuals shall include complete catalog cuts, wiring diagrams, operations, and maintenance instructions.

## H. **FIRE ALARM SYSTEM**

### 1. **Description**

- a. Installation of a complete Life Safety System for Fire Control, Evacuation, and Dedicated Emergency Communications. For remodel projects the system shall be zoned per plans, electrically supervised, connected, tested, and left in first class operating condition. For remodels and additions, the system shall be addressable and networkable. All equipment shall comply with applicable standards of U.L., NFPA, and local authorities having jurisdiction. Conform to the requirements of the Americans with Disabilities Act (ADA) for audible-visual horn-strobe units. Visual indication units shall be provided in all instructional areas and in all room accessible to students and or parents.
- b. Location of the controls, alarm actuating devices, and audible-visual alarm signaling devices shall be shown on the plans.
- c. Incorporate any legal requirements for Civil Defense switches or sirens.
- d. All FAS designs shall be submitted to and reviewed by CSFD or the authority having jurisdiction. Contractor must provide required shop drawings and obtain all applicable permits and inspections.

- e. All FAS installations (new and modifications) must be reviewed, permitted, and inspected by the authority having jurisdiction.

**2. Project Criteria**

Work in this Division is to be performed by a single source specialized individual or firm for project meeting the following criteria:

- a. New construction and building additions, regardless of contract amount.
- b. Renovation/remodel involving more than 5,000 gross square feet.
- c. HVAC, plumbing, electrical and communications projects involving more than 100 square inches of penetrations of fire-rated walls, floors or ceilings.

**3. Default Standards**

In the absence of other information, standards of the following organizations apply: Underwriters Laboratories Fire Resistance Directory, current edition.

**4. Products**

Furnish Simplex 4100 ES Series fire alarm systems as necessary for the installation.

- a. Control Panel: Panel components shall be completely pluggable and solid state. All lamps on control panel shall be visible through door. Panel shall have adequate power supply to power all smoke detectors, speakers/strobes, lamps, and applicable magnetic door closers/holders. The Fire Panel must be coded to permanent classroom numbers (not architectural plan numbers), provided by School District. The Fire Alarm Control Panel (FACP) shall contain, but not be limited to, the following components:
  - i. Common Control Module
  - ii. One (1) set of dry contacts to activate on "alarm" and one (1) set of dry contacts to activate on "trouble".
  - iii. Addressable Signaling Line Circuit Modules
  - iv. Interface to existing circuitry (where applicable)
  - v. Relay Module
  - vi. Addressable Speakers and Addressable Strobe Light Circuits
  - vii. Simplex SafeLINC Module
  - viii. Battery Backup
  - ix. Enclosure
- b. Annunciation and Initiating Devices:
  - i. Manual Fire Alarm Station: Double action station: A downward pull of the lever shall activate the system. The lever shall remain in the down position until the station is manually reset by a special key. Stations to be semi-flush mounted where shown.
  - ii. Smoke Detectors: Photo-electric type, 24VDC operation, complete, with necessary auxiliary contacts for remote indication or door closer operation Detection shall be provided throughout all egress corridors, outside elevators, and in rooms with special hazards or high value equipment.

- iii. Audiovisual Unit: This device shall meet the requirements of the ADA for light output and sound level and provide visual alarm indication as well as audible in a common enclosure. Unit shall have a 24VDC Xenon flasher. The audible device shall operate on 24VDC. In some locations, visual only indication units shall be permitted when the audible levels are adequate but the visual indication is not Audible Notification shall utilize addressable speakers. Strobe lights shall be addressable and be clear in color for Fire Alarm signaling and Blue for lockdown notification. Strobes shall be synchronized in a uniform flash pattern to prevent individuals with photosensitive epilepsy from potentially experiencing seizures due to unsynchronized strobes.
  - iv. Duct Smoke Detectors: Detector shall operate on same voltage and principle as described for ceiling mounted smoke detectors. Detector shall be addressable and integrated directly into the Fire Alarm System. Duct detector test switches shall be located in hallways or closets (not restrooms or classrooms) and should be mounted at an accessible height.
  - v. Remote Indicator Lamps: Required for all duct-mounted detectors. All remote indicator lamps mount on a single gang box by EC. Install in locations to be visible by building personnel. Lamps to indicate when detector is in the alarm condition. Only one lamp will be required to annunciate an alarm per each mechanical loft. Provide plastic laminate nameplate(s). Remote indicator lamps must be accessible in hallways or closets (not restrooms or classrooms).
  - vi. Exterior Horn and Lamp Assembly: Unit shall be approved for weatherproof mounting. Unit shall contain an addressable, audible signaling device and a flashing light in a common enclosure.
  - vii. Thermal Detectors: Detector shall operate on the rate-of-rise principle. A temperature increase of 15° F or greater within one minute will cause an alarm.
  - viii. Fixed Temperature Detectors: Detector shall operate on fixed temperature principle set at 195° F.
  - ix. Carbon Monoxide (CO) Detectors shall be addressable and installed at every location of a gas-fired appliance or boiler as required by State Health Code and other applicable codes. District 11 also requires installation of a CO detector in each kiln room even if the kiln is electric, because there is CO generated during the actual clay firing process.
  - x. No equipment shall be installed in restrooms or locker rooms other than required devices.
- c. Other Requirements
- xi. Door Closer/Holder: Magnetic door closers supplied by others shall be wired by EC. These shall be 24VDC units. Power and control from fire alarm system.
  - xii. Remote Graphic, Custom: Annunciator shall depict building layout and Fire Alarm initiating devices. Orient layout with respect to mounting location, easily available to Fire Department.
  - xiii. All wiring shall be installed in metallic raceways, except in areas of high humidity with the potential for severe corrosion, such as pool mechanical rooms.
  - xiv. Lockdown Notification Initiation Duress/Panic Switches: Switch shall be addressable and located adjacent to every Manual Fire Alarm Station as well as inside each classroom and at the school/building reception desk. Additional switches may be added at various locations, such as key offices or staff lounges, based on site-specific requests from school administration and approved by District COTR.
- d. System Operation.
- i. Fire Detection and Control:

1. Each annunciation and initiation device shall have a unique address and be identified at the FACP and every remote annunciator.
2. Actuation of a UL-approved alarm initiating device shall, at both the fire alarm control panel and remote annunciator:
  - a. Light the respective red zone alarm LED. This LED will remain lit until the actuating device is restored to normal and the system is reset. Addressable systems indicate the address and description of the device in alarm.
  - b. Cause the respective red zone alarm LED to flash. This LED will continue to flash until the alarm acknowledge switch is actuated. Once acknowledged, the zone LED will be constantly illuminated until the actuating device is restored to normal and the system is reset.
  - c. Evacuation:
    - i. The audible alarm signals will sound continuously throughout the entire facility. When an alarm condition occurs, a fire alarm evacuation signal shall be transmitted over the horns (or speakers) and the visual signal shall flash until reset. The tone from a horn shall be a code-3 slow whoop sweeping from 800Hz to 1200 Hz. The programming of volume and audibility from either horns or speakers shall comply with all applicable codes.
    - ii. Should subsequent alarm actuation of a different zone occur, the alarm devices will sound until silenced or the main control panel is reset.
    - iii. The systems shall be capable of automatically transmitting fire information to the Owner Security Office and/or a contracted central monitoring station, as designated by the District. Dry contacts (normally closed, which open on alarm or trouble conditions) are needed for "alarm" and "trouble" conditions.
    - iv. There shall be an adequate quantity of auxiliary outputs to provide interfacing to HVAC, smoke dampers, security, and door controls as required per plans and specifications.
    - v. Each alarm initiating circuit, horn circuit, and battery voltage shall be supervised.
    - vi. Any disarrangement of system wiring, such as loss of power, opens or grounds, shall activate the audible and visual "trouble" indicators. Actuation of the trouble acknowledge switch shall silence the audible trouble indicator, but the trouble LED will remain lit. A subsequent trouble will reactivate the audible trouble indicator. The trouble LED shall be noncancelling, except by an actual clearing of the trouble condition.
    - vii. Power for operating DC smoke detectors will be obtained from a supervised power supply within the main fire alarm control panel, or if applicable from remote annunciator panels.
    - viii. The control unit shall drive its primary operating power from a 120VAC single phase 60Hz supply. There shall also be a 24V-battery standby power source capable of operating the entire system for a period to 24 hours in a supervisory mode and then be capable of operating the alarm devices for a minimum of fifteen (15) minutes.



**5. Installation**

- a. The system shall be installed in accordance with applicable section(s) of NFPA 72, NFPA 720, and other State and local codes. All final wiring and connections shall be in strict accordance with the manufacturer's wiring diagrams.
- b. The Contractor shall furnish and install in accordance with the manufacturer's instructions, all wiring conduit and the outlet boxes required to complete the system as described herein and as shown on the plans. All wiring shall be in red conduit and shall meet national, state, and local electrical codes.
- c. Wire size minimums shall be specified by the manufacturer and shall be free of defects, shorts, and grounds before connection to the control panel as shown on the shop drawings.
- e. All required outlet boxes shall be shown on the shop drawings and shall indicate size, type, and supplier, and shall be used with no variances except by written approval of the manufacturer and the engineer.
- f. Systems connections will be verified by the manufacturer's representative before applying power to the system for final check out.
- g. Fire alarm wiring is to be installed in completely separate conduit and outlet system, divorced from any other wiring system.
- h. Coordinate voltage of damper motors, fire alarm flow switch, etc., with fire alarm system.
- i. Duct detectors shall be located where required by NFPA 90A. Mechanical Contractor shall locate and install detectors; Electrical Contractor shall provide all wiring including fire alarm wiring. HVAC shutdown wiring to conform to local codes by Mechanical Contractor.

**6. Thermal and Moisture Protection**

- a. Specify Underwriters Laboratories fire rated assembly designations in the contract documents
- b. Firestops are required at every construction joint and penetration in fire rated assemblies.
- c. Sprayed cementitious fireproofing as required per IBC.
  - i. Minimum bond strength per ASTM E736: 200 psf
  - ii. Air erosion per ASTM 859: 0.00 grams loss
  - iii. Surface Burning per ASTM E84: Smoke = 0, Flame = 0, Fuel = 0
  - iv. Use W/D ratio to determine application thickness
- v. Remove paint, lubricant, compounds and other contaminants from substrate metal as recommended by the fireproofing manufacturer to assure specified bond strength.
- vi. Mineral fiber fireproofing is prohibited.

**7. Inspection**

Owner reserves the right to perform a separate commissioning inspection and/or retain the services of an independent testing agency to inspect, sample, and confirm compliance with work in this section.

**8. Owner Training**

Coordinate with Owner and Owner's designated representatives to provide owner training and instruction for use and maintenance of installed systems.

**9. Submittals**

**Required** a.

Product Data

- b. Shop Drawings or schedule
- c. Manufacturer instructions and Field Reports
- d. Provide the minimum required documentation per NFPA 72 2019 chapter 7

**10. Closeout**

All submittals listed above updated to record status

**I. SECURITY SYSTEM**

Design Team and Contractors shall provide for all power and conduit needs for integration of security systems which are typically furnished and installed by the District's Security Services vendor. All security equipment including the BAS should be on emergency power circuits.

Basic guidelines for design consideration include exterior, interior openings and interior motion detection. All exterior doors will be protected with surface mounted door contacts. These contacts will be Sentrol 1045t switches, and grouped in zones for specific areas of the facility. Interior areas such as main administrative areas, computer labs, or other sensitive areas, should be considered for protection. Interior motion detection will cover main corridors, administrative areas, and computer labs. The motion detectors shall be C&K Dual Tec. Devices. The model numbers shall be dictated by the coverage requirements. Control equipment will be specified by the owner at the time of initial design.

Coordinate design and development of systems and technologies with DISTRICT 11 Security Office and COTR.

**J. AUTOMATED TEMPERATURE MONITORING AND CONTROL SYSTEM**

Refer to CSSD 11 Design & Construction Standards Division 15 Section M for HVAC system controls.

**K. CLOCK SYSTEM**

All clocks for classrooms and other designated spaces shall be American Time & Signal Model #E56BAND301BP 12" Slimline Black Atomic Clocks. Clocks for Gymnasiums shall be American Time & Signal Model #E66BAND301BP 15" Slimline Black Atomic Clocks.

**L. TELEPHONE RACEWAY SYSTEM**

**1. General.**

- a. Coordinate with District Communications and Technology Departments. Voice over IP required.
- b. Work Included: Call for the Electrical Contractor to provide all telephone raceways, outlet boxes, blank device plates, and terminal cabinets, and show locations on the drawings. Consult with the telephone company, and comply with their requirements and local codes.
- c. Verify requirement with local Fire Department regarding extension of telephone conduit for emergency service at a specified location at front of building or to a fire alarm box.

**2. Installation.**

- a. Conduit runs of less than 100 feet from point-to-point shall not contain more than two 90° 24" radius bends. Conduit runs exceeding 100 feet from point-to-point or exceeding two 90° bends shall contain accessible pull boxes. Conduit runs shall not contain oval or square fittings. All feed conduits to

telephone terminals shall enter top or bottom on extreme right or left side. Provide plastic pulling string in all raceways over 50 feet. Provide blank covers for all boxes.

- b. Design and provide rooms for the Main Distribution Frame “MDF” and the intermediate distribution frame “IDF” to service both the telephone and computer hub needs. Coordinate with DISTRICT 11 Communications and IT Departments.

#### M. COMPUTER AND TECHNOLOGY SYSTEMS

Design Team and Contractors may be required to provide conduit, raceways, or boxes for cabling and equipment to be provided by others under separate contracts. Coordinate with DISTRICT 11 COTR, Communication, and Technology Departments.

#### N. INTERCOMMUNICATION SYSTEM

##### 1. Scope.

- a. Coordinate requirements with the District’s Communication and Technology Departments for specification and provision of electronic communication and sound distribution systems.
- b. In general, this system shall provide emergency announcement, two-way intercommunication, provisions for background music, and distribute class change signals throughout the facility.

##### 2. Equipment.

- a. Consult with the Owner for equipment to be specified.
- b. The system shall feature function identified, color keyed illuminated pushbuttons with associated color guidelines. Step-by-step operating instructions shall be printed directly on the front panels of the control units.
- c. The system shall consist of the following: A sound and communications center (equipment rack), classroom speakers, other remote speakers, call-in switches, and all associated material, hardware, and wiring necessary for a completely installed and operating system which meet the specified requirements.
- d. Ease of operation by the average user should be a prime consideration.
- e. The Sound and Communications Center should incorporate one program channel and one intercom channel, and should be manufactured, assembled and tested by the factory.
- f. The Channel Master Control Panel shall feature functions identified, color keyed, illuminated pushbutton switches with associated color guidelines. Emergency and normal operating procedures shall be permanently printed on the front panel. The panel shall be solid state and shall provide a built in microphone, all-rooms and selected-rooms program transmit pushbuttons, remote emergency telephone facility, output level indicators, and automatic output level control. Panel shall contain the following:
  - i. Preset Control: Bass and treble tone (boost and cut)
    - Channel output level
    - 3 microphones
    - 4 auxiliary
    - External all call adjust

- Level indicator adjust
- ii. Front Panel Control: 3 microphone selectors
- 4 auxiliary selectors
  - Monitor speaker level
  - 2 program transmit pushbuttons
  - Emergency push button
- g. The Communications Control Panel shall feature function identified, color keyed, illuminating pushbuttons with associated color guidelines. Operating procedures shall be permanently printed on the front panel. The panel shall be solid state providing automatic level control. The panel shall provide automatic supervisory and call in tones. The panel shall contain the following:
- i. Preset Control:
    - Panel level (incoming)
    - Room level (outgoing)
    - VOR sensitivity
  - ii. Front Panel Control:
    - Push-to-talk pushbutton
- h. AM/FM Tuner/Tape and compact disc player. The tuner shall be completely solid state, with full-range tuning.
- i. The front panel control shall include a tuning control, AM/FM switch, tone control, balance control, ON/OFF volume control, and an FM stereo indicator light.
- ii. The cassette tape player shall play standard 1-7/8 IPS stereo cassettes. Frequency response shall be 50 to 8000 Hz with less than 0.3 WRMS wow and flutter. Compact disc player shall be a single disc type.
- iii. The power amplifier shall be completely solid state, and shall be capable of delivering sufficient output for the building, with 25% reserve, with less than 3% distortion from 40 to 10,000 Hz. Balanced or single ended 25 or 70V shall be within 2dB from no load to full load.
- iv. The amplifier shall have protective circuits, including a thermally operated relay and an automatically resetting electronic circuit, to reduce dissipation under overload or short circuit conditions.
- i. The power supply shall furnish 24VDC. The supply shall operate on 105 to 125VAC by use of primary transformer taps. The input shall be protected by an electronics fold back circuit and a resettable circuit breaker. The fold back circuit shall be self-restoring when the overload or short circuit condition is removed.
- j. The equipment should be mounted in a wall-mounted or vertical cold rolled steel rack, welded and bonded to form a solid assembly. Bolted construction not acceptable.
- k. The intercom console shall consist of, but not be limited to the following:
- Rack enclosure
  - Channel "A" master control

- 1 Communications control
- 1 Power supply
- 2 Speaker select panels
- 2 Time cross connect kits
- x Time control relays
- 1 Time program chassis
- x Time program chassis relays
- 1 AM/FM cassette/CD player
- 2 100W power amplifiers
- Tone generator
- Annunciator power supply
- Desk microphone

Allow for calls, announcements, and emergency announcement to be accomplished from handset, desktop, master, or selected stations throughout the school rather than just from the microphone at the central rack.

- l. Remote intercom field equipment shall consist of, but not be limited to, the following:
    - Call-in switches
    - Time-tone enclosures
    - Hallway speakers
    - Backboxes and grilles for gym speakers
  - m. AM/FM Antenna. Call for roof-mounted antenna with necessary mast mounting, guy wires, transformers, lighting arrestors, etc. If possible to piggyback the FM signal off the cable TV system, consider eliminating the rooftop antenna.
  - n. All intercom wiring shall be shielded type, and shall be run in minimum 3/4" conduit.
3. Operation and Performance Requirements.
- a. The system shall provide, as a minimum, the following functions:
    - i. Emergency announcements: At a preset volume level, to all system speakers, regardless of speaker selector switch positions, by the operation of a single, press-to-talk switch and by the use of built in control panel microphone. The switch shall be located on the Channel A Master Control Panel and be color coded (red) with emergency announcement instructions clearly labeled immediately above the switch. The switch shall illuminate when pressed. The emergency operation shall bypass all other control functions and override all other programs.
    - ii. All Call Capability: Transmission of a voice announcement to all classrooms and other speaker locations by the operation of a single switch. The all call switch shall be labeled ALL ROOMS and shall illuminate when pressed.
    - iii. Intercom Capability
      1. Provide simultaneous use of 100W program channel and an intercom channel.
      2. Provide annunciator call-in tone.

3. Adequate power to override high noise level areas such as shops, music rooms, gyms, etc., permitting practical 2-way voice communications.
  4. Automatic volume level, one for talk, and one for listen, to maintain a constant, predetermined sound level on all conversations.
  5. Supervisory tone: Facilities for automatically sounding a supervisory, warning tone signal (beep) over any speaker selected by the central control or an administrative control center, to alert personnel in the room to the call and to prevent unauthorized monitoring (eavesdropping). The warning tone shall repeat at regular intervals.
- iv. Program Capability
1. Separate inputs and preset volume controls for three microphones with preamplifiers and for four auxiliary program sources. Select program sources as follows:
    - a. Reception of either AM/FM radio broadcasts or reproduction of recorded music and other program material from built in tuner/cassette/CD player, and their distribution to any and all speakers.
    - b. Distribution of programs originating at remotely located microphones, with provisions for volume control at the remote location.
  - b. Program source selection shall be accomplished by pressing the appropriately labeled color coded pushbutton switch.
  - c. Built in control center microphone, with external microphone required.
  - d. Distribution of voice announcements from the control center microphone to any or all speakers.
  - e. Selective distribution of program material to any or all classrooms or other speaker locations. One program channel shall be provided.
  - f. Selective distribution of all program material to other speaker locations with adequate reserve panel space for expansion.
  - g. Automatic volume level on all program material shall be maintained at a predetermined level by means of built-in compressor.
  - h. Preset bass and treble controls (boost and cut).
  - i. Permit monitoring of all program material before distribution to the selected speakers.
  - j. Provide dedicated intercom switch for isolated program distribution to the gymnasium, hallway, and exterior speakers.
4. Installation.
- a. All sound system wiring shall be in conduit.
  - b. All horns shall be furnished complete with appropriate mounting hardware to suit installation.
  - c. Coordinate gypboard "tents" for speakers in all fire rate ceiling locations as required.
  - d. Classroom selection shall be arranged sequentially by permanent classroom numbers (not architectural plan numbers), provided by School District.
5. Instruction. At a time designated by the Owner, provide instruction to Owner's personnel on operations and maintenance.

O. PUBLIC ADDRESS SYSTEM

1. Coordinate with DISTRICT 11 Facilities, Communication, and Technology Departments. Show and specify a complete voice reinforcing system in the Gym/Multipurpose room and/or the Cafeteria. The following specific equipment listed is intended only as a guide to equipment which has been satisfactorily used in the past, and is not mandatory.
2. Equipment.
  - a. System components shall consist essentially of a recessed, locked amplifier, with one octave equalizer with microphone compressor, ceiling speakers, microphone, and microphone receptacles.
    - i. Mixer amplifier: TOA #W906, with (4) H31-S microphone inputs (rear), and E01 input (front)
    - ii. Microphones: 2 each: AKG D190E with Switchcraft 13M connectors
    - iii. Floor Stands: 2 each: Atlas MS-20
    - iv. Gym and Cafeteria Speakers: Consider sound sphere type speakers
    - v. Grilles: Soundolier 51-8
    - vi. Backbox: Soundolier Q408
    - vii. Lift Jax: Switchcraft SF Series (school to supply portable amp)
    - viii. Microphone Outlets: Switchcraft G3FS

3. Operation and Performance.

System is to provide:

- a. Sound reinforcement into the Gym/Multipurpose room from either "live" performance, or prerecorded material, such as tapes and compact discs.
  - b. Switches are to be provided on the front panel of the amplifier to allow certain speakers to be turned on or off.
  - c. A speaker location and switching diagram engraved in plastic laminate is to be fastened permanently to the front door of the amplifier.
  - d. Provide for 4 microphone inputs, 1 compact disc player input, and 1 tape player input.
  - e. The Gymnasium PA system shall also accept input from the school intercom system. The ceiling speakers shall be common to the Gymnasium PA system and the school intercom system. Automatic switching shall enable emergency announcements on the school intercom system to override the program on the gym PA system.
4. Installation.
- a. All sound system wiring shall be in conduit.
  - b. Mount amplifier about five feet up; height may be adjusted to course out the in masonry walls. c. Coordinate gypboard "tents".
5. Instruction. At a time designated by the Owner, provide instruction to Owner's personnel on operation and maintenance.

P. TELEVISION SYSTEM

1. Coordinate with DISTRICT 11 Facilities and Technology Departments. In general, this system shall provide raceways for future television system, unless consultation with Owner indicates that a full television cabling system is required, or unless it is determined that this system be integrated with other communications systems.
2. Cable television company will furnish outside signal cable to main TV distribution panel or box. Design Team and Contractor may be required to specify and provide cabling, splitters, amplifiers, outlet boxes, outlet covers, etc.

#### Q. AUDITORIUM SOUND SYSTEMS

1. Sound systems should be consulted on a case by case basis with the District IT Department and the District auditorium manager.
2. Sound systems in high schools shall include but not be limited to the following: a multi-channel mixing console with no less than 32 microphone input channels to include 2 stereo input channels. All channels will have a gain level knob, individual channel 48v phantom power control, tone control, auxiliary output levels of no less than 4 auxiliary outputs with pre and post switchable control, balance or pan control, a mute button, signal and clipping LED indicators, sub master / LR assignment buttons and mute group buttons. The mixing console will have no less than 4 dedicated sub master output faders and no less than 2 matrix outputs. Allen and Heath Series mixers are encouraged.
3. The front of house speaker system should provide even coverage to all fixed seats in the auditorium facility and should be no less than a 3 way speaker system with adequately matched amplification power levels to match manufacturer requirements. Speaker "DSP" systems must be properly configured to limit maximum power output to all speakers within the speaker system to prevent over driving as well as frequency cutoffs matching the manufacture recommendations of all speaker systems.
4. All high school auditorium systems must include no less than 4 auxiliary "monitor" outputs dedicated for on stage use of stage monitors. Powered or "active" monitor speakers are acceptable but not required. All auxiliary outputs are required to have compression and limiting active to protect and limit over driving all stage monitor systems. All auxiliary monitor return sends shall have active and accessible 1/3 octave equalization to facilitate audio correction. Yamaha "wedge" two way type speakers with 15" drivers are the District norm but not required.
5. Systems wiring: All high school sound systems are required to have all microphone inputs and returns or audio console connection located in one "I/O" location at either down stage right or down stage left walls no more than 10 feet away from the proscenium opening with any distributed "face plates" located in areas such as the front of the stage or other locations accessible to "patch" into the main "I/O" location. Patch panel type systems are acceptable but must still allow for the single I/O location for connection. Auxiliary returns to facilitate stage monitors may be line level and may be routed through the main I/O panel in a similar method to the microphone input method only if the system is designed with for use with powered or "active" monitor speakers. If external amplification is to be used with stage monitor systems the "I/O patch panel" must accommodate this properly and use "neutrik speakon" type connections for all powered outputs throughout the entire system. Main returns for front of house speaker systems are not required to route through the main I/O panel and may run directly from the audio console to the DSP at the main amplifier rack. The main I/O panel should include a left and a right program output 3 pin xlr connection to facilitate connection to any portable media services or the district media production broadcast truck.
6. The sound system in its entirety should be powered up and powered down with a switching sequencer and relay control to turn on and off the system without any audible "pops" from individual equipment turning on or off. The sequencer should be able to be turned on at an on stage location near the main I/O panel or



by the audio mixing console and must be key operated. No accessible “toggle” switches or buttons are acceptable. System may only be turned on and off by key access.

7. High school audio systems should include a wireless audio assistance or ADA compliant assistive listening system and be provided with no less than a minimum of 4 ear bud type receivers. If applicable local code requires a higher number be present against the total seating capacity of the auditorium then the greater number applies.
8. All high school sound systems should include a back stage audio “program” monitor system using a 70v or similar type speaker system to all associated back stage rooms and hall or lobby areas. This may include but not be limited to the following: projection or lighting control booths, dressing rooms, green rooms or drama classrooms, associated corridors and any additional nearby classroom that may include band or choir classrooms. All classrooms must include an audio attenuator in line of any associated speaker within that classroom to be turned off or volume lowered. Program monitors should be fed a direct output from the auditorium mixing console using a matrix output. The hallway or lobby “program monitors” should be fed signal from a second matrix output to a separate amplifier from the back stage audio program monitors. The same matrix output may also be wired into the main building PA system for the ability of whole campus program assignment.
9. Communications system, a wired headset communication system shall be implemented in all high school auditoriums. Connection shall use 3 pin XLR “microphone cable” connection and shall be located but not limited to the following locations: down stage left, down stage right, fly system locking rails, follow spot locations / booth, lighting booth, audio booth, and orchestra pit. The District standard is Clear Com type systems that can integrate into our media production services remote broadcast truck. A complete system will include no less than 2 separate communications channels (A & B) to isolate communications to “departments” as necessary. Output or connection locations shall include both the A and B channels on a separate 3 pin XLR connection. System should be provided with no less than 6 headsets, 5 single channel belt packs, and one 2 channel belt pack. Communications system should be supplied a “program” audio signal from the auditorium sound system to a dedicated “program audio” input with in the communications system.
10. Discussion of digital audio systems is encouraged but not required.

## R. CONTROLS

1. Manual Dimming Switches
  - a. Dimming switch must be compatible with ballast.
  - b. A separate on and off illuminated switch shall be provided on device.
  - c. Preset light level setting shall be provided on device.
  - d. Device shall fit in a single-gang wall box.
  - e. Device shall operate ballast on a 0.5 to 10 VDC signal.
  - f. Device shall be available for 120 or 277 VAC.
  - g. Device shall be UL listed.
2. Interface between Mechanical and Electrical Equipment.
  - a. The following schedule is suggested for the division of Mechanical and Electrical subcontractor responsibilities. Architect is free to change it to suit specific project conditions. It is suggested that the identical schedule appear in both the Mechanical and Electrical divisions of the specifications:

Item	Furnished By	Set By	Power Wiring	Control Wiring
Equipment Motors	MC	MC	EC	
Motor Starter & Overload Heaters	MC	EC	EC	MC
Fused & Unfused Disconnect Switches, Thermal Overload, and Heaters	EC	EC	EC	
Manual Operating & Speed Switches	MC	EC	EC	EC
Control Relays and Transformers	MC	MC	EC	MC
Line Voltage Thermostats and Time Switches	MC	MC	EC	MC
Low Voltage Thermostats	MC	MC	MC	MC
Temperature Control Panel	MC	MC	EC	MC
Motor & Solenoid Valves, Damper Motor, PE & EP Switches	MC	MC		MC
Pushbutton Station & Pilot Lights	MC	MC		MC
Temporary Heating Connections	MC	MC	EC	MC
Refrigeration Cycle Controls	MC	MC	EC	MC
Duct Mounted Fire & Smoke Detectors	MC	MC	EC	MC/EC

MC= Mechanical Contractor

EC = Electrical Contractor

\*Motor interlock by MC – Fire alarm system interconnection by EC

b. HVAC Equipment Installation

- i. All starters shall be furnished by Mechanical Contractor and shall be complete with OL heaters conforming to NEC and NEMA requirements.
- ii. Provide rain-tight switches for units on roofs.
- iii. Control relays and transformers furnished by MC except where electrical specifications and/or drawings state otherwise.
- iv. EC shall refer to mechanical specifications and plans for power and control wiring and advise Architect of discrepancies prior to bidding. EC shall be responsible for wiring as outlined, whether on mechanical or electrical drawings and specifications. No extras allowed for Contractor's failure to provide for items on mechanical drawings or specifications.
- v. Exhaust fans: Furnish and install circuits, feeders, disconnect switches, and make all connections to motors and controls. Furnish two-pole switches where controlled in combination with lighting.
- vi. Provide one duplex receptacle (WP) adjacent to roof-mounted equipment, within 50' radius. Provide conduit and wire to nearest available 120V circuit as required.

3. Motors.

All motors furnished under Division 16 shall be single phase, 120V when less than ½ HP and shall be 240/480V three phase for ½ HP and larger, unless specifically noted otherwise.

S. COMPLETION, TESTS, INSTRUCTIONS

1. Completion.

- a. Clean all electrical equipment and accessories.
- b. Test all systems and place in proper work order prior to demonstrating systems to Owner.
- c. Perform tests required by authorities having jurisdiction.
- d. Instruct Owner's representative(s), on the proper operation and maintenance of the electrical systems.

2. Operating and Acceptance Tests.

- a. After the installation is completed, the following operating and acceptance tests shall be performed in the presence of the Owner's representative, who shall observe the testing procedure. This observer shall witness the test readings and procedures and so indicate on the test report. The Contractor shall prepare a brief test report indicating the values of all test readings, where measured, together with any other pertinent information. They shall send three (3) copies of the test report to the Architect/Engineer and if acceptable the Architect/Engineer will forward two (2) signed copies to the Colorado Springs School District 11 Facilities Office.
- b. The Contractor shall arrange for and furnish all equipment, instruments and personnel required for the operating and acceptance tests outlined below.
  - i. With all equipment and lighting turned on (insofar as is practicable) take load measurements at the main service and for all feeders leaving the main distribution panelboard and record these phase by phase.
  - ii. Perform an insulation resistance test on all feeders leaving the main distribution switchboard. All readings shall be within the requirements as recommended by NEC.
  - iii. Perform an insulation resistance test on all phase bussing within the main switchboard with the service disconnected, with all fuses in place, the mains closed, and all outgoing feeder switches open. A 500 volt meter shall be used for this test. iv. The service ground shall be tested to demonstrate that the resistance to ground does not exceed 5 to 10 ohms recommended; NEC maximum is 25 ohms.
  - v. Load balance test the distribution system. Unbalance between phases shall not exceed 10 percent with full lighting and mechanical loads. Correct any unbalanced load conditions exceeding this limit. Corrections shall be indicated on record drawings.
  - vi. Conduct a careful visual inspection of switchboard bus structure and cable connections to insure that factory and field connections are tight. Special attention shall be given to all bus and cable connections, which must be electrically and mechanically secure.
  - vii. Include such other acceptance or operating tests as recommended by the electrical design engineer for various systems involved. viii. Include in specifications a requirement that the Contractor notify the Architect and Owner when electrical testing is scheduled.
- c. Operating and Maintenance Manuals.

- i. Make up the operating and maintenance manuals as specified and submit no later than two (2) weeks prior to the completion of the project.
- ii. Equipment described in manuals shall include the following:

Electrical Distribution Equipment

- Switchboard, panelboards
- Safety switches
- Transformers
- Contactors
- Circuit breakers
- Fuses
- Wiring devices

Lighting

- Lamps
- Ballasts
- Luminaires
- Dimmers
- Time Controls
- Low Voltage Controls

3. Communication Systems

- Intercom
- Public address
- Master-slave clock and program
- Fire alarm
- Security

4. All other electrical systems which require periodic cleaning, adjustment, service, or maintenance.

- a. Information contained in the operation and maintenance manuals shall consist of catalog data on each item, together with parts lists, wiring diagrams, description of routine maintenance required, suggested frequency of maintenance and recommended replacement parts operation, and maintenance manuals shall be 8-1/2" x 11" size.
- b. Submit one copy of the manual to the Engineer for review prior to preparation of final copies. After review, make changes as noted and prepare three (3) final copies of manual to be turned over to the Owner and Engineer.
- c. This contract will not be considered completed nor will final payment be made until all specified material, including test reports, is received in this operating and maintenance report and the manual is approved by the Engineer.

T. CONTRACT CLOSEOUT REQUIREMENTS

Refer to Division one (1) of the CSSD #11 Design and Construction Standards and to the project-specific Request for Proposal (RFP) or other form of Contract Solicitation issued by DISTRICT 11 for specific requirements for preparation and provision of Operation and Maintenance Manuals, Project Record Documents, Warranties, and other required contract closeout documentation.

**<<<<END OF DIVISION 16>>>>**